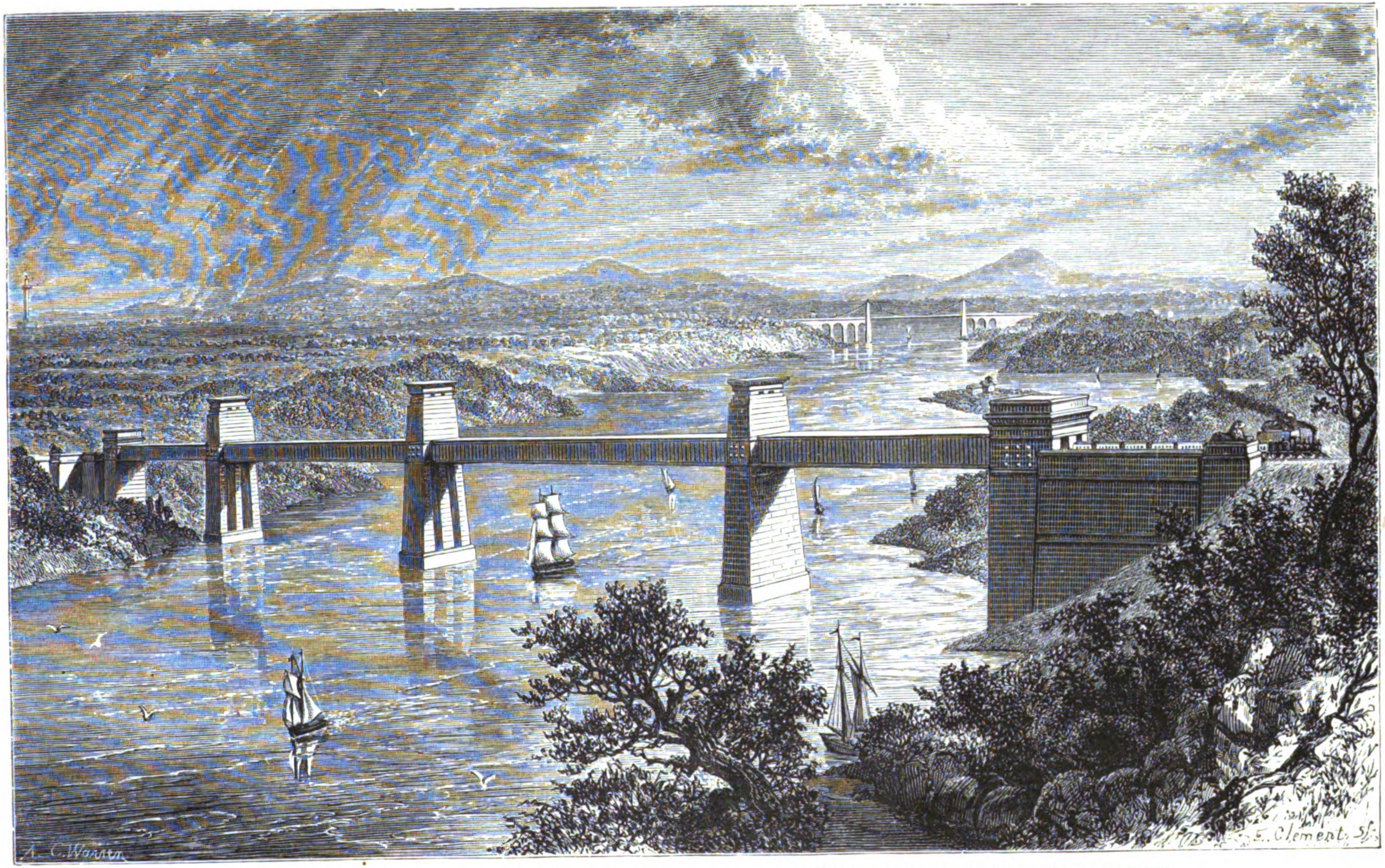

BRITANNIA TUBULAR BRIDGE ACROSS THE MENAI STRAITS, VIEWED FROM THE CAERNARVON SIDE.

PLATE LXXII. TELFORD'S SUSPENSION BRIDGE AND THE MARQUIS OF ANGLESEA'S COLUMN IN THE DISTANCE. See page 2646

KNIGHT'S

AMERICAN MECHANICAL DICTIONARY.

A DESCRIPTION OF TOOLS, INSTRUMENTS, MACHINES, PROCESSES, AND ENGINEERING; HISTORY OF INVENTIONS; GENERAL TECHNOLOGICAL VOCABULARY;

AND

DIGEST OF MECHANICAL APPLIANCES IN SCIENCE AND THE ARTS.

By EDWARD H. KNIGHT,
CIVIL AND MECHANICAL ENGINEER, ETC.

Illustrated
WITH UPWARDS OF SEVEN THOUSAND ENGRAVINGS.

VOLUME III. — REA–ZYM.

"Thus Time brings all things, one by one, to sight,
And Skill evolves them into perfect light." — LUCRETIUS, Book V.

First Steam Engine.

NEW YORK:
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LIST OF FULL-PAGE PLATES.

Vol. III.

quired to be removed in sharpening. *a b* show the most ordinary forms; each is ground transversely, the former on a wheel of 12, and the latter on one of 4 inches diameter.

In some cases, as *c*, the blade is ground longitudinally, giving it a thinner edge; these are termed *rattlers* by the Sheffield cutlers in consequence of their tendency to vibrate when shaving a heavy beard. Others (*d*) are ground in both ways. These are called *half-rattlers*. *e* is formed by setting the blade in a backing. *f* has a brass frame or guard to prevent persons whose hands are tremulous from accidentally cutting themselves. It is called a guard-razor.

Ra'zor-pa'per. Smooth, unsized paper, one side of which is treated with a composition of crocus and flour-emery in powder. It is used to wipe the razor, and is intended as a substitute for the strop.

Ra'zor-strop. An implement for sharpening razors or other thin-edged tools. It usually has a handle and a case for receiving it when not in use. Some kinds have but two abrading surfaces, — that to which the razor is first applied, consisting of leather thinly coated with fine emery-powder; and the second, by which keenness of edge is finally imparted, of leather alone. Others have four sides, coated respectively with a hard composition and with leather of different degrees of fineness, to which the razor is successively applied.

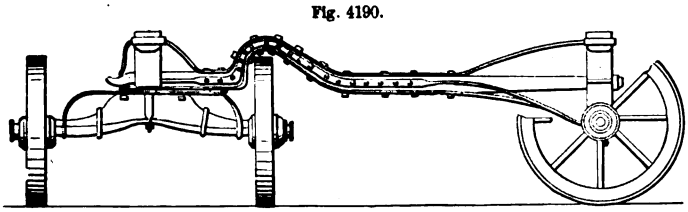
Barbers keep their razors in order after being once *set* by rubbing on a leathern strap suspended by one end, and held by the other.

Reach. 1. (*Vehicle.*) A pole connecting the rear axle to the *bolster* of a road-wagon. A *coupling-pole.*

Some modern carriages have none, the *bed* or body performing that duty.

A reach for a certain description of city wagon is shown in Fig. 4190. It is arched in front, so that the fore wheels may pass under it, enabling the vehicle to be turned in a shorter space. The circular sway-bar is extended, so as to support the reach when turned in any position.

Fig. 4190.

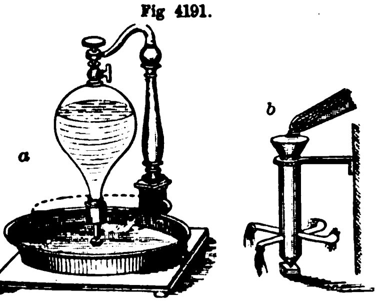


Wagon-Reach.

2. (*Hydraulic Engineering.*) That portion of a canal between two locks having a uniform level. Also called a *pond.* *Locks, lifts, inclines, slides,* or *sluices* connect *reaches* of different levels.

Re-ac'tion Wa'ter-wheel. A wheel to which a rotary motion is imparted by the action of streams of water issuing tangentially from its sides under the pressure of a head of water entering it from above. The principle, which is that of recoil, is embodied in *Barker's mill* and in the turbine. It differs in nothing from Hero's Æolipile, except that in the latter steam under pressure is the motor. Reaction water-wheels are made single or double, the latter having two on a single shaft. One form has radial buckets on which the water confined in a vertical chute impinges (see FLUTTER-WHEEL) and then escapes at the ends through wheels on the reaction principle. This form has a horizontal axis. See also TURBINE.

Fig 4191.



Reaction Water-Wheels.

The motive power exerted by liquids escaping horizontally is illustrated by a device called the hydraulic tourniquet (Fig. 4191), consisting of a vessel pivoted at its upper and lower extremities and having two pipes at bottom whose ends are bent in opposite directions. On filling the vessel with water, it escapes through these tubes, causing the vessel to revolve on its axis.

Perley and Pattee's saw-mill, at the Chaudière Falls, Ottawa River, Canada, has 6 gang-saws, each driven by a Rowe reaction-wheel, 5 feet in diameter, 400 inches sectional area of discharge. The head is 14 feet, and the power of each is about 70 horses.

Read'ing-glass. A large magnifying lens, used to assist in reading, etc.

Read'y Reck'on-er. A table or an instrument for making simple calculations, as the amount of wages due a workman for a given time, etc.

Re'al Ra'di-us. (*Gearing.*) The radius of the circle touching the crests of the teeth of a cog-wheel. The radius of the *pitch-circle* is called the *geometrical radius.*

Ream. A quantity of paper of any size containing 20 quires or 480 sheets. A common practice is now to count 500 sheets to the ream.

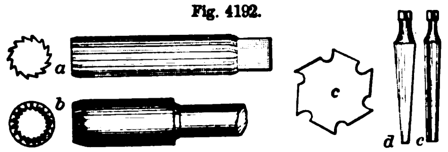
Ream'er. Sometimes, but incorrectly, written *rimmer.* A tool used to enlarge a hole and bring it to a shape the counterpart of the tool, whether cylindrical or tapering.

Broaches are *reamers,* being multiple-sided taper rods, whose angles cut the sides of the holes in which they are rotated. See BROACH.

The reamer is used in *truing* or rounding the holes made by a rock-drill.

As a machinist's tool (*a b*), it is fluted and slightly tapering; the blades being worked out of the solid metal by planing or milling on a machine. The flutes are then *backed off* like a *tap* to give a saliency to the cutting-edge.

Fig. 4192.

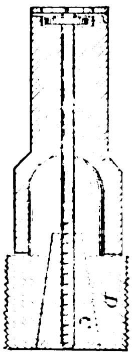


Reamers.

Instead of mere longitudinal fluting, the grooves in the tool may be made spiral, a right and a left hand, crossing obliquely so as to leave the surface in diamond-shaped portions. The flutings are then planed out and backed off, the result being a toothed reamer *c* of effective character.

The flat-sided reamers, such as *d e*, triangles, squares, and pentagons, are properly termed *broaches.*

Fig. 4193.



Expanding Tap and Reamer.

Tools to be driven through a hole are DRIFTS (which see).

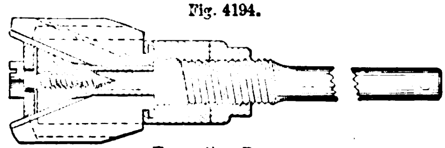
Half-round reamers are used in braces to enlarge holes in sheet-metal or small castings.

A revolving tool which cuts one size as it goes is a *drill*. A *reamer* is a cutting tool for enlarging a hole, and should enter the hole a piece before it begins to cut, so as to work steadily and straightly. This is not descriptive of the action of a drill, even though employed to enlarge an opening, as the *cored-out* hole in a casting.

In Fig. 4193, the cutters *D* are made in sections, having dovetail projections fitting grooves in the conical plug *C*, which is drawn upwardly so as to expand the tool radially to cut a dovetailed or undercut recess.

In Fig. 4194, the cutters are moved longitudinally by connection with a nut on the shank, and are

Fig. 4194.

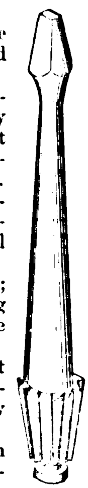


Expanding Reamer.

driven outward in their guide-slots by the conical end of the shank.

Ream'ing-bit. A broach of hardened steel having a taper form and angular cutting-edges. See BIT.

Fig. 4195.



Reaming-Bit.

Fig. 4195 has a guide at the end of the reamer to fit the hold to be enlarged and maintain the reamer in central position.

It is used for boring out truly or enlarging a hole commenced by a bit of ordinary construction. It has usually a shank about as large as the hole made by its cutting-face, to insure the straightness of the hole. Frequently, it has cutting-edges on its cylindrical portion, and acts to dress off irregularities and make a perfectly cylindrical opening.

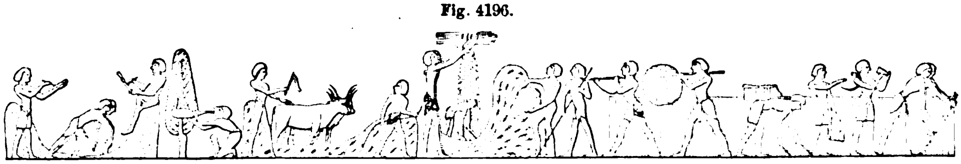
Reaming-bits are used in drilling metal; also in dressing to roundness and enlarging the size of holes bored by rock-drills. See REAMER.

Ream'ing-i'ron. (*Calking.*) A blunt chisel used for opening the seams between the planking of a ship preparatory to calking them with oakum.

Reap'er. A machine for cutting grain in the field. Wheat and barley were commonly cultivated in ancient Egypt. The former was cut in five months after sowing, the latter in four. The wheat was bearded, and generally cut below the ear, as in the annexed figure. It was cut with a smooth-edged or a toothed sickle. Both are represented in the tombs, and illustrations are given in this work under the caption SICKLE.

The whole series of harvesting and thrashing operations are shown in the accompanying illustration, which is from a tomb at Thebes of the probable date of 1490 B. C. The condition of the standing wheat

Fig. 4196.

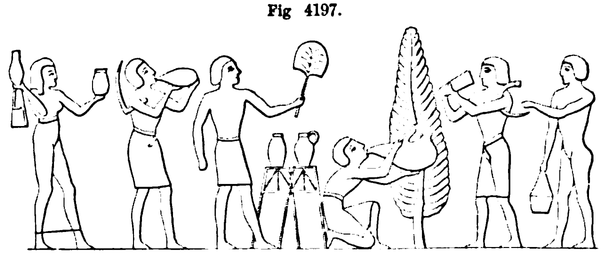


Harvest Scene (Thebes, 1490 B. C.).

shows that it was cut below the ear. Two men are working together, and, according to the then usual mode of representing such things, the motions of the parties are exactly simultaneous. The next man is taking a drink, sickle over his shoulder, in a manner quite customary among us, at this distance of thirty-three centuries. The man behind him is probably a gleaner, and urges him to hurry, as he too wants a drink. Next is shown a gleaner with his basket slung upon his back. He picks up the scattering ears and jerks them into his basket, like the chiffonier of Paris with his rags. We next see two men with a rope basket, carrying the ears from the field to the heap where they are tramped by cattle; a man tending with a whip and another throwing in the ears with a three-pronged fork. Then comes the winnowing; men with scoops lift the grain and chaff, throwing them up in the air, that the wind may blow away the chaff. By this time all parties are dry, and here is a kid-skin bottle hanging in the tree and a dusty Copt taking a pull at it. The next scene is at the grain-heap, where two scribes keep tally, — one, of the amount brought from the winnowing-floor, and the other of the amount sent to the granary.

Another harvest scene from the tombs is worth noticing in this connection, though the part selected is more specific in the refreshment line than in the work performed. In Egypt, as with us, the cool drink at the end of the row was not the least pleasant part of the day's experiences, but they could not rest in the shady fence-corner for lack of the trees and the fences. In the drawing, one tree lends its welcome shade, and to a limb is hung the kid-skin bottle at which the "fellah" is sucking. On the stand are two jars waited on by another "fellah" with a flabella, — call it a fly-brush. A thirsty man is devoting himself to a bottle, and a female comes up with a fresh supply. Another reaper, sickle on

Fig 4197.

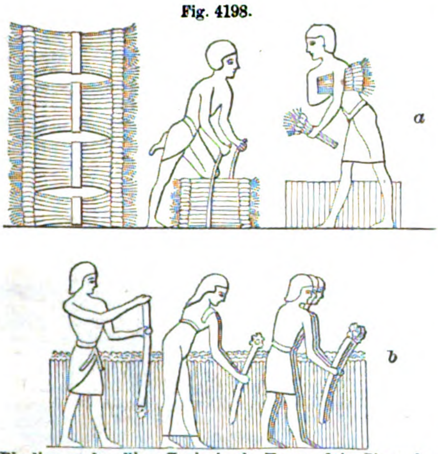


Harvest Scene (Time of Moses).

his shoulder, has a cup, and a poor, naked gleaner with his baskets puts in a claim for a drink.

While, as has been stated, it was common to reap the standing grain just below the ears, we also find two other modes, and they were also practiced in Gaul in the time of Pliny, 1,500 years afterward. One was to cut low and bind in sheaves, and the other to pull up by the roots. The figures represent these two scenes. The last-mentioned mode

Fig. 4198.



Binding and pulling Grain in the Egypt of the Pharaohs.

was practiced with the millet, doura, or whatever it was, — Wilkinson says *sorghum*. This was pulled, bound in sheaves, and carried to a place where the grain was stripped from the stalk by a man who drew it, a bunch at a time, over a comb or hackle. The operation is illustrated in a tomb at Eilethyas. The same instrument is now used for removing the capsules and seed from the flax-plant. It is called a *ripple*. See RIPPLE.

This *stripper* is probably like the *paddle-fork* mentioned by Pliny.

The references in the Bible to reaping and to the sickle wherewith it was cut are frequent, but add nothing to the perspicuity of the Egyptian paintings.

Coming down to early classic periods, so called, we find that the Greeks added nothing and the Romans little to the crude old mode of cutting grain by the curved sickle of Egypt.

Varro describes three modes of reaping as common in Italy: —

1. Cut low by a hook, the ears being afterward cut off and sent in baskets to the granary.
2. Cut off below the head by a toothed sickle, and the heads carried off in baskets.
3. Cut off at half the length of the straw.

In the first century of the Christian era we hear from Gaul. Says Pliny (A. D. 70): —

"The mode of getting in the harvest varies considerably. In the vast domains of the provinces of Gaul, a large hollow frame, armed with teeth and supported on two wheels, is driven through the standing grain, the beasts being yoked behind it (*in contrarium juncto*); the result being that the ears are torn off and fall within the frame. In other countries the stalks are cut with the sickle in the middle, and the ears are separated by means of paddle-forks."

The accompanying cut is a good restoration of the Gallic harvester of Pliny's day. Palladius wrote the *De re rustica* in the fourth century A. D., and gives a good description of this contrivance, which was similar to our "heading-machines," having a row of sharp teeth at the front edge, between which the straw passed, the head being torn off at the angle where the teeth met, and falling into the box of the machine.

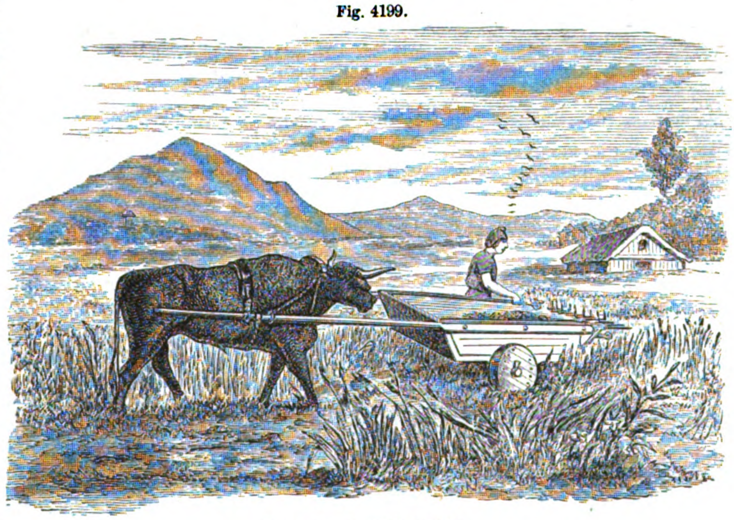
The description of Palladius is as follows: —

"In the plains of Gaul, they use this quick way of reaping, and without reapers cut large fields with an ox in one day. For this purpose a machine is made, carried upon two wheels; the square surface has boards erected at the side, which, sloping outward, make a wider space above; the board on the fore part is lower than the others; upon it there are a great many small teeth, wide set in a row, answering to the hight of the ears of the corn, and turned upward at the ends; on the back part of this machine two short shafts are fixed, like the poles of a litter; to these an ox is yoked, with his head to the machine, and the yoke and traces likewise turned the contrary way: he is well trained, and does not go faster than he is driven. When this machine is pushed through the standing corn, all the ears are comprehended by the teeth, and heaped up in the hollow part of it, being cut off from the straw, which is left behind; the driver setting it higher or lower, as he finds it necessary; and thus, by a few goings and returnings, the whole field is reaped. This machine does very well in plain and smooth fields, and in places where there is no necessity for feeding with straw."

After the lapse of fourteen centuries this machine has been reinvented, and is now used as a *header* for gathering clover-seed. See Figs. 1346, 2465.

The separation of the ears from the grain in the sheaf, mentioned above as being performed by paddle-forks, was probably done by drawing the bunches of grain over a paddle whose end

Fig. 4199.



Reaper in Gaul (*A. D.* 70).

was deeply notched and the teeth sharpened. The motion would be something like that of hackling hemp, and the ears would be speedily removed by this means. The object in saving the wheat, etc., in the head instead of in the sheaf, was probably to economize mow room. When stored in the ear instead of being first thrashed, it was as a precaution against weevil. Some have interpreted the passage of Pliny to refer to a comb of similar character, which caught the ears of the standing grain and tore them off or held them while they were beaten off by a paddle. This reminds one of the still simpler plan of the Northern Indians of Minnesota and Canada, who collect their store

of wild rice by leaning the heads over the side of the canoe and beating out the grain.

The above plans of heading the grain leave the straw in the field, which is a merit or otherwise, according to the circumstances of the case, — location, market, and mode of farming.

It would be absurd to overlook the different circumstances of Minnesota and Middlesex, which determine the question of economy. Pliny well says: —

"The diversity of the methods employed in harvesting mainly depends upon the extent of the crops and the price of labor."

The modern era of reaping-machines commences with the latter portion of the last century. The names of those who made the earliest attempts should be preserved, for in this, as in almost all similar cases, it was after a succession of earnest attempts by different parties that the desired success was achieved. Each great invention that has blessed us in modern times has been fought over. Witness steam-engines, steam navigation, photography, reaping-machines, and the electric telegraph. Most of those who worked at these problems added somewhat to the eventual success, and we may surely consider the matter with amiability and try to avoid acrimony.

The first modern machine resembled the old Gallic implement, in the respect that it stripped the head from the straw. The English machine of Pitt, in 1786, had a cylinder on which were rows of *combs* or *ripples*, which tore off the ears and discharged them into the box of the machine. For about two-score years attention was principally directed to revolving cutters or systems of revolving blades.

The motion of the cutting apparatus being derived from the rotary motion of the wheels supporting the implement, it naturally occurred to connect the axle or wheel with a rotary cutter, and later with an oscillating one, which had its analogues in the swing of the scythe and the reach of the sickle. A few attempts were made at a reciprocating knife, but they were scarcely heeded, and probably never made. The first reciprocating knife was in 1822.

As to the mode of attaching the horses, it was almost universally deemed necessary to hitch them behind the implement, which they pushed before them. Up to 1823 but four inventors hitched the team in front of the implement: one was in 1806; the others in 1820, 1822, 1823.

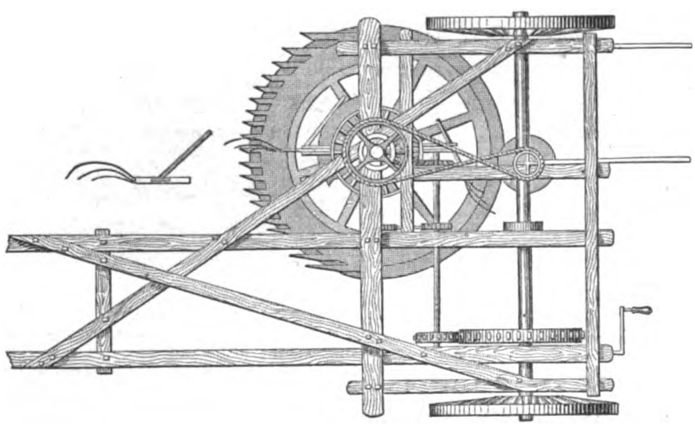
As soon as this idea did occur to the inventors, they made the horse walk alongside the swath, cut by the knives, constituting what is known as the *side cut*.

1799. Boyce had a vertical shaft with *six rotating scythes* beneath the frame of the implement. This was the first patented reaper.

1800. Meares tried to adopt *shears*.

1805. Plucknett introduced a *horizontal rotating circular blade*. He had a score of followers, and the first machine used

Fig. 4200.



Gladstone's Reaping-Machine (1806).

in this country, and patented by Bailey (Fig. 4200) in 1822, was of this character. Two machines by Smith, of Deanstone, in England, in 1811, and Scott, of Ormiston, in 1815, were made on this principle, were used practically, and had considerable local celebrity. Smith's machine was illustrated in "Hall's Dictionary," in 3 vols., folio, 1811.

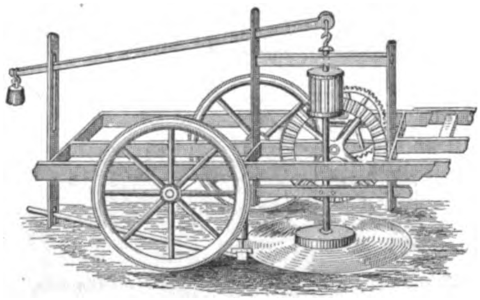
1806. Gladstone patented his *front-draft*, *side-cut*, revolving-knife machine. A segment *bar with fingers* gathered the grain and held the straw while the knife cut it, the fingers having the function of shear-blades. The forward draft was also adopted by Mann in 1820, and by Ogle, 1822, in his reciprocating cutter-bar machine.

1807. Salmon had a machine with some new features, — a row of *vibrating knives* over *stationary blades*; *fingers* to gather the grain to the cutters; a *rake*, suspended and reciprocating sideways to carry the grain off to the side. The machine was pushed ahead of the horse, or was propelled by hand. The machine of Bell, 1826, which was brought forward to confound the American exhibitors in 1851, has the same kind of cutters, and was also propelled.

1820. Mann had revolving rakes on a vertical axis, to sweep the standing grain past the cutter, and deliver it in a swath.

1822. Ogle shows the first *reciprocating knife-bar*. It is the

Fig. 4201.



Bailey's American Mowing-Machine (1822).

type of the successful machines, but was constructed so poorly that its merits never became apparent. It was drawn by horses in *advance*; the cutter-bar *projected at the side*, and it had a *reel* to gather the grain to the cutter. The machine had a *grain-platform*, which was tilted to drop the gavel. The *first dropper*.

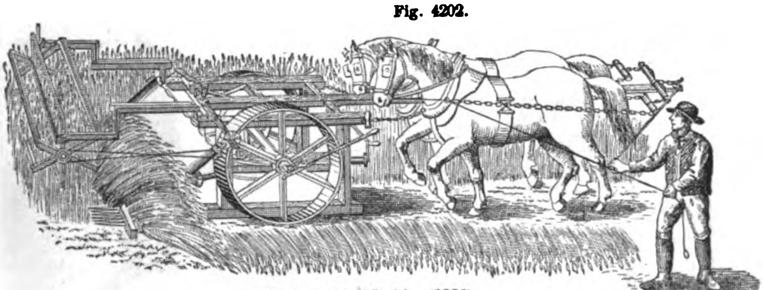
The machines previously mentioned are British. Fig. 4201 represents a self-sharpening mowing-machine, the first patented in the United States, in 1822. It has a circular revolving scythe on a vertical axis, rotated by gearing from main axle. The edge of the scythe in its revolutions passes under a whetstone fixed on an axis, and revolving with the scythe. The horse is in shafts, and *walks* in front of the left side of the machine, and always on the mowed ground after the first swath is cut. The grass, as it is cut, is first thrown by the progressive motion against a rise in the scythe-frame toward the center, and by the same motion is afterward thrown off in a regular row, following the center of the machine.

The machine of the Rev. Patrick Bell was tried at Powrie County, Forfar, Scotland, in 1828. It cut a swath of five feet with the power of a single horse, about an acre an hour. It was used again in 1829, and occasionally for a few years succeeding, then slept till 1851, when the World's Fair of 1851 in London introduced the American machines to the British public. The old Scotch machine was then brought from its limbo to challenge the American stranger.

The machine had a square frame on two wheels, which ran loose on the axle, except when clutched thereto to give motion to the cutters. The cutter-bar had fixed triangular cutters, between each of which was a movable vibrating cutter, which made a shear cut against the edges of the stationary cutter on each side. It had a reel with twelve vanes to press the grain toward the cutters, and cause it to fall upon a traveling apron which carried away the cut grain and deposited it at the side of the machine. The reel was driven by bevel-gearing.

The following machines are American: —

Fig. 4202.



Bell's Reaping-Machine (1826).

1846. Cook had a pendulous *rake swinging backwardly.*

1847. Ketchum had an endless chain cutter or *belt of knives.*

1847. Hussey's *slotted finger, open at top; knife of triangular sections.*

1848. Pease had a *grain-rake traveling sideways* beneath the platform, with slots for the fingers. Mann the same next year.

1848. Goble and Stuart had a revolving rake passing horizontally across the platform.

1849. Haines suspended the frame carrying the conveyor, reel, and cutter to the axles of the bearing-wheels, and hinged the frame to the tongue, so that it was capable of turning upon its bearings by means of a lever, to elevate and depress the cutter.

1825. Ten Eyk had a horizontal cylinder, with spiral knives cutting against straight edges. The same was shown by Budding in 1830.

1828. Samuel Lane, of Maine, combined the reaper and thrasher.

1831. Manning had a row of fingers and a reciprocating-knife. It was pushed in front of the horse.

1833. Schnebly had a horizontal endless apron traveling intermittingly, and delivering its gavel at the side.

1833. Hussey, of Maryland, made the first valuable harvester. It was patented as a mower. It had *open fingers*, the knife consisting of triangular sections reciprocating in the space, cutting shearwise against the guards. It was *front draft*, *side cut*, and had a platform. The open-top slotted finger was patented by Hussey in 1847. The cutter-bar was on a hinged frame. The raker rode on the machine.

1834. McCormick, of Virginia, patented his reaper, which, with various improvements, in 1845 and 1847 received a Council medal at the London World's Fair in 1851. This machine had a sickle-edged sectional knife, reciprocated by crank and pitman by gear connection to the drive-wheel, on which the frame rested. Spear-shaped fingers gathered the grain, which was laid over to the cutter by a revolving-reel. A *divider* was used on each end of the platform. The driver and raker had seats on the machine. The gearing and crank were placed forward of the driving-wheel.

1835. Randall had a *pair of knife-bars* reciprocating past each other. Wray, 1852, had the same.

1836. Briggs and Carpenter combined the reaper and thrasher. Moore and Haskell, the same year. Ridley, in Australia, seven years afterward, did the same, and supposed himself to be the first inventor.

Hazard Knowles, the machinist of the Washington Patent Office, invented in 1837 a reaping-machine having a scalloped reciprocating cutter; the cutting apparatus jointed to a double arm, the opposite end of which was in turn jointed to the main frame, coincident with the axis of the crank-shaft; both supporting-wheels were drivers for the cutters. It was a front-cut machine, and had a lever to raise the cutting-bar to clear stumps and other obstructions. A machine was constructed in 1838, and in 1839 was purchased by Joel Lupton, who rode upon the machine along the turnpike to his home, near Winchester, Va. The machine was used occasionally during a few of the following years, but was soon laid aside, owing to a fear of the neighbors that it would disturb the relations of labor. It was afterward purchased by one of the large firms of reaping-machine makers, who became involved in the tedious and expensive litigation which ensued when the reaper became an important article of manufacture and trade. This machine is principally curious in its anticipation of so many of the important features of the more useful machines. Like Bell's machine in its history, though far superior to the Scotch machine in mechanical structure and adaptedness, it was a conception embodied in a single machine, and became an abandoned experiment, to be brought forward when the inventions and contests of others gave it an importance. It was a machine of great possibilities, but its inventor failed to assert his rights. His position in the Patent Office prevented his becoming a patentee, and he preferred to retain his salary to embarking in the business of making machines of so novel a character. About 1863 the machine was brought forward in a patent suit. It may be presumed that it formed but another instance of the rule, that a single machine made and practically hidden away shall not be allowed to defeat a patent when a subsequent inventor has showed due diligence. It also indicates that the patent is a *quid pro quo*, an exclusive right in return for an invention adequately described on record.

1838. Wheeler had a machine with a revolving endless apron to deposit grain in a box with a sliding bottom, by which it was deposited in gavels. A *dropper.*

1840. Lamb. A platform to receive the gavels and carry the *binder*. The first hand-binder.

1841. Churchill thrashed out the grain, the heads of grain being pushed into the thrasher-cylinder.

1842. Reed discharged the grain from the bed by rake-fingers projecting through slots in platform.

In 1849, Jonathan Haines, of Illinois, invented the "header," which is the principal machine on the Pacific coast.

1849. Purviance made the platform removable, to convert the reaper into a mower.

1849. Platt's self-acting *rake sweeping over quadrantal platform*. Same feature in Palmer and Williams's and in Seymour's, 1851.

1850. Adkins's cutter-bar on *hinged frame.*

1850. Knowles and Bevington's side *dropper.*

1850. Heath's *binder*, with a reciprocating rake beneath the platform.

1851. Watson's automatic *binder.*

1851. Miller's *backwardly reciprocating rake.*

1851. Allen geared the operative parts from both wheels, to distribute the driving-power.

1852. Atkins had a rake rigged on a vertical post. It had a jointed arm which swept across the curved platform and gathered the gavel against a shield; the post, rake, and shield then turned 90° on an axis, the rake was raised, and the gavel dropped in rear of the driving apparatus.

This list is but a commencement, but brings us to a period when things became lively in this line. Since this period nearly 8,000 patents have been granted in the United States for harvesters and attachments therefor.

In the summer of 1855, at a competitive trial of reapers about 40 miles from Paris, France, three machines were exhibited, from America, England, and Algiers. The following was the result in a field of oats: —

The American machine cut an acre in.....22 minutes.
The English machine cut an acre in......66 minutes.
The Algerian machine cut an acre in......72 minutes.

In 1855, Jonathan Haines patented a machine in which the finger-bar extended across the rear end of the main frame, and was connected at each side with the front end of said frame by rods jointed at one end to the frame, and at the other to the finger-bar. The inner of these rods was a drag-bar to advance the cutting apparatus. The outer was a brace to maintain its position at right angles to the line of advance. It was supported laterally by a brace jointed at one end to the end of the finger-bar, and at the other end to the main frame at or near the axis of the crank-shaft.

In the Ball machine, shortly afterward, the drag-bar was joined rigidly to the finger-bar, and thus united drag-bar and brace in itself. The lateral brace was the same.

1856. The combined rake and reel of the "Dorsey" machine sweeping in a general horizontal direction across the quadrantal platform.

1857. Crook introduced an arrangement of driving-gears of unequal size to be used separately for changing the rapidity of vibration of the cutters.

1860. The Henderson rake, or what is known as the "Wood" machine, having a chain below the platform which carries the rake in a curved path.

1861. The Sieberling "dropper," which is a slatted platform that vibrates to discharge the gavel.

1861. Dutton inclosed the gearing in a metallic case, forming a part of the main frame.

Plate XLVI. shows three forms of the Whiteley "Champion" harvester of Springfield, Ohio. The upper figure is the mowing-machine; below it is the reaping-machine, with *dropping* arrangement, which deposits the gavel behind the cutter-bar; the lower figure is the self-raking reaper.

The reaping and automatic binding-machine of S. D. Locke, of Hoosick Falls, N. Y., made by Walter A. Wood of that place, and shown in Plate LI., is believed to have overcome the difficulties of the

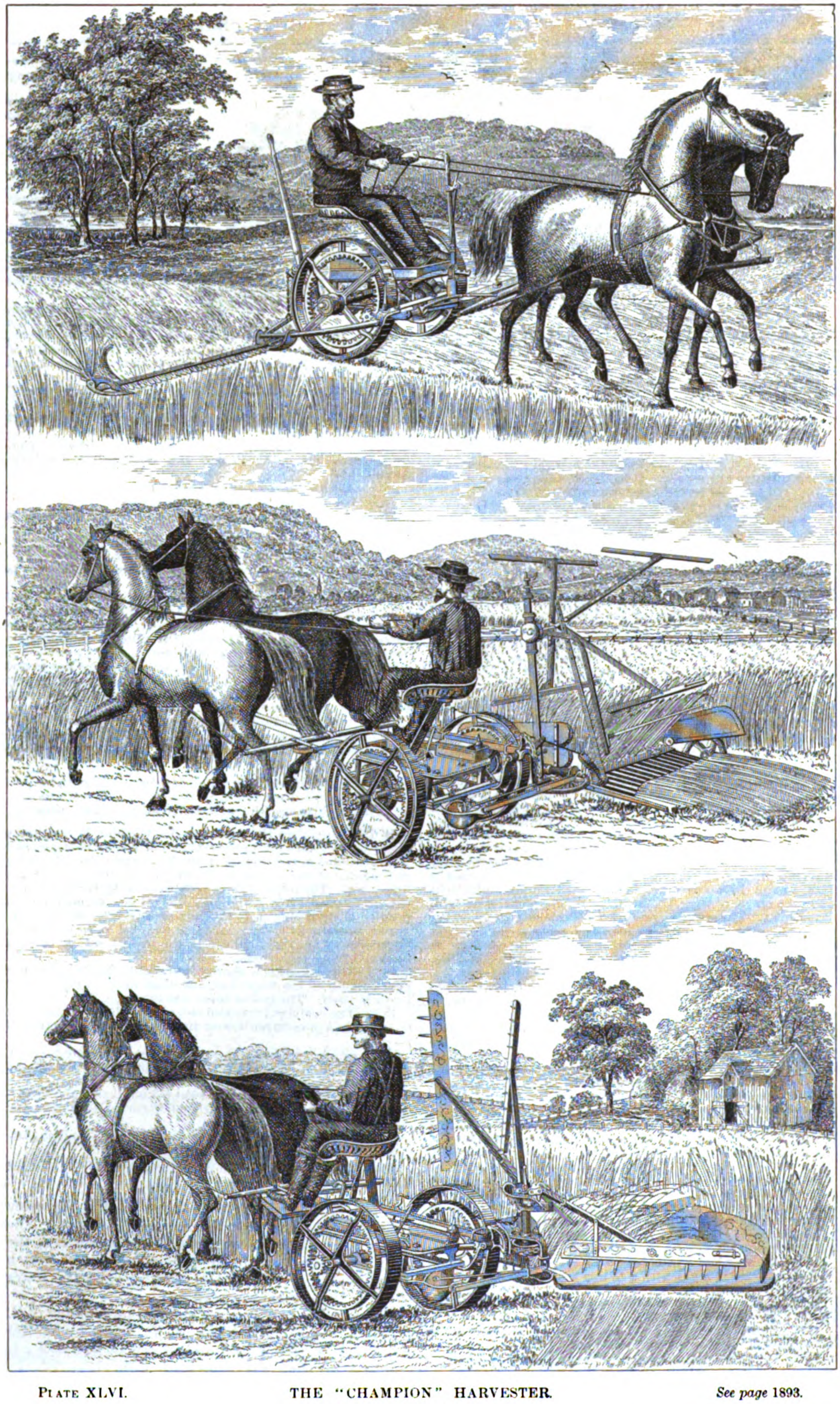


PLATE XLVI. THE "CHAMPION" HARVESTER. See page 1893.

As a Mower: a Dropper: a Self-Raker.

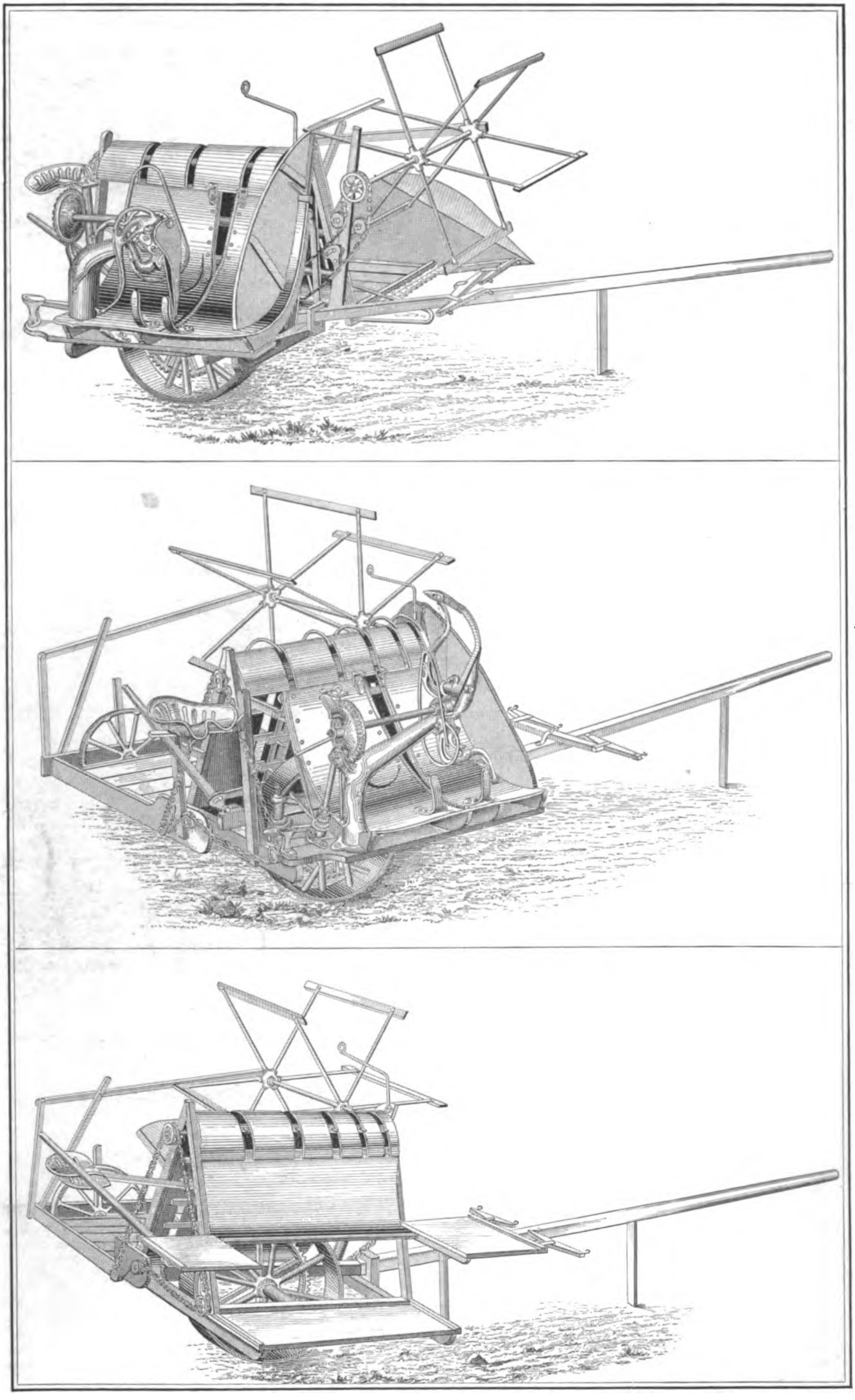
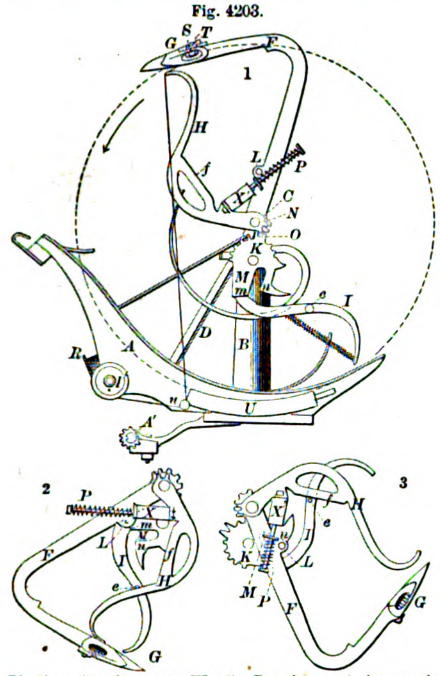


PLATE LI. SYLVANUS D. LOCKE'S HARVESTER AND BINDER. *See page* 1893.

(*Machine of* 1874. WALTER A. WOOD, *Manufacturer.*)

Fig. 4203.



Binding Attachment to Wood's Reaping and Automatic Binding-Machine.

binding problem, after persistent attempts for twelve years past. Some of the machines were sent into the harvest-fields the past summer (1874), and a thousand will probably go out next season.

The grain, as it is cut, falls upon a continuously moving, side-delivery, elevating carrier, and is delivered into the cradle or receptacle *A* of the binder, the operative mechanism of which comprises a right arm *F*, which carries the head *G* with the end of the binding wire and the twisting device, and a compressing arm *H*, both rotating upon a common axis above the cradle, and a vibrating left arm *I*, moving upon an axis parallel with the axis of the arm *F*.

The arm *I* is vibrated by the rotation of the arm *F*; in one direction by segment-gear teeth, and in the other direction by a cam and pin.

The motive power is derived from the driving-wheel of the reaper, and is transmitted to the binding arms through a series of shafts with connecting gear-wheels, supported by a crane-post *B*; a treadle-clutch serves to gear or ungear the binding mechanism at will. The binding-wire is supplied from a reel *R* mounted beneath the cradle *A*, and its feed is controlled by a spring take-up and tension *I'*.

The end of the binding-wire is held by a nipper at *T*, and from thence passes down through a slit in head *G*, between the leaves of a pinion *S* contained in said head, and thence over the extremity of arm *H* down to the guide-pulley *u* and to the reel.

The rotation of arm *F*, from the position shown in Fig. 1, is accompanied by a movement of the arm *I* in an opposite direction, to bundle, compress, and hold the straw between the arms *H* and *I* (as shown at 2), while the head *G* is conveying the binding-wire completely around it and fastening the ends. The arm *I* then relaxes its pressure, and the bound sheaf is discharged (3). The running and standing parts of the wire are brought together beneath the sheaf by the passage of the head G close to the guide-pulley *u*, whereby the standing part is led into the mouth of the head *G* and between the leaves of the pulley *S* on the side opposite to the end of the wire; at the next moment the head *G* strikes into the rack-box *U*, and the gripper at *T* is caused to open and release the end of the wire, and immediately close again, severing the standing wire outside of the pinion *S* and gripping the new end. The pinion *S* is immediately thereafter caused to revolve by engaging with the rack *U*, to twist together the ends of the wire and complete the band.

In addition to the above general movements may be mentioned the following: When the arm *F* has nearly reached the position shown in Fig. 1, the long teeth *O* engage with the corresponding teeth *N* and advance the arm *H* more rapidly than the arm *F*. This pushes the wire forward, and ensures its engagement with the pinion *S*. When the arm *H* recovers its position by the action of the spring *P*, the wire is retained in engagement with the pinion *S* by a ledge or stop on the under side of the head *G*. The spring *X'* permits the arm *H* to compress the sheaf with an elastic pressure The arms *H* and *I* continue to approach each other until their segment-gears disengage, when the movement of the arm *I* becomes coincident with the movement of arm *F* (2). This is ensured by the engagement of the pin *L* with the shoulder *m* and slot *M*. When the pin *L* reaches the bottom of the slot and impinges against its front side *n*, the arm *I* is advanced faster than the arm *F*, and the sheaf is thereby released (3). The final discharge is facilitated by the engagement of the pin *e* with the cam-surface *f*, whereby the compressor *H* is caused to advance faster than the arm *F* and discharge the sheaf from the machine.

This apparatus is constructed so as to be easily removed from the reaper, either to facilitate transportation, or to permit its place to be occupied by a platform and stand for hand-binders. It is also constructed so that the removal of the arm *I* and some slight changes in other parts of the apparatus enable it to discharge the grain in unbound gavels as a dropper

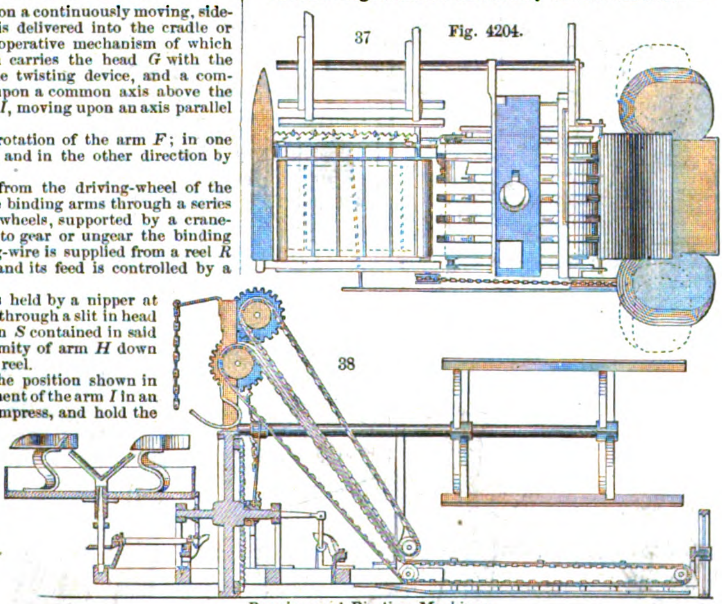
Plate LI shows the machine as a binder in two positions, and also as a hand-binder. In the latter case the two men stand upon the platform and alternately take the gavels from the cradle in which the grain accumulates as it falls down the incline. Each turns to his own binding-table, fastens his band, tips the sheaf off into the stubble, and then turns to gather another gavel.

Among the successful binders must also be noticed that of James F. Gordon, of Rochester, New York. See his patents of August 27, 1872; June 16, 1874; June 30, 1874. Speaking in general terms, his machine has an elevated side delivery, by means of a traveling apron, the grain slides down an incline till arrested by a revolving gaveler, and lies in the bight of the binding-wire. The end of the binding-arm is thrown forward into the twister, carrying the wire around the gavel: the binder-frame then reciprocates, the band is twisted, followed by the cutting of the wire, unclosing of the binder-arm, and dropping of the sheaf.

Barta's self-binder (1871) has also worked successfully in the field. It uses cord, makes a square knot, and binds a gavel of any size, even no larger than the arm.

The following automatic binders may also be consulted: —

Fig. 4204.



Reaping and Binding Machines.

Bowron, January 16, 1872, cord band, secured by wire.
Carpenter, December 22, 1868, wire.
Clinton, July 13, 1869, cord.
Chapman, May 7, 1872, wire.
Fowler, June 7, 1870, stitches woven from gavel.
Withington, February 20, 1872, two wires.
Whitney, May 26, 1874, wire.

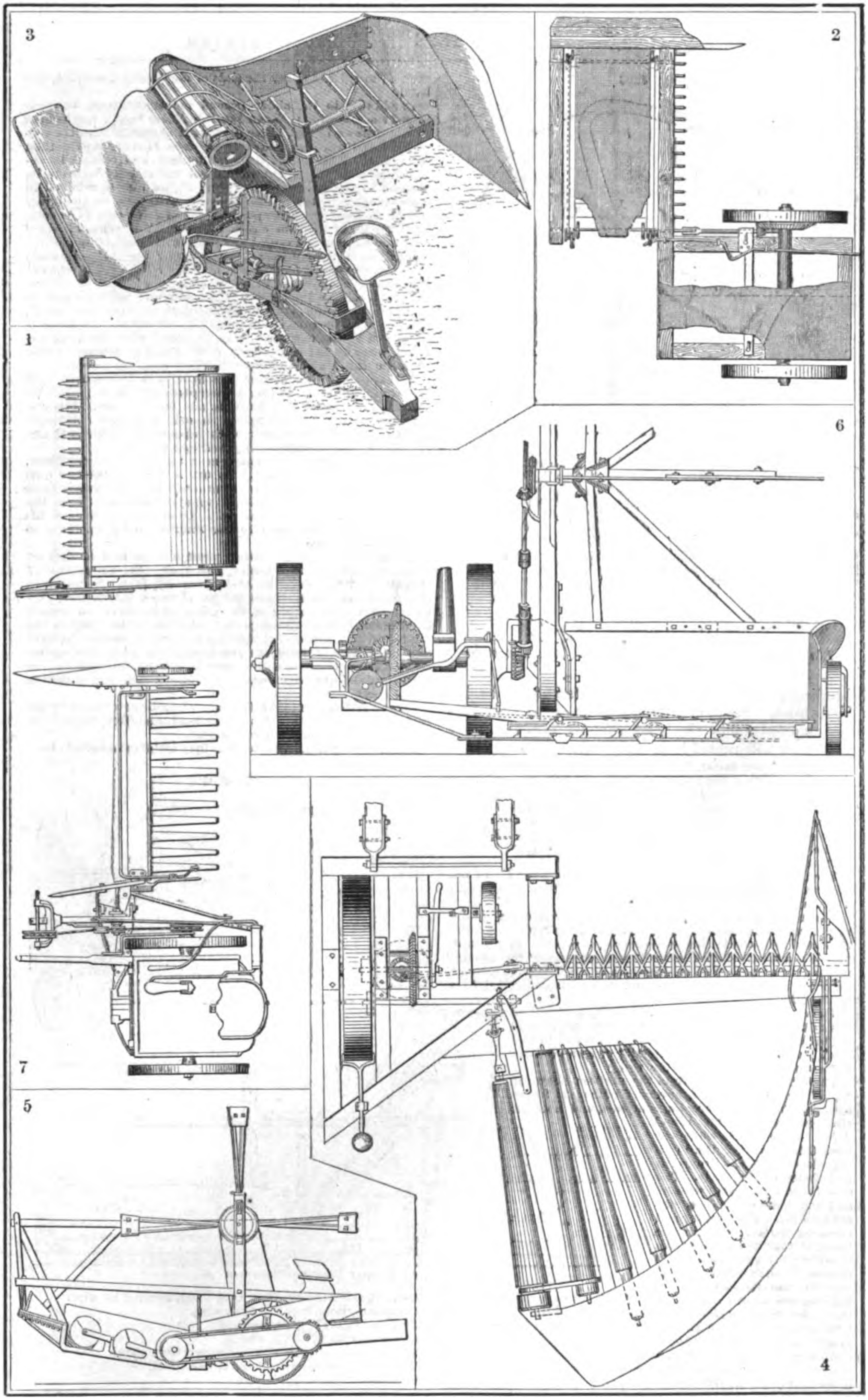


PLATE XLVII.

REAPING MACHINES.

(Principles of Action.)

See page 1893.

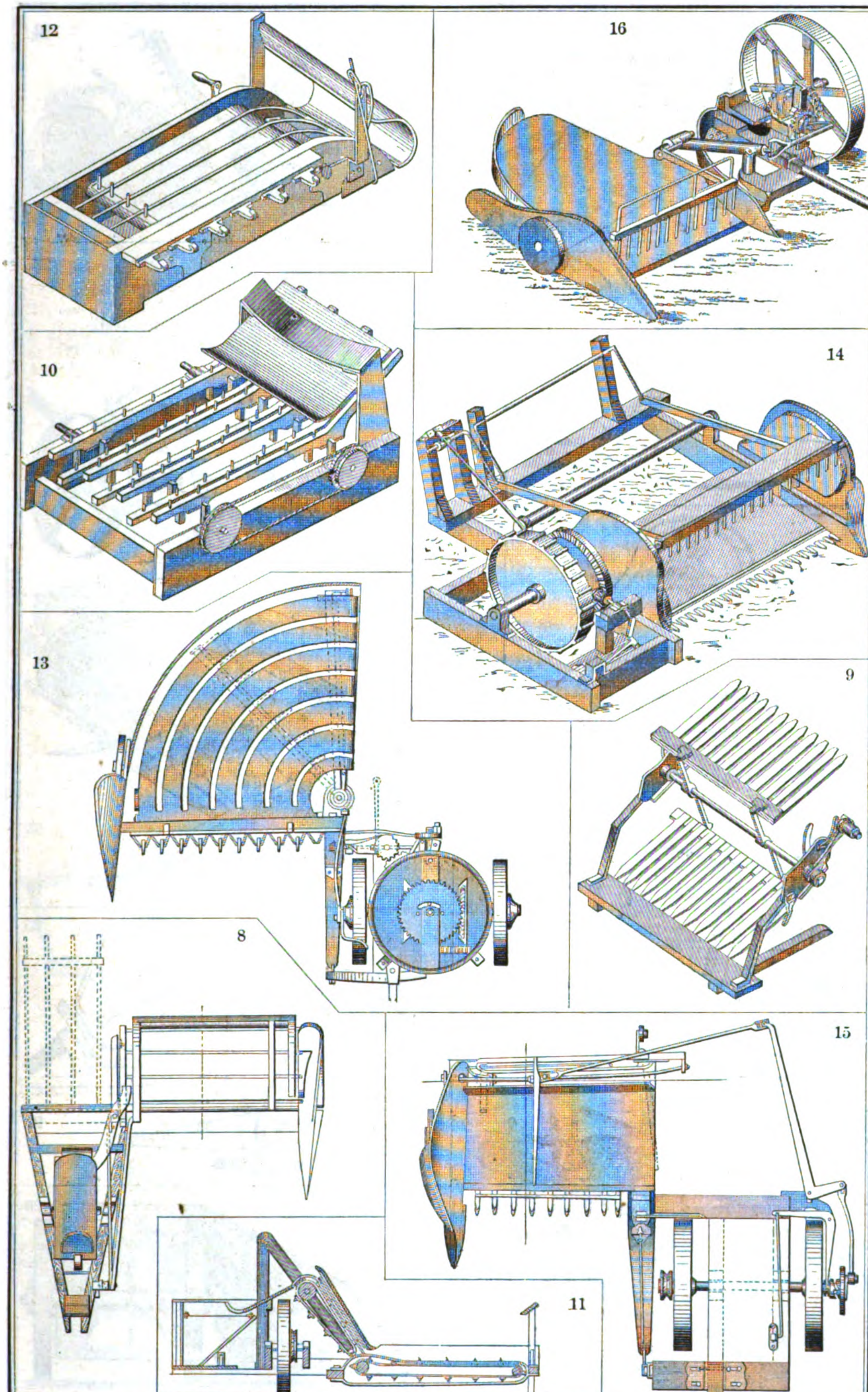
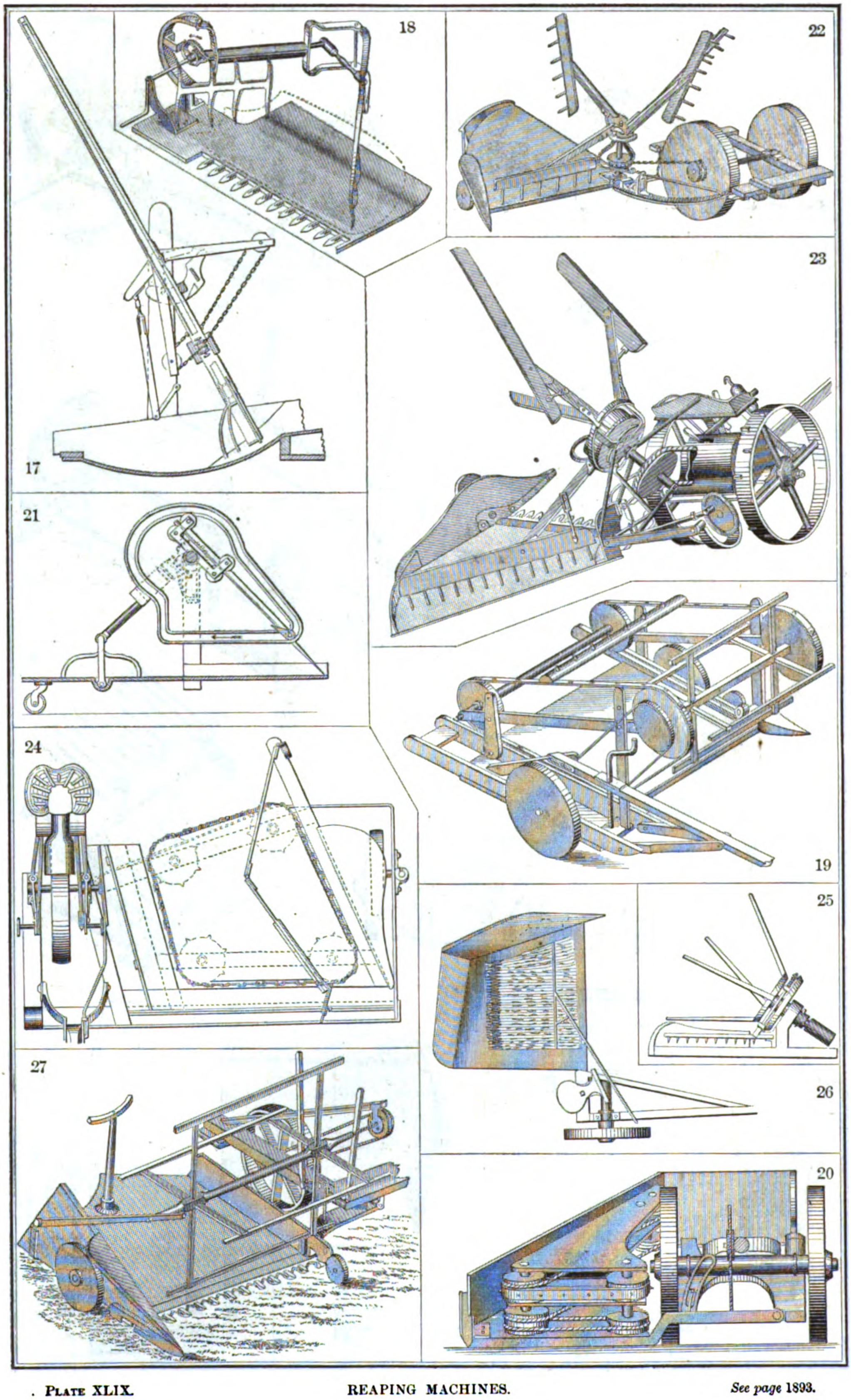


PLATE XLVIII. **REAPING MACHINES.** *(Principles of Action.)* *See page 1893.*



. PLATE XLIX. REAPING MACHINES. See page 1893.

(*Principles of Action.*)

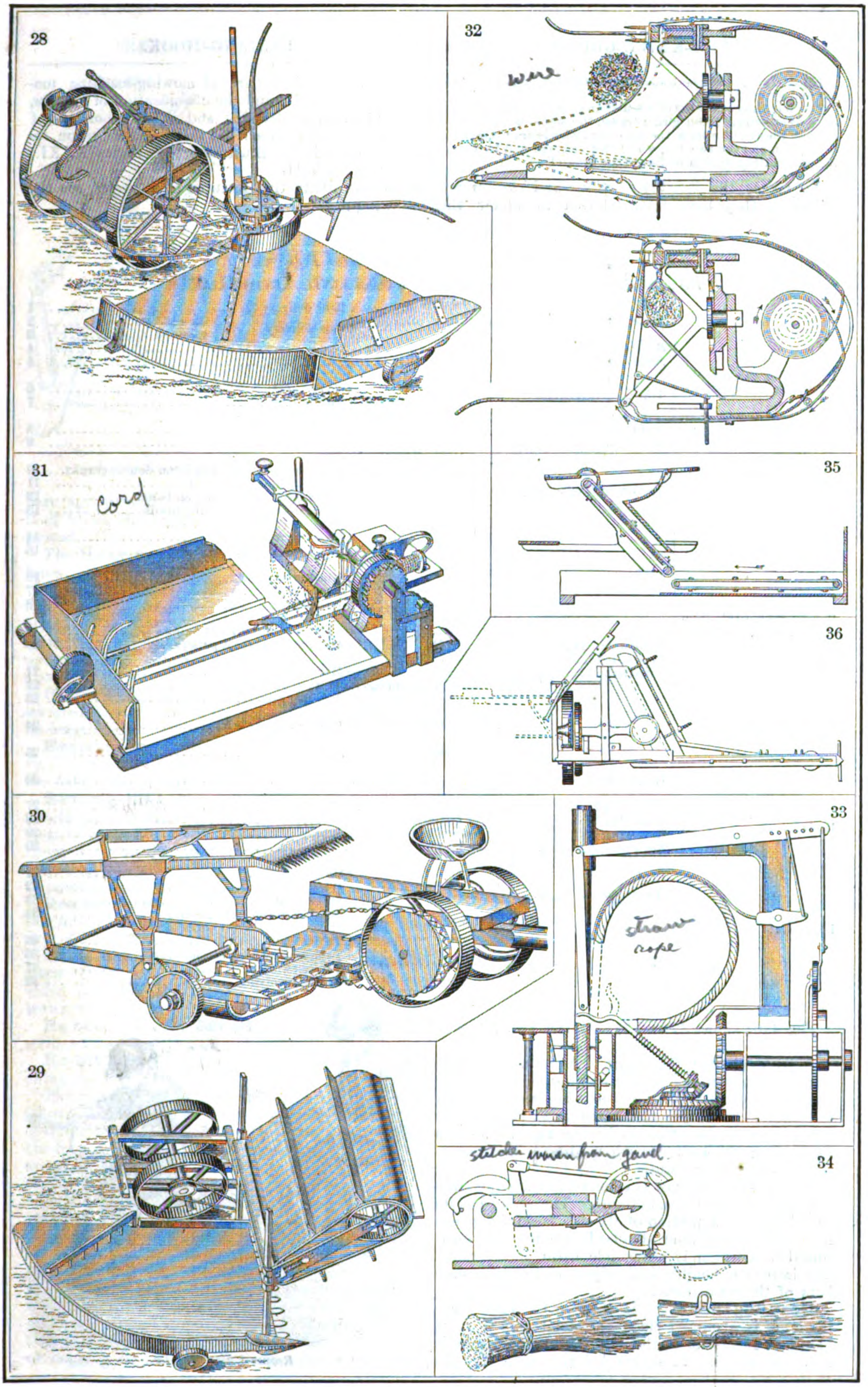


PLATE L. **REAPING MACHINES.** *(Principles of Action.)* *See page 1893.*

Fig. 3247, page 1488, is an adaptation of a steam-engine to reaping and mowing.

The implement consists of a boiler and steam-engine, erected on a light wrought-iron girder-frame, the whole being carried on four wheels, of which the two hind wheels are utilized for propulsion and the two fore wheels for steerage and for carrying the cutting apparatus free of the ground.

So far as the *mowing-machines* and *reapers* are identical, they have been referred to under the former head. See chart of mowing-machine motions, Plate XXX., and the classification of *mowers*, page 1488. The drawing and cutting portions of the apparatus are described in the classification referred to, and are illustrated on Plates XXXI., XXXII., XXXIII.

For the distinctive features of a reaper, see the following: —

Classification of Reapers by Structural Features.

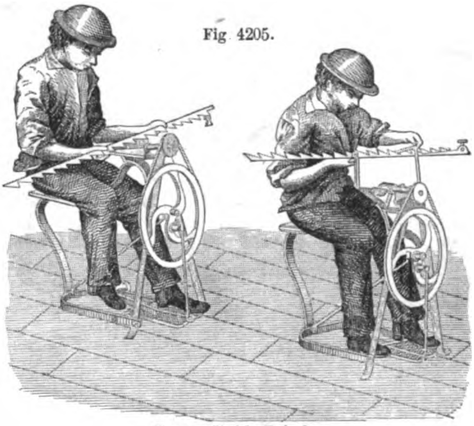
The numbers refer to corresponding numbers on Plates XLVII., XLVIII., XLIX., L.

Discharging the gavel by movement of platform	*Endless apron*	Rear delivery			1
	Endless apron	Side delivery	On a level		2
			Elevated		3
	Rollers				4
	Screw-conveyors				5
	Tilting	To one side			6
		To the rear			7
	Swinging				8
	Revolving				9
Gavel discharged from stationary platform	*Teeth operating below platform*	Teeth upon heads hung upon double cranks			10
		Teeth upon endless belts			11
		Teeth upon heads hung on belts			12
		Teeth upon reciprocating heads			13
	Automatic rake operating above platform	*Reciprocating*	*Rectilinear*	Front to rear	14
				Side to side	15
			Curvilinear	Horizontal path	16
				Vertical	17
				Irregular	18
		Rotary	*Endless belt*	Upon horizontal shaft pulleys	19
				Upon vertical shaft pulleys	20
			About an axis	Horizontal axis	21
				Vertical axis	22
				Inclined axis	23
			Heads connected to an endless belt		24
		Reciprocating and rotary combined			25
	Hand-rakers				26
Reels	Revolving beaters on horizontal axis				27
	Revolving beaters on vertical or inclined axis				28
	Revolving beaters carried on endless belts				29
	Reciprocating rising and falling beaters				30
Binders	*Automatic*	Cord			31
		Wire			32
		Straw rope			33
		Stitches woven from gavel			34
	Hand	Tables rigid			35
		Tables hinged			36
		Tables swinging			37
		Tables revolving			38

Fig. 4204 shows 37 and 38, the last two forms of binders cited in the classification.

Reap'er-knife Grind'er. A form of grindstone or emery-wheel for sharpening the knives or sickle sections of reaping and mowing machines. In the figure, one shows the machine as adapted for grinding, and the other as having two knife-rests for holding the knife-bar when filing. The emery-wheel is driven by treadle.

Fig. 4205.

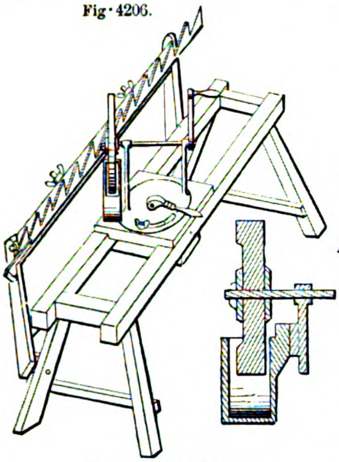


Reaper-Knife Grinder.

In Fig. 4206, the saw is clamped to the adjustable bar at the top of the side frame. The stone has its periphery and a portion of its side faced for grinding. The grindstone standards are upon a horizontal disk which is adjustable upon the carriage. The latter has longitudinal adjustment on the slide bars of the main frame.

Reap'ing-hook. (*Husbandry.*) The reaping-hook is a curved blade of steel set in a short handle. It has no teeth, and this distinguishes it from the sickle. It superseded the sickle in the

Fig. 4206.



Reaper-Knife Sharpener.

Fig. 4207.

Reaping-Hooks.

best agricultural counties of England before the reaping-machine appeared.

The Hainault scythe is a reaping-hook. See SCYTHE.

It is called the *scythe-hook* in Scotland, and is there credited to the Irish. The Dutch hook is broad, thin, more nearly circular, but does not *reach* into the grain so far. Ichabod!

Hutton's reaping-hook (English) is serrated from the point through half its length only.

Reap′ing-ma-chine′. (*Husbandry.*) A machine for cutting grain in the field. See REAPER.

Rear′ing-bit. (*Menage.*) A bit having a curved mouth-piece, which forms the flattened side of a ring, to each side of which are attached driving-rein rings, while on the lower side is another ring of the same size, into which the martingale-strap is buckled, to prevent the horse lifting his head when rearing.

Rea′son-piece. (*Building.*) A timber which lies under the beams on the brick or timber in the side of a house. A *wall-plate. Raising-piece.*

Reau′mur Ther-mom′e-ter. One in which the space between the freezing and boiling points is divided into 80°, the former being 0°. See THERMOMETER.

Re′bec. (*Music.*) A Moorish violin with three strings tuned in fifths, and played with a bow.

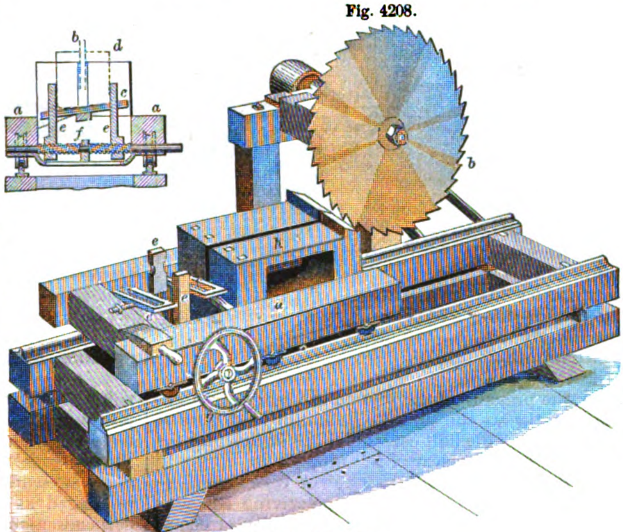
Re-bit′ing. (*Engraving.*) A process for deepening the lines on engraved plates.

The plate is cleaned perfectly and the surface polished. A *ground* is then carefully made by a *dabber*, covering the face only of the plate and not clogging the lines. The parts which do not require *rebiting* are *stopped out*. A wall of wax is then laid around the engraving, the acid solution is poured on, and is allowed to remain till the required depth of lines is attained. As each portion acquires the required depth it is *stopped out*, and the *biting-in* resumed on the remaining exposed parts. See GROUND; ETCHING; BITING-IN; LINE-ENGRAVING, etc.

Re-bolt′ing-ma-chine′. A species of sawing-machine for rebolting large blocks of timber without quite separating the smaller bolts from each other, so that they will hold together, admitting of handling or dogging in the shingling or other machine in which they are to be finally cut up. By this means the machine may be supplied with timber to its full working capacity, while, at the same time, cutting the shingles or other pieces as narrow as desired.

In the perspective view (Fig. 4208) *a* is the carriage which moves under the saw *b*. The depth of the carriage under the blade is such that the latter does not reach the bottom, so that the bolt, secured in the saw-carriage and shown by dotted lines, will not be cut entirely through at *d* in the section. *c* is a tilting rest for the bolt, upon which the sap side of the latter, generally bevel to the other sides, is placed, and held so that the saw kerf will pass down to such a depth as to leave sufficient wood to hold the portions together. *e*, core-clamps which work upon right and left hand screws *f*, and are operated by the crank *g*. These serve to hold the bolts securely while being cut. A portion of the carriage *h* is elevated, in order to accommodate pieces which are to be divided entirely, as in ordinary sawing-machines.

Fig. 4208.

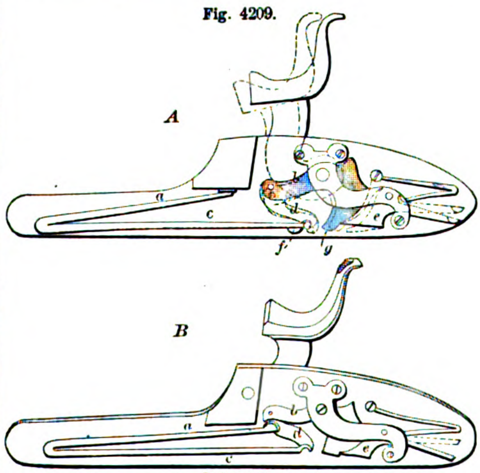


Rebolting-Machine.

The track of the carriage is made in two portions, one above the other, so that the upper part can be vertically adjusted as may be required, for saws of different sizes, or as the blade wears away.

Re-bound′er. (*Fire-arms.*) A device in a gun-lock for throwing the hammer back from the nipple after striking and exploding the cap.

Fig. 4209.

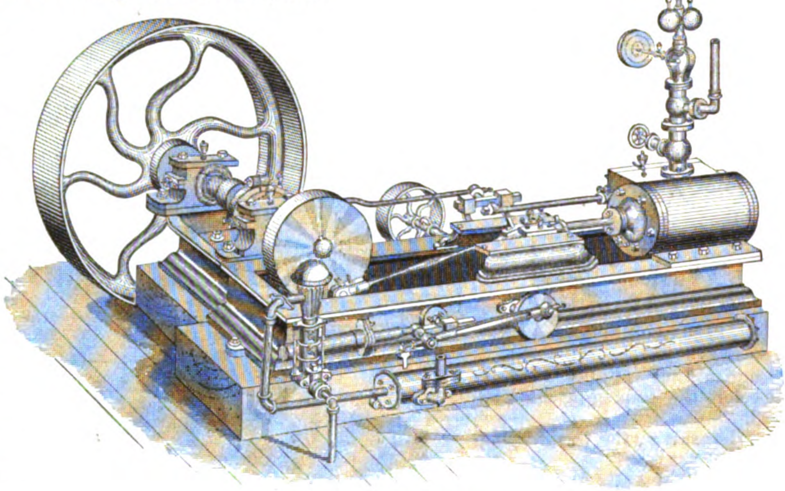


Rebounders.

This is usually effected, as at *B*, Fig. 4209, by lengthening the shorter branch *a* of the main-spring so that the arm *b* of the tumbler shall strike it just previous to the impact of the hammer on the cap, caused by the action of the long branch *c* of the main-spring transmitted through the swivel *d*; the effort made by the branch *c* in restoring itself, after the momentary compression, throws back the tumbler sufficiently far to permit the sear *e* to enter the half-cock notch.

In Dane's patent (*A*), used in the Parker gun (see SHOT-GUN), the long branch of the main-spring is arrested by a stop *f* at about the position of half-cock, the tumbler being carried forward by its momentum until it strikes the cap, when the pressure of the sear on the cam-shaped extension *g* throws the tumbler back until the nose of the sear enters the half-cock notch, or sufficiently far to lift the hammer clear of the nipple.

Fig. 4211.



Reciprocating-Engine.

Re-ceiv'er. 1. (*Chemistry.*) A vessel connected with the neck of a retort for receiving the products evolved therefrom during distillation or chemical reaction. See ALEMBIC; CONDENSER; STILL.

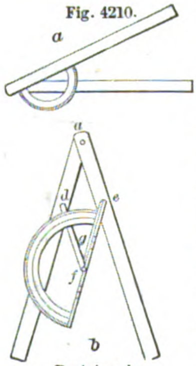
In the laboratory it is frequently made of glass, and is of globular form, but may be of any convenient shape; the material must, however, be such as will not be acted on by the substances to be decomposed or produced during the operation.

2. (*Pneumatics.*) *a.* The bell-glass on the table of an air-pump.

b. The vessel which is adapted to collect the gas from the PNEUMATIC TROUGH (which see); or to contain gas for blow-pipes, exhibitions of stereopticons, oxyhydrogen light, or microscopes.

Re-ceiv'ing-mag'net. (*Telegraphy.*) An electro-magnet through which the current from the line wire passes and is intensified, in order to actuate the sounding or recording mechanism.

Fig. 4210.



Recipiangles.

Re-cip'i-an'gle. An instrument (*a*) with two legs and a graduated arc, used by military engineers for measuring and laying off angles of fortifications. The legs are attached at one end by a double-headed screw, which forms the axis. The center of the protractor is applied at the reëntering angle of the instrument, and its graduated margin shows the angle of divergence of the legs.

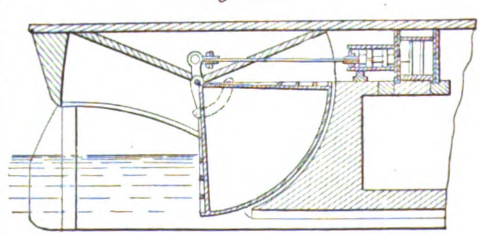
Another form (*b*) of the *recipiangle*, called the *parallelogrammatic*, has two links connecting the legs and meeting at the center *f*. The length between the points *a d* and *a e* is exactly equal to the distances *d f* and *e f*, so that when the legs are brought into line, the point *f* coincides with the point *a*. The center of the protractor is exactly over the point *f*, which also bisects the angle of the instrument at all adjustments. The marginal graduation of the protractor permits the angle subtended thereby to be read. The protractor is hinged at *g*, so that it may be lifted and stand perpendicular to the plane of the instrument. The instrument is adapted for taking salient or reëntering angles.

Re-cip'ro-cat'ing-en'gine. (*Steam-engine.*) The common form of engine, in which the piston and piston-rod move back and forth in a straight line, absolutely as in the cut, or relatively to the cylinder, as in oscillating-cylinder engines.

The term is used in contradistinction to ROTARY-PISTON ENGINE (which see), and is a very general one, including as it does by far the greater number of steam-engines, either devised or in use.

Re-cip'ro-cat'ing-pro-pel'ler. One having a paddle which has a limited stroke and returns in the same path. The propeller is reciprocated by a horizontal engine. It is enveloped at the sides and before, so that the water does not impinge against its forward side. The propeller is made sufficiently buoyant to raise it to position for making the effective stroke.

Fig. 4212.

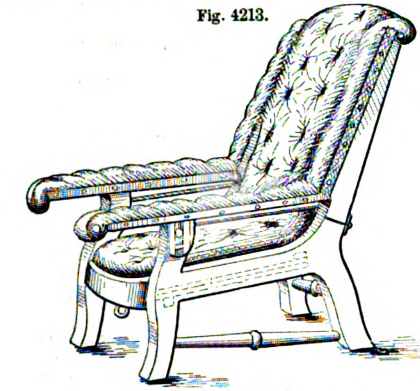


Reciprocating-Propeller.

Re-clin'ing-chair. One whose back admits of

being tilted, allowing the occupant to assume an inclined or recumbent posture. In the figure, the back is hinged near the seat, and a given inclination is maintained by the engagement of notches beneath

Fig. 4213.



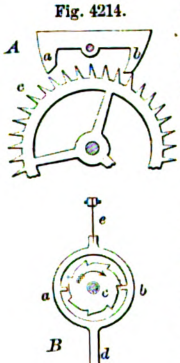
Reclining-Chair.

the arms, with spring teeth on the front posts. A slide in front forms a foot-rest. Spring cords erect the back. See FOLDING-CHAIR; INVALID-CHAIR; CAR-SEAT.

Re-coil'-es-cape'ment. A recoil-escapement is one in which, after the pallets leave the teeth at each oscillation of the pendulum, the extremities of the teeth slide along the surfaces of the pallets, and thereby give an impulse to the pendulum or balance.

The *vertical* escapement of a watch is a *recoil*, and the word is used as distinguished from a *dead-beat.* In the former there is a recoil of the train, and in the latter the impinging surfaces of the pallets are cut to a curve concentric with the axis of vibration, and during the time one of the teeth is against the pallet the scape-wheel remains perfectly at rest. See ESCAPEMENT; DEAD-BEAT.

Fig. 4214.



Recoil Clock-Escapements.

The anchor-escapement *A* was invented by Clement, of London, about 1680. The anchor is caused to vibrate on its axis by the oscillations of the pendulum. The teeth of the scape-wheel *c* impinge alternately against the outer surface of pallet *b* and the inner surface of pallet *a*. As these surfaces are not concentric with the axis of oscillation, a *recoil* of the train ensues, for the reason just stated, that as the pallets leave the teeth, the extremities of the latter slide along the acting surfaces of the pallets, and through them transmit a sufficient impulse to the pendulum to overcome the loss by friction and the resistance of the atmosphere. See also Fig. 193, page 97.

Another clock-escapement *B* has a pallet-ring surrounding the scape-wheel *c*, the pallets *a b* projecting from its internal periphery and catching alternately, as the pendulum rod *d* oscillates, upon teeth on opposite sides of the scape-wheel.

The pallet-ring is suspended by a piece of watch-spring *e* from a stud.

Re-cord'er. 1. (*Music.*) A musical instrument like a flageolet.

"Flutes and soft recorders."
MILTON.

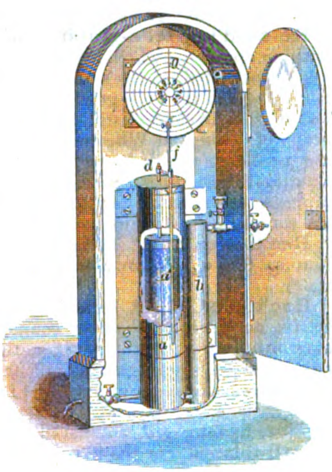
"To Drumbleby's, and there did talk a great deal about pipes; and did buy a recorder." — PEPYS'S *Diary*, 1668.

It was used in teaching birds to pipe.

2. A registering apparatus. See REGISTER.

Re-cord'ing-gage. Generally speaking, any gage provided with means for leaving a visible record of its indications.

Fig 4215.

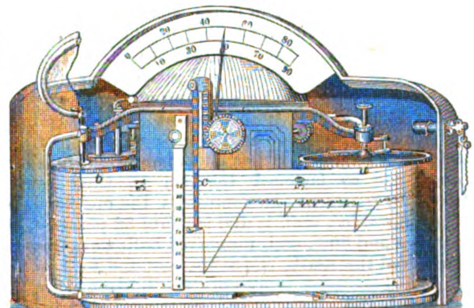


Recording-Gage for Gas.

That shown (Fig. 4215) is particularly designed for measuring gas pressures. The two cylinders *a b* connected by a short pipe *c* are partially filled with water. *a* contains a float *a'* having an upwardly projecting rod *d* passing through a hole in its cover and connected with a guide-rod which carries a pencil-holder at the end of a flexible spring *f*, by which the pencil is caused to press against a disk of cardboard *g*, ruled with radial divisions for the hours and circular divisions for inches of pressure, and rotated by clock-work. Gas being admitted to the upper part of the cylinder *b* depresses the water therein, and causes a difference of level in the two cylinders which varies as the gaseous pressure fluctuates, its amount being registered by the line traced by the pencil on the cardboard, which is renewed at intervals of twelve hours. See also SPEED-RECORDER.

Edson's recording-gage (Fig. 4216) has several air and steam tight connected drums made of thin elastic metal; these, on being expanded by the influx of steam, raise a rod attached to the upper drum, which operates a segment-rack connected by gearing with a horizontal rack and a pawl, causing a partial slight rotation of the drum *a*, which consequently draws forward the paper previously wound upon the roll *b*, on to itself. The expansion or contraction of the connected drums also raises or depresses the arm

Fig. 4216.



Edson's Recording Steam-Gage.

c, carrying a pencil or tracer at its lower extremity, making vertical or diagonal lines on the paper, which is ruled with horizontal lines indicating pounds, as the steam-pressure varies. The rolls may also be rotated by connection with the engine, affording a more continuous record. A graduated arc and pointer are attached, to more conveniently show the pressure at the moment; and a hammer and bell or other device may also be connected to sound an alarm when the pressure exceeds a given amount. See STEAM-GAGE.

Re-cord'ing-tel'e-graph. A telegraph provided with an apparatus which makes a record of the message transmitted, as the symbol telegraphs of Morse and Bain, and the type-printing telegraphs of House and Hughes, in contradistinction to the indicator-telegraph of Cooke and Wheatstone, which has a pointing needle or needles, and the audible one of Sir Charles Bright, which sounds upon bells, and the Morse as at present generally used, which is read by the sounds. See List under TELEGRAPH.

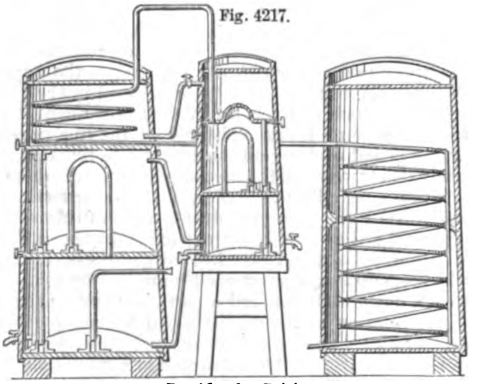
Rec'ti-fi-ca'tion. Redistillation or resublimation to free a substance from impurities or from water.

Rec'ti-fi'er. 1. A second still for redistilling spirits, or a second chamber connected to the main or primary still. In the rectifier, the *low wines* are redistilled to concentrate them; or *high wines* are farther concentrated and purified to form alcohol.

In some cases, flavoring matters, such as oil of juniper, to form gin, are placed with the *low wines* for redistillation: or the flavor is added in the form of vapor.

In Fig. 4217, the tub has three chambers and means for heating the *singlings* before charging the lower chambers, so as not to check the continuous

Fig. 4217.



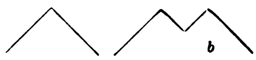
Rectifier for Spirits.

process of evaporation incident to the use of a single-chambered vessel. The upper chamber receives the low wines, and they are heated by the steam in the middle chamber. The chambers are charged successively from the upper one, and provision is made for avoiding collapse and for carrying off vapor.

2. (*Nautical.*) An instrument for determining the variation of the compass on board ship. It consists of two circles, either laid upon or let into each other, and so fastened together in their centers that they represent two compasses, the one fixed, the other movable; each is divided into 32 points of the compass and 360°, and, numbered both ways from the north and the south, end at the east and west in 90°. The fixed compass represents the horizon, in which the north and all the other points are liable to variation. — ADMIRAL SMYTH.

Re-dan'. (*Fortification.*) A work having two faces forming a salient angle in the direction from which an attack may be expected; it is open at the gorge.

Fig 4218.



Redans.

A *double redan* (*b*), or *bonnet deprêtre*, has a reëntering angle for mutual defense.

The *redan* is the simplest field-work, and is used for defending the avenues of approach to a village, bridge, or defile.

In front of another field-work, it is called a *flèche*.

When *flanks* are added to the *faces*, the work becomes a *detached bastion* or *lunette*.

Red Brass. An alloy containing 8 parts copper and 3 zinc.

Red Brick-dust. (*Foundry.*) Used as *parting-sand* (which see).

Re-doubt'. (*Fortification.*) *a.* A detached field-work inclosed by a parapet, the salient points of which are but imperfectly or not at all protected by a flank fire. It may be square, star-shaped, or irregular in plan, according to the requirements of its site and surroundings.

b. An interior work within the main line of ramparts, as the *redoubt* of the *ravelin*, *redoubt* in the *places-of-arms*. See RAVELIN.

These are designed as places of assemblage in offensive exterior operations, or for retreat in case of a repulse.

Red-short I'ron. Iron which is difficult to weld and is brittle when heated is said to be *red-short* or *hot-short*. This defect is due to the presence of sulphur.

Red-staff. (*Milling.*) A straight-edge employed to detect irregularities in the face of a mill-stone. The edge is reddened with ocher, and colors prominent irregularities on the face of the stone.

Red-stuff. A trade term for the oxides of iron used in grinding and polishing, such as *crocus* and *rouge*.

Red Tom'bac. An alloy containing 11 parts copper and 1 zinc.

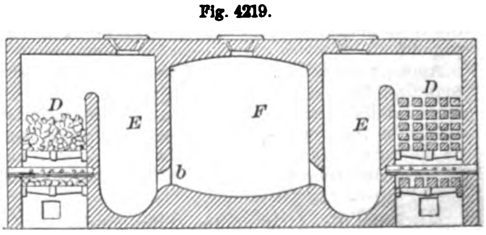
Re-duc'ing-fur'nace. (*Metallurgy.*) A furnace in which ores are deprived of their oxygen and reduced to the metallic state by the action of intensely heated vapors containing carbon, sometimes assisted by other reagents.

It is generally of the reverberatory kind, and is used in the reduction of litharge, the treatment of copper ore in several stages, and for obtaining the precious metals. See BLAST-FURNACE; REVERBERATORY-FURNACE; SMELTING-FURNACE; and others cited in the lists under METALLURGY and FURNACE.

Siemen's furnace has two parallel sides sloping downward, so as to form a kind of trough between them. The ore is charged at both sides on the top of the furnace, and slides down the inclined planes of the two sloping sides. At the bottom of the furnace the gases from the producer and the necessary supply of air are admitted, and produce an intense flame, the products of combustion rising upward through the masses of ore, which are acted upon in a similar manner to that in the blast furnace.

Maunton's furnace (Fig. 4219) has regenerators *D D* and

Fig. 4219.

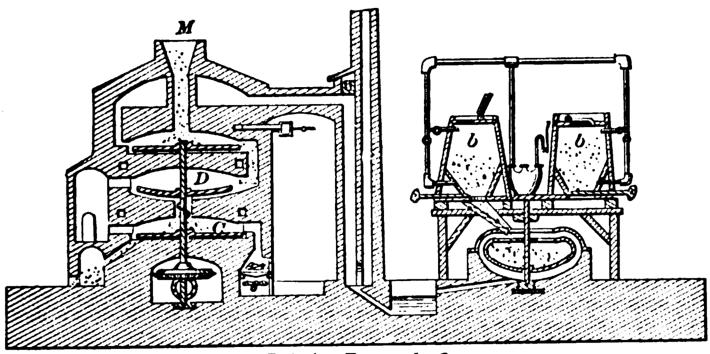


Reducing-Furnace for Ores.

fuel-chambers *E E* on each side of the reducing-chamber *F*, which is charged with finely comminuted ore. The hot-air blast is caused to pass into the reducing-chamber *F* alternately from the regenerators *D D* through openings *b* at its base.

In Ott's furnace for reducing the precious metals (Fig. 4220), the ore, having previously been separated from a portion of its impurities, may be mixed with two to four per cent of sodium, potassium, calcium, magnesium, iron, copper, or with their hypochlorites. The ore, dry or with water, is introduced through the funnel *M*. In the upper oven the ore is heated. In the second oven *D*, where sulphur is eliminated, the steam and hot air are injected, and most of the sulphur is carried off. In the lower oven *C* it is farther heated and treated with hydro-carbonaceous vapors from the furnace to decompose the sulphates. The volatile metals passing off from this chamber are condensed

Fig. 4220.



Ott's Reducing-Furnace for Ores.

in the shower-bath of the diving-flue. Hyponitrous-acid gas or oxygen may be introduced into the furnace. If the ore be auriferous it is placed in the tanks *b b*, dampened with steam, and saturated with chlorine gas, after which it is treated in the centrifugal machine. If the ore be argentiferous it is brought from the furnace immediately to the centrifugal machine and treated with hot water returned several times over and over the same ore, and the liquid resulting from that treatment is pumped up from the lower tank to the upper tank, and from thence falls in a fine shower down the diving-flue, where the sulphureted hydrogen produced in the furnace precipitates the silver in form of sulphite. This is repeated several times. The sulphite is melted with iron, producing sulphuret of iron and silver.

Re-duc′tion-com′pass-es. *Proportional* dividers or *whole-and-half* dividers.

Reed. 1. (*Weaving.*) Called also the *sley* or *slay*. An appurtenance of the loom, consisting of two parallel bars set a few inches apart and furnished with a number of parallel slips of metal or reed, called *dents*, between which the warp-threads are passed. The lengths of reeds are estimated in quarters of a yard, as $\frac{3}{4}$, $\frac{4}{4}$, $\frac{5}{4}$, $\frac{6}{4}$, etc., and, if necessary, by a smaller fractional denominator, as $\frac{7}{8}$, $\frac{9}{8}$, or $\frac{13}{16}$, $\frac{15}{16}$, etc.

In Scotland they are estimated thus: —

20 splits .... 1 porter.
5 porters .... 1 hundred.

In other parts of Britain the estimate is by the number of *splits* or *dents* in 24½ inches, or in 1 inch.

The reed is set in a swinging frame, called the *lathe*, *lay*, or *batten*. In the hand-lathe, the bottom of the batten is furnished with a shelf, called the *shuttle-race*, along which the shuttle is driven.

The office of the reed is to beat the *weft* up to the *web*, and the force of the blow determines the compactness of the fabric. Two threads of yarn pass between each of the *reed-splits* or *dents*.

The number of *dents* in a reed of a given length determines the fineness of the cloth.

One form of linen-prover has 4 perforations to adapt it to the varying modes of estimating. The number of threads visible in this perforation ascertains the number of threads in the standard measure of the *reed*.

The first is ¼ of an inch in diameter, and is intended to ascertain the number of threads per inch.

The second is for the Holland reed, being $^1/_{200}$ part of 40 inches.

The third is $^1/_{700}$ part of 37 inches, and is adapted to the Scotch reed, so called by Ure, as being the regulation reed of that country.

The fourth is $^1/_{200}$ of 84 inches, and is adapted for the French cambrics.

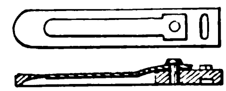
Two warp-threads count for 1 split.

2. (*Music.*) *a*. Formerly, an instrument made from a reed with holes to be stopped by the fingers.

b. A vibrating musical tongue of wood or metal (formerly made from a *reed*).

It is used in wind-instruments of two classes.

Fig. 4221.



Melodeon-Reed.

1. The *oboe*, *clarinet*, *bassoon*.

2. The *accordeon*, *concertina*, *melodeon*, *harmonium*, *parlor-organ*, and that variety of pipe in the large organ known as the *reed-pipe*, in contradistinction to the *flute* or *mouth pipe*. See ORGAN-PIPE.

Some reeds batter against the seat and some are *free*.

3. (*Mining.*) The tube conveying the train to the charge in the blast-hole. Also called the *spire*.

4. (*Ornamentation.*) *a*. Semi-cylindrical ridges, closely arranged in parallel order and designed for ornament.

b. A succession of beads on an object.

Reed′ing. This term is applied (technically) to the *nurling* on the edge of coins. It was originally placed upon coin to prevent it being filed away or clipped. It is done at the same time that the impression is given to the obverse and reverse faces of the coin, the collar which holds the blank being *fluted* or *indented* on its inner periphery for that purpose. The pressure on the dies expands the metal into the indentations of the collar, giving the *reeded* or *crenated* form to the edge.

It is sometimes called *milling*, but that term is also applied to the swaging pressure by which the edge is expanded and a flange raised, which protects the faces of the coin and enables them to be built into a pile.

Reed-or′gan. (*Music.*) A melodeon, or parlor-organ.

An organ whose pipes are provided with *reeds*, in contradistinction to the *flute* or *mouth* organ, whose pipes have a lip to cut the wind escaping through an aperture in a diaphragm. See FLUTE-ORGAN.

The *reed-pipes* consist of a foot to carry the wind to the reed, a thin tongue of hard brass, whose extremity is fitted into a mold by a wooden plug. Its free extremity is vibrated by the force of the wind, and gives a sound of a pitch proportioned to the length, thickness, and elasticity of the tongue.

The wind from the reed traverses a long pipe, which gives character and quality to the sound. Both classes of pipes are employed in large organs.

Reed-pipe. (*Music.*) An organ-pipe in which the musical tone is produced by the vibration of a metallic tongue.

In some reed-pipes the tongue is made to batter against its seat as in the clarinet; in others the tongue plays in the opening of the reed. The *free-reed* has been used in China from time

immemorial, but was introduced into Europe by M. Grenié in 1810.

The reed or tube has a longitudinal, narrow opening in front, covered by the *tongue*, which is firmly fixed to the reed at its upper end, but plays freely at the lower end, where it is somewhat bent away from the *reed*. A *turning wire* presses against the tongue so as to regulate the length of the portion subject to vibration. The reed terminates below in a cone, into which the air is driven. The shape of the tube above the cone is varied so as to obtain the required quality of tone, while the pitch depends upon the length, thickness, and elasticity of the tongue. A given number of vibrations per second are necessary to the production of a certain note; the slower the vibrations, the graver the tone, and conversely. See PIPE.

The free-reed, instead of beating on the edges of the opening, plays back and forth in the slot.

Reed-plane. (*Joinery.*) A concave-soled plane used in making beads.

Reed-stop. (*Music.*) A set of pipes furnished with *reeds*, and associated with the *flute*-stops of an organ, to give a variety to the effects.

Reef. (*Nautical.*) *a.* The portion of a square sail between the head of a sail and any of the *reef-bands*. On the *tablings* of the *leech* of the sail are *earings* and *cringles*, to which the *reef-tackle* is secured. The reef is tied up by *reef-points*, the knot being a *reef-knot*. The *first reef* in a square sail is included between the head and the upper reef-band; the *second reef* between this and the next lower reef-band, and so on.

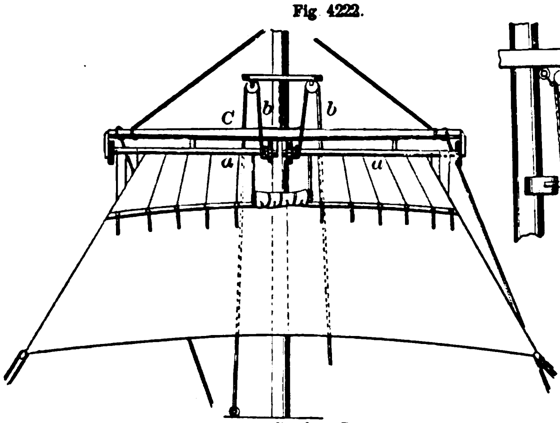
Fore-and-aft sails are reefed from the foot, the first reef being the lowest. The uppermost, called a *balance* reef, extends diagonally upward from the outer leech when *close-reefed;* that is, when all the reefs are taken in, the area of the sail exposed to the wind is reduced about one half.

The object of the reef is to diminish the surface of the sail when the wind is blowing hard.

In the ordinary process of reefing square sails, the seamen ascend the rigging and *lay out* on the yard, standing on the *horses* or foot-ropes while they gather in and secure the hauled-up portion of the sail. Many attempts have been made to avoid the necessity for this difficult and dangerous operation, which is a fruitful source of accident. The first, we believe, was by Captain Forbes, of Boston.

In Ingersoll's apparatus two rolling spars *a a* are journaled beneath and connected with the yard *C*. These are rotated by parbuckles *b b* operated from the deck; the sail is wound around

Fig. 4222.



Reefing-Gear.

them to any desired extent, and prevented from unrolling by ratchets and pawls at their ends.

b. The bowsprit of a cutter or that of a ship-of-war with a ram-bow is said to *reef* when it is run-in or shortened by sliding in-board.

c. Reefing the paddles in steamships is effected by disconnecting the float-boards from the paddle-arms, and bolting them again nearer the center of the wheel, to diminish the dip when the vessel is deep.

Reef-band. (*Nautical.*) A strong horizontal strip of canvas extending across a sail at right angles to the lengths of cloth.

In square-rigged vessels there are four of these bands to the topsails, from three to six feet apart, according to the size of the sail, and two bands to the foresail and mainsail. Fore-and-aft sails have also a band extending diagonally upward from the outer leech, for balance-reefing.

Each band is pierced with holes for the *reef-points*, by which it is tied to the yard in shortening sail.

Reef-knot. (*Nautical.*) A knot formed by passing the ends of the two parts of one rope through the loop formed by another whose two ends are similarly passed through a loop on the first; the two parts of one rope are passed above, and of the other below the loop through which they are inserted. A longitudinal pull tightens the knot, which can only be untied by pushing the loops in opposite directions.

Called also *square-knot*, *flat-hitch*.

When one end of one rope is passed above and the other below the loop it forms a *granny's-knot*.

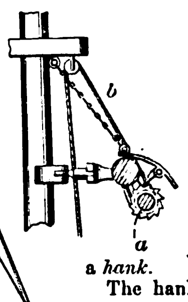
Reef-line. (*Nautical.*) A line sometimes (seldom) used in reefing. It passes spirally around the yard, and through the eyelets in the reef-band successively, so as to draw the latter up to the yard when the line is hauled upon.

Reef-pen'dant. (*Nautical.*) A tackle by which the after leech of a fore-and-aft sail is drawn down to the boom in reefing.

Reef-point. (*Nautical.*) One of the flat pieces of braided cord attached by eyelets to the *reef-band* of a sail, and serving to diminish its area.

The *reef-band* has usually two holes in each width of cloth, and the *points* taper toward each end. The small end of each is passed through an eye in the large end of the other, and being rove through the eyelets in the *reef-band*, one hangs down before and the other abaft the sail.

Reef-tack'le. (*Nautical.*) A tackle by which the *reef-cringles* on the leeches of a sail are drawn up to the yard for reefing.



Reel. A revolving device on which fiber, thread, cord, rope, fabric, etc., are wound, to form them into hanks or skeins, and for various other purposes.

1. (*Cotton-machinery.*) A machine on which cotton is wound, making hanks each having 840 yards in length of thread.

The circumference of the *reel* is 4½ feet; when it has performed 80 revolutions a *lay* is formed, measuring 120 yards, and 7 of these lays make up a *hank*.

The hank-yarn is specially designed for warps.

2. (*Silk.*) The revolving frame on which silk is wound from the cocoons, or yarn is wound off from the spindle of a hand-spinning machine, and reeled into cuts or hanks.

3. (*Rope-making.*) Spun yarns are wound on a reel preparatory to tarring or laying up into strands as the twisting of each length is completed. See ROPE.

4. (*Nautical.*) A revolving frame to hold a line or cord, as, —

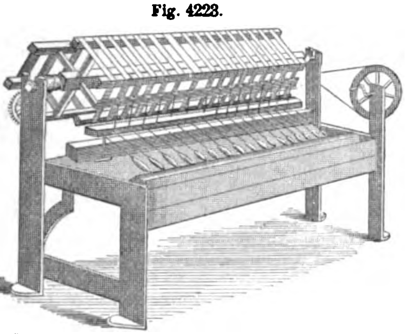
a. The *log-reel* or spool for the *log-line*. See LOG.

b. The *deep-sea* reel for the *deep-sea* lead-line of 150 or 200 fathoms. See SOUNDING.

c. The *spun-yarn* reel, etc.

5. (*Angling.*) A skeleton barrel attached to the

Fig. 4223.

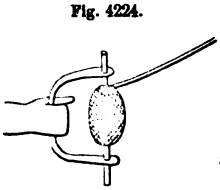


Reel for Cotton Yarns.

butt of an angler's rod, around which the inner end of the line is wound, and from which it is payed out as the fish runs off with the bait, and is gradually wound in again as his struggles become less violent, bringing him to land or to the landing-net. *A fishing-reel.*

The reel represented in the accompanying figure is from an ancient painting at Beni-Hassan, and was used for winding the cord by which the fish-spear or bident was recovered after throwing. In its construction it was merely a stirrup-shaped piece of metal, and a turning pin on which the cord was wound.

Fig. 4224.



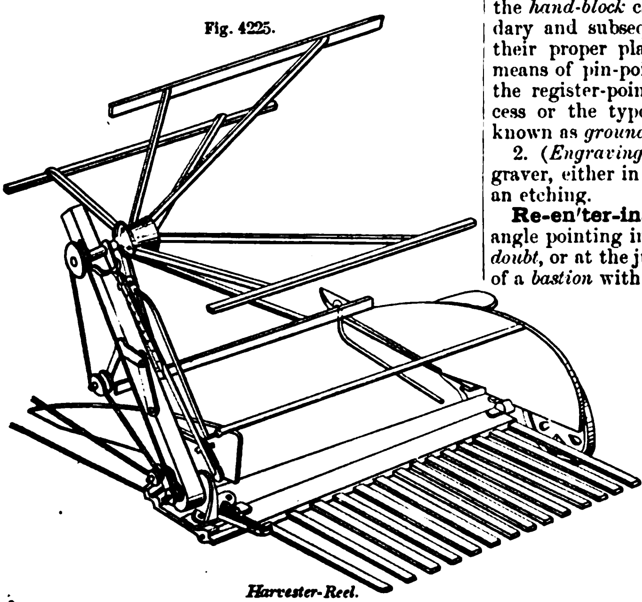
Egyptian Cord-Reel.

6. (*Telegraphy.*) A barrel on which the strip of paper for receiving the message is wound in a recording telegraph.

7. (*Oven.*) A cylinder with radial arms rotating in a heated chamber carrying pans in which loaves of bread are placed for baking in the *reel-oven.* See OVEN.

8. (*Milling.*) The barrel or drum on which the bolting cloth is fastened.

Fig. 4225.



Harvester-Reel.

9. (*Agriculture.*) A device having radial arms carrying horizontal slats, and rotated by gear or pulley connection with the axle of a harvester, for pressing backward and holding the stalks of grain in position for being severed by the knives.

The example shows the *reel* and the *dropper.* See REAPER, Plates XLIX., L.

Reel'ing-ma-chine'. (*Cotton-manufacture.*) *a.* A machine for winding the yarn off the bobbins of the spinning or twisting frames, and forming it into hanks or skeins. Fig. 4223.

b. A machine for winding thread on to reels or spools. See SPOOLING-MACHINE; SILK-REEL.

Reel-ov'en. A baker's oven in which the bread-pans are swung on the horizontal arms of a rotating reel.

The reel has a horizontal axis, which is rotated by gearing on the outside. To each arm of the reel — the number of the arms varying with the capacity of the oven — is a pendulous shelf or bread-pan. These at one part of their revolution are presented at an opening, through which the unbaked loaves are introduced, and thence pass downward toward the arch of the furnace. As each pan comes opposite to the opening it receives its load, and by the time all are filled the first one is again at the opening, the loaves baked and ready to be removed, clearing the pan for another batch. The baking is thus a continuous operation, the time of rotation of the reel being adapted to the completion of the process. In a later invention the pans, instead of being pendulous, are placed above the reel-arms, and the latter are preserved in horizontal position by pendulous weights beneath. See OVEN (Fig. 3444, page 1583).

Reem'ing. (*Shipbuilding.*) Opening the seams between planks for the insertion of new oakum.

The tool is a *reeming-iron* struck by a *reeming-beetle.*

Reem'ing-bee'tle. (*Shipbuilding.*) The larger mallet of the calker by which he drives the *reeming-iron.*

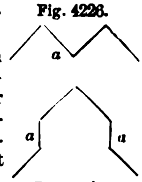
Reem'ing-i'ron. (*Shipbuilding.*) A sharp iron wedge used by calkers to force the planks apart temporarily, to admit the oakum.

Re-en'ter-ing. 1. (*Calico-printing.*) A term in the *hand-block* calico-printing applied to the secondary and subsequent colors, which are adapted to their proper place in the pattern on the cloth by means of pin-points. These are the equivalents of the register-points of the chromo-lithographic process or the typographic printing in colors. Also known as *grounding-in.*

2. (*Engraving.*) The deepening of lines by a graver, either in repairing a plate or for perfecting an etching.

Re-en'ter-ing-an'gle. (*Fortification, etc.*) An angle pointing inward (*a*), as in a *redoubt,* or at the junction of the *flanks* of a *bastion* with the *curtain.*

Fig. 4226.



Reëntering-Angles.

Re-fin'er-y. An apparatus for removing impurities or crudities from metals, spirits, petroleum, sugar, and what not.

The term is a general one, and with metals may include *reducing*-furnaces of various kinds. Also *roasting, decarbonizing,* and *desulphurizing* furnaces, *Bessemer processes,* etc. (which see). See also MALLEABLE IRON, page 1378.

See also SUGAR-MACHINERY.

With liquors, the term includes apparatus and machinery for rectifying and ageing liquors.

With petroleum, it includes apparatus for removing the various crudities which are in the raw product.

Re-fin'ing. The process of freeing metals, liquids, or other substances from impurities or crudities which impair their quality or unfit them for their appropriate uses.

1. Liquids are, in some cases, refined by adding soluble substances which entangle the foreign matters, and sink to the bottom, as with wine and cider. This is termed *fining*. In other cases, the refining is by chemicals which combine with the impurities and form a precipitate.

Sometimes standing a length of time suffices to effect the separation, the supernatant liquid being decanted.

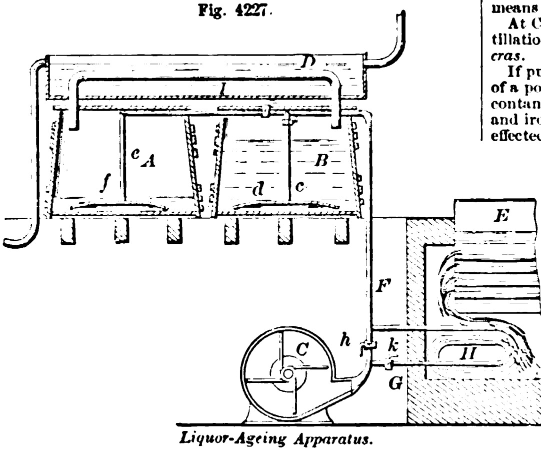
2. Saltpeter is refined by dissolving it in hot water until the water is saturated with salt. On cooling, the salt is deposited in a comparatively pure state.

3. Vinegar is refined by passing it through a filter to separate the mucilaginous matter. See RAPE.

4. Alcoholic spirits and liquids generally are refined by successive distillations. (See RECTIFICATION; STILL.) The same process is applicable to mercury, sulphur, and other substances, which may be volatilized at a high temperature and afterward condensed.

In one form of apparatus for refining and ageing liquors air from a blower *C* is heated in a coil *H* communicating with the pipe *F*, which has two branches *c c* extending downward through a disk near the bottom of the tubs *A B*. The liquor in the tub *B* is first heated to the temperature of 90°, and agitated by air passing from the coil *H* through the pipes *F c*, and rising from beneath the disk *d*, the cock *k* is closed and *h* opened, and cool air forced in through the pipe *F*. These processes are continued for the space of about a month, or until the desired result is attained. The air and alcoholic vapors pass over from *B* to *A* through the condensing-pipe *I* in the water-chamber *D*, the air being discharged from *A* through an aperture above.

Fig. 4227.



Liquor-Ageing Apparatus.

5. Petroleum is refined by treatment with sulphuric acid and by distillation.

6. The process of cupellation (see CUPEL) is largely employed for refining silver. In this, lead, already in combination with or added to the silver, is oxidized by heat and absorbed in a porous cup, taking with it most of the other impurities which are not previously expelled by the heat.

7. Gold is refined by cupellation and by *parting*, that is, dissolving in nitric acid. See PARTING; GOLD.

8. Iron is refined in the furnace and by *puddling*. See IRON; REFINING-FURNACE; PUDDLING; BESSEMER-PROCESS.

Re-fin'ing-fur'nace. (*Metallurgy.*) The furnace in which metals undergo a process of purification and separation from the impurities with which they are usually contaminated, and are rendered fit for use in the arts. In some cases the metal is reduced from the ore and refined by one continuous operation; in others, two or more are required.

The art of refining gold, silver, iron, tin, and copper was practiced previous to times of which we have any authentic history, implements of bronze and copper and ornaments of the precious metals being found among other relics of the prehistoric age, both in the Old and New Worlds.

In ancient times, the precious metals were refined by successive reheatings.

"Silver tried in a furnace of earth, purified seven times." — Psalm xii. 6.

"They gather silver, and brass, and iron, and lead, and tin, into the midst of the furnace to blow the fire upon it, to melt it." — Ezekiel xxii. 20.

From the former of these passages we may infer that a high degree of purity was attained by seven successive refinings. Purifying the precious metals and then reducing their standard by means of alloying does not appear to have been generally practiced, and is not to this day in the East.

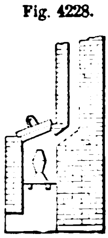
At Freiburg, Saxony, silver amalgamated by the barrel process is, after distillation, refined in crucibles, previously brought to a red heat. The silver is gradually introduced in lumps, and when fused strewn with powdered charcoal, and the crucible covered with an iron plate. After the lapse of a few minutes the impurities which had risen to the surface, together with the unconsumed charcoal, are skimmed off, more charcoal added, and the process repeated, occasionally stirring the molten metal, until its surface becomes bright and clean. When the process is complete, the silver should be malleable and dissolve completely in nitric acid. It is afterward cast into hemispherical ingots. The dust from the furnace flues is, after being sifted, mixed with and treated as ordinary silver ore. The slags and sweepings from the various melting operations are crushed and afterward fused with carbonate of soda and niter, by which means the silver is obtained in the metallic state.

At Constante, Spain, the porous silver obtained from the distillation of amalgam is melted in a species of cupola called a *cras*.

If pure, a loss of silver is entailed by exposing it to the action of a powerful blast; but if, as is generally the case, the metal is contaminated by impurities, such as lead, sulphur, antimony, and iron, which impair its malleability, their removal is readily effected by this apparatus.

Fig. 4228 is a section of a furnace for refining metals in pots. It is lined with the most refractory fire-brick, and has an opening of some 12 or 15 inches diameter, protected by a cover at top, through which the crucibles are introduced and the operation attended to. The grate-bars are removable, and, when required, an artificial blast is introduced beneath them by pipes.

Fig. 4228.


Refining-Furnace.

The operation of *refining* cast-iron consists in exposing it to heat and agents by which the carbon, silicon, and other extraneous matters are oxidized and removed. The pig-iron is either subjected to a preliminary purification in a *refining-furnace* or on a *hearth*, and the operation completed in a *puddling-furnace* (the English method), or it is effected in one operation in a puddling-furnace by an operation termed *boiling* (the American method). See PUDDLING.

When the operation is an intermediate one, the partially refined metal is run from the hearth into a bed, quenched with water, and broken with sledges to enable it to be handled into the puddling-furnace.

The bed of the refining-furnace is small, and the hollow boshes are of cast-iron, through which water flows, to resist the influence of the fire upon the sides of the chamber. Blasts of air are admitted through tuyeres, and the process consists in exposing the molten iron to the oxygen of the air, so as to burn away a part of the carbon and also remove certain noxious matters with which the iron is combined. The iron is then run into molds.

Lewis's refining reverberatory-furnace is thus worked. The fire of pitcoal is made on the grate bars, and when a melting heat is attained, the door of the iron-chamber is opened, and the basin occupying the middle of the floor is covered with a bushel of charcoal laid over a stratum of silicious sand, previously introduced. A bushel of hammer or forge cinder and then a ton of pig-metal is laid around the basin, which is about 10 inches deep, a space being left between the pigs so as to allow full access to the flame. The door of the iron-chamber is closed, and the fire pushed until the iron is about to melt. The iron is then dragged by a *rabble* into the basin, and the molten surface covered with a bushel of charcoal. The fire is kept up and the metal frequently stirred. When the decarbonization has proceeded to a sufficient degree, the metal is run off.

The consumption is said to be 15 to 18 bushels of pitcoal, 2 bushels of charcoal, making a ton of refined from 22 cwt. of pig metal.

The fluid iron from the blast-furnace is sometimes transferred direct to the refinery, thus saving the time and fuel required for remelting the pig-metal.

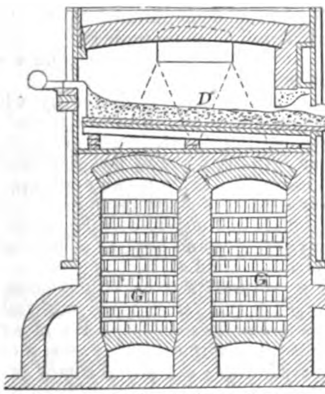
Various fluxes have been patented or proposed for assisting the process.

Hampton, 1856, slakes quicklime with a solution of alkali or alkaline salt. Du Motay and Fontaine use scoriæ from the puddling-furnace, oxides of iron and alkaline silicates or carbonates; Sanderson, 1855, uses substances containing oxygen or other element, by which silicium, aluminium, etc., are removed. Blackwell proposed remelting in a cupola furnace alone, or with the addition of substances containing nearly pure iron oxides.

Nasmyth and others have employed steam passed through or caused to impinge upon the molten metal in a state of ebullition. Bessemer, in 1855, patented a process of this kind.

In Martin's furnace (French), pig-iron is fused and maintained at a temperature of 1,600° to 2,000° C. on the hearth *D* of a reverberatory-furnace having a

Fig. 4229.



Martin's Refining-Furnace.

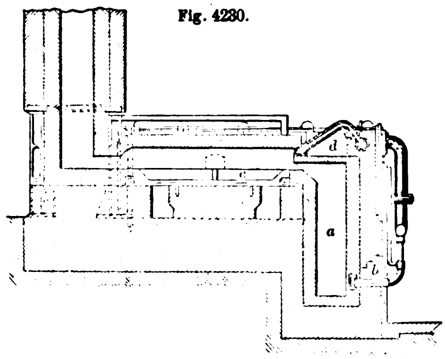
covering of refractory sand and heated by means of a Siemens regenerator *G G*. Ore, or puddled steel, or old iron in small pieces, is thrown in, and manganiferous iron afterward added.

At some of the Pittsburg iron-works the metal is refined by mechanically mingling pulverized oxides of iron with the molten crude metal direct from the blast-furnace. This is run from the furnace into a large kettle, and thence poured into a revolving circular trough. Pulverized ore from a hopper descends and covers the melted metal as fast as it runs into the trough, whose continuous rotation causes the formation of alternate thin layers of the crude metal and ore which combine to form malleable iron. Lake Superior, Champlain, or Iron Mountain ore is employed.

Chlorine, hydrogen, and coal gas, the oxides of manganese and zinc, etc., have also been employed.

In Eck's furnace (German), coal gas is used. A quantity of coal is introduced into the generator *a* through an opening in the bottom, and when this has become fully ignited the opening is bricked up and the generator filled with coal from above; a moderate supply of air to support combustion is allowed to enter through the lower tuyeres *b*. When the refining-hearth *c* has become thoroughly dried and heated, about 40 cwt. of iron

Fig. 4230.



Gas Reverberatory-Furnace.

is distributed over the hearth, so as to expose as much surface as possible to the action of the flame. The fusion of the charge is effected in about three hours, the gas generator being always kept filled and the supply of air from the lower tuyeres diminished after each introduction of fresh coal, as the latter yields its gas more freely at first.

Air introduced through the upper tuyeres *d* effects the combustion of the gas as it passes from the generator on to the hearth. During the progress of fusion the metal is shifted, so that each part may in turn become exposed to the hottest portion of the blast, in the vicinity of the fire bridge.

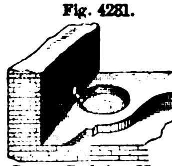
When all the iron is fused, about five pounds of limestone are thrown over its surface, in order to convert the dross into fusible slag.

The blast from two side tuyeres is now directed upon the fused metal, blowing aside the slag and creating currents in the mass, so that a fresh surface is continually exposed: the operation is assisted by stirring with an iron rod, and fresh limestone occasionally added, the total amount used being about 1 per cent of the crude metal.

The iron is withdrawn through a tap-hole at the side of the furnace, the opposite tuyere being employed to aid in forcing it out. The duration of the treatment after fusion varies from 2½ to 5 hours, the latter time being required to produce pure white iron.

Re-fin'ing-hearth. The copper-refining hearth has a hemispherical crucible of about 16 inches diameter, and lined with a puddle of 2 parts charcoal, 1 part clay. It is partly surrounded by a raised border, the open portion of which has a door to prevent the escape of the fuel. The lining is renewed before each operation, and is burnt on by a fire ignited in the crucible before charging with the fresh charcoal and pieces of black copper. The blast being let on and the copper fused, metal and fuel are added from time to time, the scoriæ being let off by a side-channel.

Fig. 4231.



Copper-Refining Hearth.

Sulphurous acid escapes and other volatile ingredients, if present. When the operation is complete the workman stops the blast, throws water on the hearth, rakes back the scoriæ with his *rabble*, and throws water on the metal, which congeals a thick film on the surface; this is of a red color, and is known as a *rosette*, the metal being *rose-copper*, and obtained by successive *quenching* and removal of the *rosettes*.

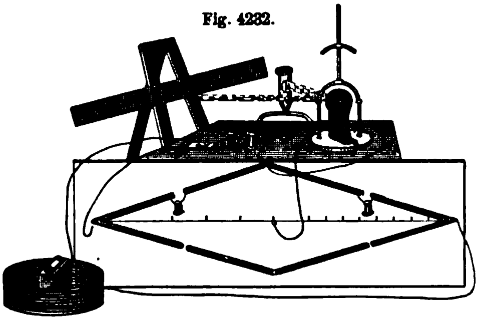
A farther refining, to reduce the suboxide of copper and obtain malleable metal, is conducted in a crucible covered with small charcoal and placed in a hearth similar to the foregoing.

Re-flect'ing-cir'cle. (*Optics.*) An instrument for measuring altitudes and angular distances, invented by Mayer about 1744, and afterward improved by Borda and Troughton.

In principle and construction it is similar to the SEXTANT (which see), the graduations, however, being continued completely round the limb of the circle. Troughton's has three arms radiating from the center at angular distances of 120° apart, each provided with a vernier, so that each angle measured is derived from the mean of three readings at opposite points of the arc, which tends to correct errors of centering and graduation. See REPEATING-CIRCLE.

Re-flect'ing-gal'va-nom'e-ter. Sir William Thomson's reflecting-galvanometer consists of a very small magnet, made of a piece of watch-spring, suspended between two flat bobbins of fine insulated copper wire. The magnet carries a very small concave mirror, which is adjusted by means of a directing-magnet to throw the rays of light issuing from a lamp and reflected from the mirror upon the zero of a horizontal graduated scale when no current is passing or when two equal and opposite currents neutralize each other. In any other case the vibrations of the magnet cause the image to be deflected to the right or left of zero by an amount proportional to the force and duration of the current.

Fig. 4232.



Thomson's Reflecting-Galvanometer.

The figure shows the instrument employed in determining resistances in connection with Wheatstone's *bridge*.

Re-flect'ing-lev'el. The reflecting-level represents the object as reflected upon a long surface of water in an inverted position. Invented by Mariotti.

Another kind consists of a polished metallic mirror, placed at a small distance before the object-glass of a telescope, suspended perpendicularly. This mirror being set at an angle of 45°, the perpendicular line of the telescope will become a horizontal line, that is, a line of level. Invented by Cassini. See LEVEL.

Re-flect'ing-mi'cro-scope. A form of microscope first proposed by Newton, in which the image formed by a small concave speculum may be viewed either by the naked eye or through an eye-piece. Owing to the difficulty of illuminating the object, it was long disused, but has been revived by Professor Amici, who places the object outside of the tube of the microscope, and reflects its image to the speculum by means of a plane mirror, inclined at an angle of 45° to the axis of the former.

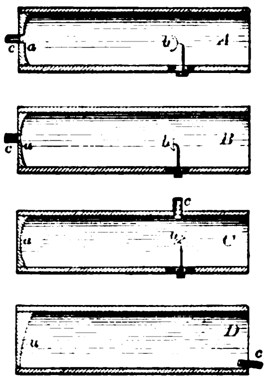
Re-flect'ing-tel'e-scope. A telescope in which the rays are received upon an object-mirror and conveyed to a focus, at which the image is viewed by an eye-piece.

There are four principal varieties: —

A Gregorian. *C* Newtonian.
B Cassegrainian. *D* Herschelian.

The Gregorian telescope (*A*, Fig. 4233) was invented by Gregory, and described by him in his *Optica Promota*, 1663.

Fig. 4233.



Reflecting-Telescopes.

The object-mirror is perforated in the axis, and the rays of light, being reflected from the surface of *a*, cross each other in the focus, where they form an inverted image, and are then intercepted by a small concave mirror *b*, which causes them again to converge to a focus, where they form a direct image viewed by the eye-piece *c*, screwed into the tube behind *a*.

The Cassegrainian telescope (*B*) differs from the Gregorian in having the small mirror *b* convex, but not sufficiently so to render the rays reflected from *a* divergent; they are therefore brought to a focus just in front of the large speculum, forming an inverted image which is viewed by the eye-tube.

In the Newtonian form (*C*), invented by Sir Isaac Newton, 1669, the rays falling on the concave speculum *a* are intercepted before being converged to a focus by the small plane mirror *b*, placed diagonally in the main tube, which reflects the image to the eye-piece inserted in the side of the tube. The small mirror *b* may be caused to approach or recede from the large speculum by means of a sliding device on which the wire supporting it is mounted.

In the Herschelian or front-view telescope (*D*), the open end of the tube is directed toward the object to which the observer turns his back. The small mirror is dispensed with, the image formed by the large mirror being viewed directly through the eye-piece. Less light is lost by this arrangement than where two mirrors are employed.

Re-flect'or. 1. (*Optics.*) A device by which the rays proceeding from a luminous or a heated object are thrown back or diverted in a given direction. A mirror. The latter term, however, appears to be less comprehensive, being usually only applied to such surfaces as afford definite images and colors, while a reflector may not merely be used for throwing back the rays of light and heat, or of heat only, but also the waves of sound.

The reflecting surface may be either plane or curved. In practice it is often made spherical or parabolic. The former does not bring the rays to a true focus, but is easily formed, and is consequently generally employed where extreme accuracy is not sought for.

"The surfaces formed by the revolution of the ellipse, parabola, and hyperbola are such that the first accurately reflects diverged rays to a focus, the second parallel rays, and the third divergent rays." — BRANDE.

The material should be as smooth and highly polished as possible. Sheet-tin is frequently used for common purposes, as for door or hall lamps, or those carried by vehicles, while for other purposes a more perfectly reflecting surface is employed, such as speculum metal or silver protected by glass. See SILVERING; PLATINIZING.

Silver is the most perfectly reflecting substance known, absorbing but 9 per cent of the incident rays, while speculum metal absorbs 37 per cent. Glass itself, owing to its property of totally reflect-

ing incident rays at a low angle, is used in certain cases.

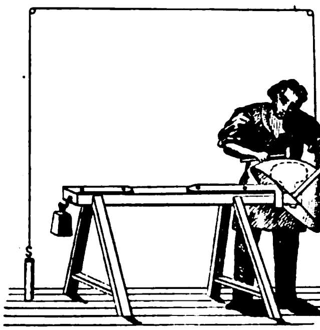
Reflectors with parabolic surfaces are employed for throwing the light emanating from objects placed in their foci in parallel straight lines to a great distance, and for converging the heat rays from a distant object, as the sun, to a focus, and also, in connection with eye-glasses, in the reflecting-telescope, which is itself often simply denominated a reflector. See REFLECTING-TELESCOPE; CATOPTRIC LIGHT; MIRROR; BURNING-GLASS.

The reflectors used with microscopes are various, according to the exigencies of the position, shortness of the focus, etc.

Under ILLUMINATOR are cited *Beck's, white-cloud, side-reflector, parabolic reflector, Lieberkuhn,* etc., — all forms of reflectors adapted to microscopes.

Paraboloidal reflectors were employed in the lighthouses at Bidstone and Hoylake, at the entrance of the Mersey, as early as 1763. These were of wood lined with mirror glass; smaller ones of tin were also employed. At present, lighthouse reflectors are made of copper heavily plated with silver. The proper curve is imparted by beating with mallets and hammers of various forms and materials; a bezel is formed around the rim, which is afterward stiffened by a metallic strap, and the interior surface polished with powder. Two ingots of pure silver and copper, of equal surface, weighing respectively 6 and 16 ounces, are tied together with wire, a flux of burnt borax and niter applied, and the ingots placed in a furnace. By repeated reheatings, rolling, and annealing, a plate 28 inches square is formed, which is then cut into a circular disk. A slight convexity is then formed at the back by beating with a round-faced boxwood mallet. The silvered side of the plate is placed on a slightly concave beechwood block and beaten from the edge gradually toward the center. The partially rounded disk is then placed concave side downward on a rounded steel former mounted on a horse, and beaten first with the peen and afterward with the face of the mallet until the proper form and size are nearly attained; it is next planished and afterward smoothed with a light hammer muffled with parchment at each end. To facilitate handling, the reflector is slung in a flexible frame counterbalanced by a weight suspended from a cord passing over pulleys. It is finally finished by carefully beating up all depressions, the accuracy of the work being continually tested by a gage or templet.

Fig. 4284.



Reflector-Making.

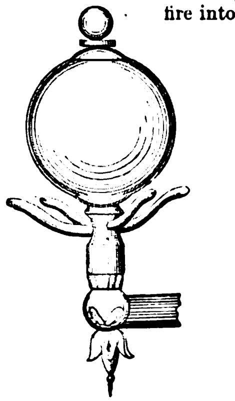
Fig. 4235 is a reflector for workshop and household purposes. It has a globular polished surface, so that the light of the several gas-jets by which it is surrounded may be equally diffused on every side.

Murch's reflector for lamps of street cars has a pair of parabolic reflectors *a a*, *b b*, joined at their apexes, where a portion of each is removed. At this central position, which is approximately at the foci of the reflectors, is a lamp *c*, whose beams are thus thrown in both directions in nearly horizontal beams of limited lateral divergence.

2. A short name for the REFLECTING-TELESCOPE (which see).

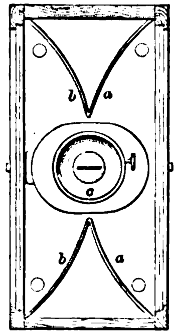
3. The reflector has also been extensively used for radiating the heat from an open fire into an apartment.

Fig. 4235.



Gas-Light Reflector.

Fig. 4236.



Street-Car Lamp-Reflectors.

Dr. Franklin and Count Rumford appear to have been the first who put forward intelligent ideas on this subject.

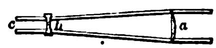
As early as 1795, a patent was taken out in England for a removable reflector, and in 1805, polished metallic reflectors were placed on each side of the fireplace, to be turned at any angle to reflect the heat of the fireplace into the room. In 1816, the fire-grate was inclosed in a hollow metallic globe opening in front of the grate. In 1852, the hearth, cheeks, and faces of the grate were made of polished steel. Several devices for radiating heat were patented in this year.

Sylvester's invention for this purpose is described as follows: The hearth is formed of a framework of hollow radiating metallic bars, diverging and fanlike in arrangement, upon the farthest end of which the fuel is supported. The air for combustion passes through the hollow bars to the fire, which also derives a supply in front in the usual way. The ends of the bars on which the fuel rests become intensely hot. The remaining portion or hearth from conduction becomes likewise heated, and radiates its warmth around. The fire, being situated upon the hearth, allows the greatest possible length of surface to the cheeks or sides of the stove, which are of polished metal, and contribute greatly to the amount of heat afforded by radiation. The smoke escapes through the apertures of a kind of louver at the back, and the ashes pass between the bars into a receptacle beneath.

Re-fract'ing-tel'e-scope. A telescope in which the rays are refracted by an object-glass, at whose focus they are viewed by an eye-piece. It is the ordinary form of telescope. See TELESCOPE; ASTRONOMICAL TELESCOPE; EQUATORIAL, TERRESTRIAL REFRACTING-TELESCOPE, etc.

The original form of the telescope, as used by Galileo, had a convex object-glass and a concave eye-glass.

Fig. 4237.



Galilean Telescope.

The rays converged by the object-glass *a* fall upon the double concave lens *b*, which intercepts them before they arrive at the principal focus, where they would make an inverted image. Being thus rendered parallel, they give a distinct vision to the eye at *c*.

The lens *b* is therefore placed between the object-glass and the image, and at a distance from the image equal to its principal focal distance. The magnifying power is equal to the focal length of the object-glass divided by the focal length of the eye-glass.

Re-frac'tion-cir'cle. (*Optics.*) The refraction-circle of the Washington Observatory was made by Ertel and Son, of Munich. The telescope has a clear aperture of 7 inches, and is $8\frac{1}{2}$ feet in length. It is supported in the middle of the axis between two piers, and it has two circles of 4 feet diameter, one on each end of the axis, divided on gold into arcs of

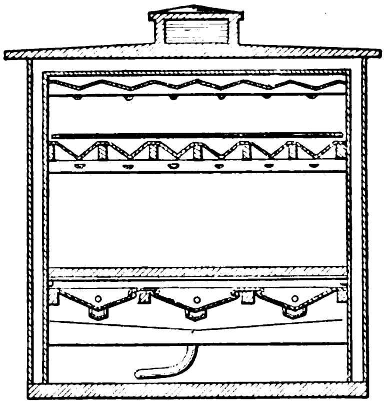
2′. Each circle is provided with six reading microscopes. See also TRANSIT-CIRCLE.

Re-fract′or. A refracting-telescope. See TELESCOPE.

Re-frac′to-ry. (*Pottery.*) A piece of ware covered with a vaporable flux and placed in a kiln, to communicate a glaze to the other articles; an operation termed *smearing.*

Re-frig′er-at′ing-cham′ber. An apartment for the storage of perishable provisions during warm weather. It is frequently a structure in connection with an ice-house. In the example, the ice is stored overhead and the meat or vegetables in the larger room beneath. The cool air descends by gravity and displaces the moist and warmer air, which ascends.

Fig. 4238.



Refrigerating-Chamber.

The moisture condenses upon the ceilings of the meat-chamber and the ice-chamber, which are formed of angularly corrugated metallic plates; and the drip from the salient angles is caught in troughs by which the liquid is conveyed to the exit-pipe.

Re-frig′er-a′tor. Refrigeration, natural or artificial, is used for keeping animal or vegetable substances by reducing the temperature below the point of fermentative disorganization. Such are fruit and meat cellars and cars.

Wort, mash, or beer coolers are of this class; also apparatus for reducing the temperature of wine must, the juice of sugar-cane or beets.

Saccharine juices and wines may be concentrated to a certain extent by freezing; the watery particles becoming congealed are removed, leaving the remainder of a greater strength.

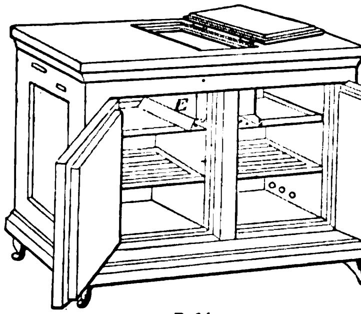
1. A *refrigerator* for cooling wort consists of a large shallow vat traversed by a continuous pipe, through which a stream of cold water is passed. The *wort* runs in one direction and the water in the other, so that the delivery end of the wort is exposed to the coolest part of the stream of water. See also LIQUID-COOLER; BEER-COOLER.

2. (*Steam.*) *a.* A casing with connecting-tubes, through which feed-water passes on its way to the boiler, and is warmed by the current of hot brine passing in the other direction, on the outside of the tubes. The hot brine, at a temperature of say 218° Fah., is that which has been removed from the boiler by the *brine-pump.* The term *refrigerator* is a misnomer. It should be called a feed-water *heater.* The latter name is applied to a somewhat similar arrangement in which the feed-water is heated by exhaust steam.

b. The chamber in one form of condenser, in which the injection-water (fresh) is cooled by a surface application of cold sea-water. See INJECTION-CONDENSER.

3. (*Domestic.*) A chest or closet holding a supply

Fig. 4239.

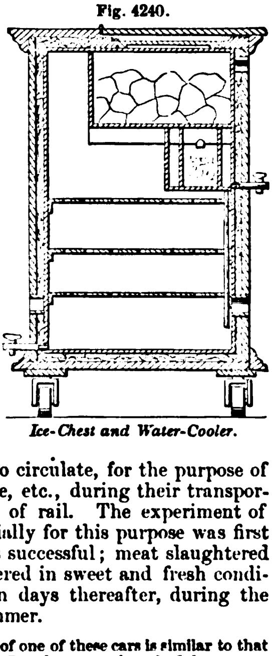


Refrigerator.

of ice to cool provisions and keep them from spoiling in warm weather. In the example, a vertical channel divides the refrigerator into two separate chambers, each partitioned into three receptacles. Air circulates between the interior and exterior walls. Two front doors and one on top afford access. *E* is the ice-box which cools the air in each of the side chambers.

Fig. 4240 shows a chest whose melting ice passes through a filter into a chamber, whence it is drawn as ice-water. Drip and water of condensation are withdrawn at the lower faucet.

Fig. 4240.



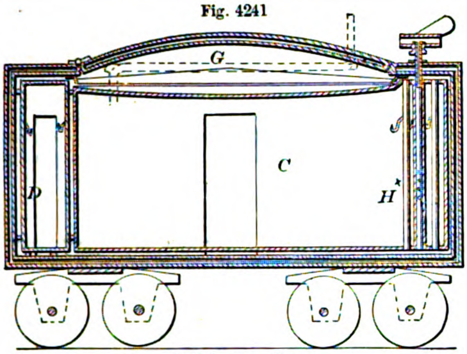
Ice-Chest and Water-Cooler.

Re-frig′er-a′tor-car. (*Railway.*) A car through which a current of artificially cooled air is caused to circulate, for the purpose of preserving meats, game, etc., during their transportation over long lines of rail. The experiment of constructing cars specially for this purpose was first tried in 1867, and was successful; meat slaughtered in Illinois being delivered in sweet and fresh condition at New York ten days thereafter, during the hottest part of the summer.

The external appearance of one of these cars is similar to that of an ordinary freight-car. In a box at each end of the car are blocks of ice placed on a grate in such a manner as to allow a current of cold air to circulate constantly through a flue near the top of the car, over the ice, down to the floor, then up among the poultry, mutton, and beef, and again around through the flue and over the ice. The circulation of air is effected by a large ventilator-wheel placed horizontally at the top of the car near the middle. The forward movement of the car keeps this wheel in motion, which, in turn, produces a current of cold air constantly from the ice to the meat in one direction, and from the meat to the ice in another direction. By this means, every piece of meat is kept at a uniform temperature of about 40° Fah. The cars are built double all around, with inside double doors, filled in with charcoal, and have a capacity for holding two tons of ice. At the principal stations they are carefully examined, and ice added whenever it is deemed necessary.

Wood's has a plurality of chambers *C D* for through and way freights; the ice-box *G* is covered by a hinged door, and air is, by means of the car-ventilator, caused to circulate through the

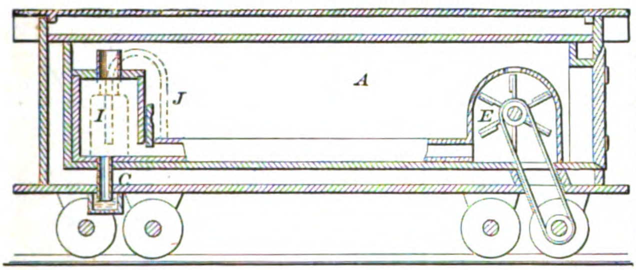
Fig. 4241



Refrigerator-Car.

open spaces between them and the walls of the car. Hollow pillars *H* carry hooks from which the meat is suspended.

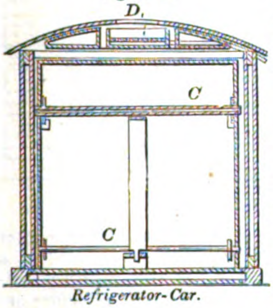
Fig. 4242.



Refrigerator-Car.

In Bray's, the refrigerating-chamber *A* is surrounded by an air-space. Air is forced by the blower *E* into the chamber through an ice-box *I*, which may contain a case in which is a freezing mixture, in this case passing through the pipe *J*. The water is drawn off by a trap *C*.

Fig. 4243.



Refrigerator-Car.

McCrea's has an ice-box *D* at top. The cooled air by its superior density descends between the inner and outer walls of the car and circulates through the pipes *C C*, passing from side to side, thus refrigerating the air of the chamber, which is at the same time kept comparatively dry, as the vapor-laden air from the refrigerator does not enter the chamber.

Re-frig'er-a-to-ry. A chamber, vessel, or pipe in which a cooling is effected, as, —

1. The worm of a still. See STILL.

2. (*Steam-engine.*) *a.* The condenser of an engine. See CONDENSER.

b. A form of heater in which feed-water extracts a portion of heat from the hot water driven out of the boiler by the brine-pump.

3. The worm or chamber of a liquid-cooler for beer, wort, wash, etc. See LIQUID-COOLER; BEER-COOLER.

4. The chamber in which ice is artificially formed. See ICE-MAKING MACHINE.

5. (*Domestic.*) The chamber in which provisions are kept by exposure to a cool atmosphere. See PRESERVING FOOD; REFRIGERATOR; ICE-CHEST; ICE-SAFE, etc.

Re-fus'al. (*Hydraulic Engineering.*) The resistance to farther driving offered by a pile. For instance, the refusal of a pile intended to support 13½ tons may be taken at 10 blows of a ram of 1,350 pounds, falling 12 feet and depressing the pile .8 of an inch at each stroke.

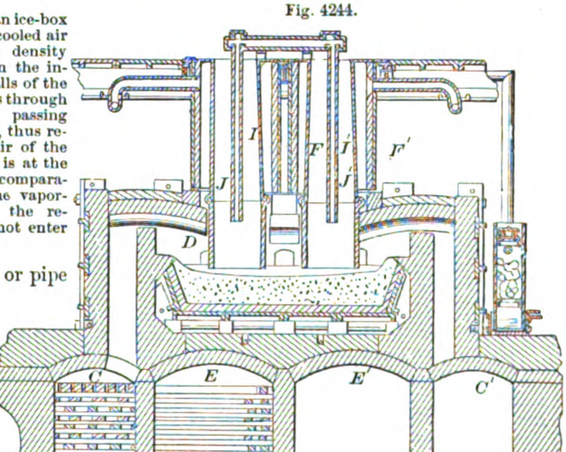
Re-gen'er-at'ing-fur'nace. A furnace in which the outgoing heated volatile products are caused to heat a mass of material, which, when the direction of the current is reversed, heats the incoming air or gas with which the furnace is supplied.

In Siemens's apparatus both heated vapor, or vapor and steam, and atmospheric air are passed through the regenerators and consumed in the furnace. It has of late been extensively employed for glass, pottery, and metal-reducing furnaces, and in the production of steel, either directly from the ore or from iron.

Fig. 4244 illustrates an apparatus particularly designed for making steel from the ore. *C C'*, *E E'*, are the regenerators. These are filled in with fire-brick, so laid as to leave a large number of passages between them, through which the air or gas may circulate on its passage to and from the furnace.

Heated gas from the *producer*, a furnace in which gases are generated by the combustion of coal, and into which steam may be injected to form hydrogen gas by its decomposition, passes through a pipe to the generator *C* at the same time that a current of hot air is passing through the generator *E*. These are conducted to the furnace *D* by pipes *J J'* in the cylinders *I I'*, through which the mixed ores, charcoal, and flux, if any, are introduced. A quantity of pig-metal is placed in the bottom of the furnace, and the reduced ore from the cylinders *I I'* is forced downward and mixed with it, and spiegeleisen added if required. The mingled air and gas, having effected the work of reduction, pass out through the generators *C' E'*, and are conducted away to the chimney. Chambers *F'* on either side of the furnace also communicate with it and with the chimney. When the generators have become heated to a thoroughly white heat, the currents are, by means of a reversing valve, diverted so as to flow in the opposite direction, entering through the generators

Fig. 4244.



Metallurgical Furnace.

C' E' and passing out through *C E*. The products of combustion are thus alternately heated by each set, and cooled by the other, to which they impart their heat, so that when discharged

into the chimney they are at a comparatively low temperature.

Re-gen'er-a-tor. A device to abstract the head from an escaping volume of air or gas, in order that it may be imparted to a body of incoming air. The object is economy of fuel by conservation of heat.

An illustration of this may be found in the air-engine of Glazebrook, English patent, 1797, and in Stirling's English patent, 1816. The latter had the metallic sieves of wire gauze afterward adopted by Ericsson. Their use in this connection is a fallacy. See AIR-ENGINE. See also REGENERATING-FURNACE.

Reg'is-ter. 1. A device for automatically indicating the number of revolutions made or amount of work done by machinery, or recording steam, air, or water pressure, or other data, by means of apparatus deriving motion from the object or objects whose force, distance, velocity, direction, elevation, or numerical amount it is desired to ascertain.

There are various special appliances of this kind, each particularly adapted for the peculiar operation which is to be investigated; many depending on the action of clock-work mechanism, which indicates results on dials, but others, as in registering meteorological instruments, having means for recording varying conditions, as with the *anemometer*, *barograph*, etc.

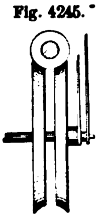
As counters, are the various devices known as ARITHMOMETERS (which see). These, in their primary intention as calculating instruments, are not mere registers, but they are attached to other devices to keep count of motions, and so become *registers* or *recorders*. Instances may be found in the recording devices of

Billiard-registers.	Steam-engine registers.
Counting-registers.	Street-car registers.
Furnace-registers.	Telegraph-registers.
Granary-registers.	Time-registers.
Measuring-registers.	Ventilation-registers.
Passenger-registers.	Watchman's registers.
Printing-press registers.	Weighing-registers
Speed-recorders.	See also list under METERS.

The device so common in arithmometers, calculating-machines, and registers, consisting of a series of wheels numbered 0 to 9, and gearing into each other, so as respectively to represent units, tens, hundreds, etc., was invented by Pascal when 19 years of age (1650).

Among the applications of gearing to produce extremely slow motions which may be utilized in counting, and are, therefore, applicable to registers, may be cited epicyclic and differential gears.

Fig. 4245.



Differential Counter.

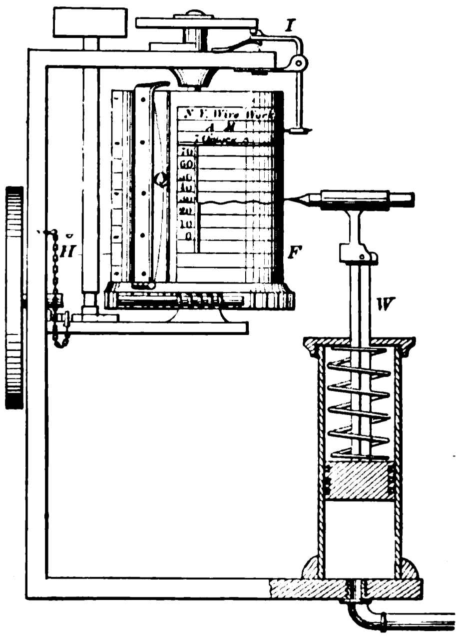
The matter as to the former has been considered at as full a length as admissible under EPICYCLIC TRAINS (which see).

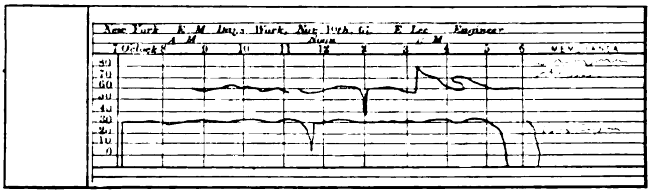
A differential device is shown in Fig. 4245. Two worm-wheels of equal diameter (teeth omitted in the illustration) have respectively 100 and 101 teeth, and are in gear with the same worm. One wheel gains 1 revolution over the other during 10,100 revolutions of the worm. Each wheel has an index-finger, and the angular distance between them on a graduated dial will form a register.

Watt first applied a *register* to the steam-engine to count the strokes.

The term *register* is also applied to a *recording indicator* (see INDICATOR), as in the example (Fig. 4246), in which an endless roll of paper wound on to the upright cylinder *F* and held thereto by a pad *Q* is uniformly drawn off therefrom by the roller *H* rotated by connection with the engine. Clock-work mechanism causes a point at the lower end of the lever *I* to puncture the paper at hourly intervals. The paper being previously ruled with vertical hour-lines with intervals corresponding to a given rate of speed, the relation of the punctures to these lines indicates whether the engine has been run at the proper ve-

Fig. 4246.





Clarke and Edson's Steam-Pressure Register.

locity. The rate of pressure is recorded by a marker on the piston-rod *W* of a cylinder connected by a pipe with the steam-chest. For this purpose horizontal lines corresponding to different pressures are ruled on the cylinder.

The rolling-mills in the United States Mint at Philadelphia are provided with dials having a hand indicating the exact distance between the rolls. It is the invention of Franklin Peale. A crank on the arbor of the index-hand is the means of adjusting the *set* of the rolls, and certain points on the graduated dial indicate the distance for half-dimes, dimes, quarters, gold dollars, eagles, and all the varieties of coin which are made at the mint. The process of rolling is called *breaking down*, and the ultimate size is obtained by repeated rolling, perhaps ten times for gold and eight times for silver. The register is set to a certain mark for each thickness, to which the bar is reduced during the successive rollings.

2. (*Printing.*) Agreement of two printed forms to be applied to the same sheet, either on the same or the respective sides thereof.

The former is used in chromatic printing, where a number of colors are laid on consecutively.

The latter is found in book and newspaper printing, where the correspondence of pages or columns on the respective sides is required.

The registering apparatus of the printing-press consists of points which pass through the paper and serve as guides for relaying the paper on the tympan in printing a second color, or as guides in folding.

3. (*Heating.*) A sliding plate acting as a damper or valve to close or open an aperture for the passage of air. As, —

a. The draft-regulating plate of a stove or furnace. Sometimes connected with a pivoted plate in the chimney, so as to be self-operating. The damper-plate of a locomotive engine.

b. A perforated plate governing the opening into a duct which admits warm air into a room for heat, or fresh air for ventilation, or which allows foul air to escape.

Savot in his work "L'Architecture François des Bastimens particuliers," Paris, 1624, is the first to mention the *register-plate.* He credits the invention to the English, saying that it is customary in England when a brazier full of fuel is well lighted, and has ceased to smoke, to pass an iron plate (*porte de fer legère*) across the chimney, and so confine the heat to the room. This plate is the same as the *damper*, but the term *register* is the older.

In the furnaces of the alchemists, openings left for the supply of air, and which could be contracted or closed by pieces of clay, were termed *registers.*

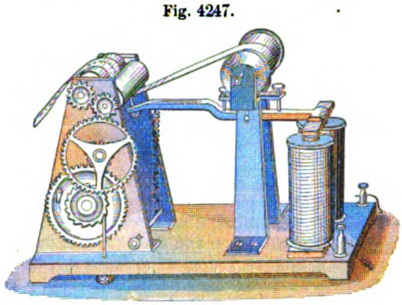
Ben Jonson says: —

"Look well to the register,
And let your heat still lessen by degrees."

4. (*Music.*) A stop of an organ.

5. (*Telegraphy.*) The part of a telegraph apparatus used for recording upon a strip of paper the message received. It consists of a clock-work, which moves the strip of paper at a uniform speed in contiguity to the *stylus* or marking-pen, whose movements are controlled by the electrical current. In

Fig. 4247.



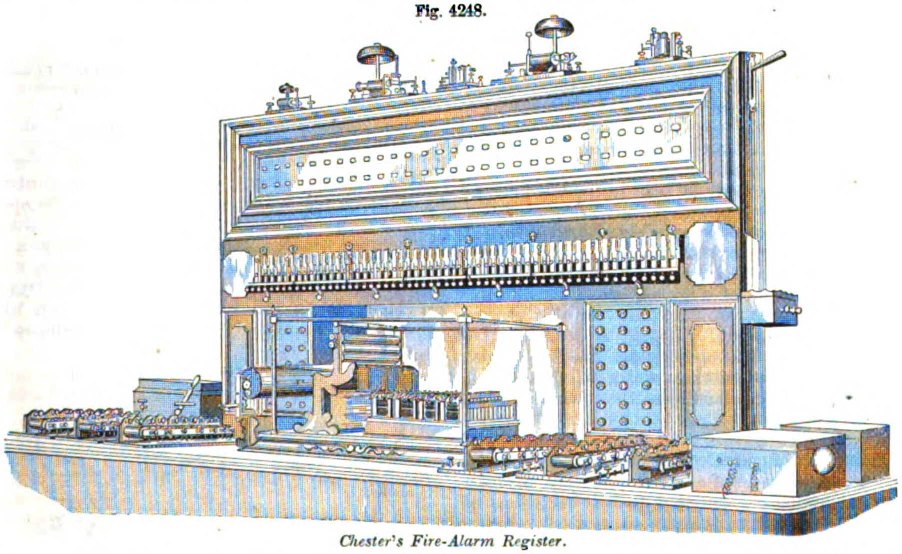
Morse Register.

the ordinary Morse apparatus this stylus is simply a sharp metallic point on the end of the armature lever, which embosses the character on the strip of paper on being brought in contact therewith.

An inking stylus or an inking roller is sometimes used in lieu of a plain stylus.

The fire-alarm telegraph register records all the alarms and tests which are sent into the central office. The line currents from the stations are received through a series of fifty-six relay magnets, which also act upon annunciators indicating the number of the station turned in.

Fig. 4248.

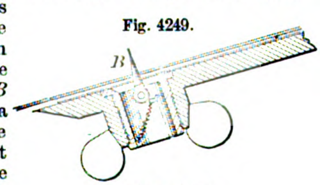


Chester's Fire-Alarm Register.

When a signal is struck at a street box the circuit is broken, the magnet appropriate to that station drops, operating a lever which throws down the annunciator corresponding to that number, rings a bell, sets in motion the register train, carrying forward a broad, endless roll of paper, and by means of a pen, of which there are fifty-six, actuated by as many magnets, imprints the signal on the endless roll. The condition of the line is also hourly tested through this apparatus.

Reg'is-ter-point. (*Printing.*) A device for puncturing or holding a sheet of paper, serving as a guide in laying on the sheet, so that the impressions on each side shall accurately correspond or *register* correctly. One is placed on each side of the table. In the example, the pivoted pointers *B* are snapped by a spring into the sheet and hold it in position till the nippers of the cyl-

Fig. 4249.



Register-Point.

inder draw the sheet, when the point automatically retires.

Reg'is-ter-ing-ther-mom'e-ter. A thermometer in which the column of mercury moves a glass or porcelain bar and leaves it at the maximum or minimum point which is reached by it between observations. See THERMOMETER; MAXIMUM THERMOMETER; MINIMUM THERMOMETER.

Reg'let. 1. (*Printing.*) A strip of wood or metal with parallel sides and of the hight of a *quadrat,* and used for separating pages in the chase, etc.

They are sometimes made type-high to form black borders.

2. (*Architecture.*) A flat, narrow molding, employed to separate panels or other members; or to form knots, frets, and similar ornaments.

Reg'let-plane. A plane used in making reglets or printer's furniture for spacing lines. The adjustable *fences* are screwed fast to the body of the plane, and project from the sole a distance equal to the hight of a *quadrat,* so that when the fences rest on the bench the plane-bit will cut no longer. See cut under ROUNDING-PLANE.

Re-grat'ing. (*Masonry.*) Taking off the surface of an old hewn-stone wall in order to whiten it and make it look fresh again.

Reg'u-la. (*Architecture.*) A band below the tænia of the Doric epistylium, extending the width of the triglyph, and having six guttæ depending from it. It also signifies the space between two adjoining canals of the triglyphs.

Reg'u-lat'ing-screw. A screw used for determining a motion.

The motion of the roller of a copperplate press, upward from the bed, is regulated by screws which bear upon the journal-boxes.

The upper roll of a bar, sheet, or other iron mill is similarly arranged.

The motions of the slides and moving parts of machinery are sometimes regulated by screws, which act as *stops* or *slides.*

Reg'u-la'tor. A mechanical contrivance for equalizing motion.

The generic name may be held to include *governors, thermostats, gas-regulators, fly-wheels, flyers, dampers, pendulums, balance-wheels, throttle-valves, compensation arrangements in timepieces,* etc. These will be found under their specific heads.

1. The brake-band of a crab or crane.

2. (*Steam-engine.*) *a.* The governor of a steam-engine. See GOVERNOR.

b. The *cataract* of a steam-engine. See CATARACT.

c. A device for admitting steam in regulatable quantity to the valve-chamber of the steam-cylinder. See REGULATOR-BOX.

3. (*Furnace.*) A device for regulating access of air to a stove or furnace. Known as a *draft-regulator.* It may consist of a *register, damper,* or *door.* Automatic appliances actuated by the variations of heat are THERMOSTATS (which see).

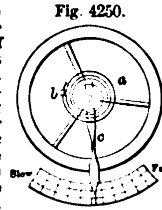
4. (*Horology.*) *a.* A clock keeping accurate time, used for regulating other timepieces.

b. The device by which the pendulum-bob is elevated or depressed.

c. The fly of the striking part of a clock or musical box.

d. An arm which determines the length of the balance (or hair) spring of a watch. By shortening the length of spring involved in the action, the rate of motion is increased, and conversely. On the under side of the arm are two pins, which embrace the spring, the center of motion of the arm being concentric with the arbor of the balance. As the arm is rotated, the pins slip on the spring, the extent of movement of the arm being indicated by a pointer on a graduated arc.

Fig. 4250.



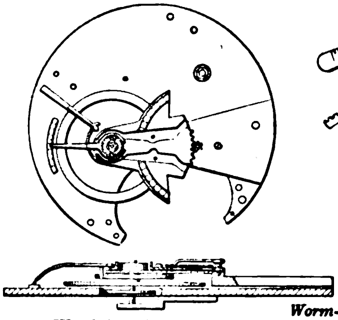
Watch-Regulator.

The balance-spring *a* is attached at its outer end to a stud *b* on the watch-plate, and at its inner end to the staff of the balance. The balance pulsates in one direction under the influence of the main-spring communicated through the train, and is returned by the recoil of the spring after passing the point at which these forces are in equilibrio. The duration of the pulsation is determined by the length of the hair-spring *a*, a longer spring allowing a longer movement of the balance. The lever *c* has two curb-pins, between which the hair-spring passes, and its activity is checked at this point. By moving the lever to the right, the effective length of the spring is decreased, and the pulsations are shortened, the balance moving quicker. When the watch is *too* fast, motion in the other direction corrects it.

Means have been employed for the more delicate adjustment of this arm, other than by a mere push. Among these are the worm-wheel and rack, as in Fig. 4252.

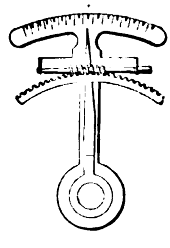
In Fig. 4251, the pointer which carries the pins embracing the hair-spring is connected to a bar having a segmental rack, actuated by a small cog-wheel; the shaft of the latter carries a pointer, by moving which a delicate adjustment is obtained.

Fig 4251.



Watch-Regulator.

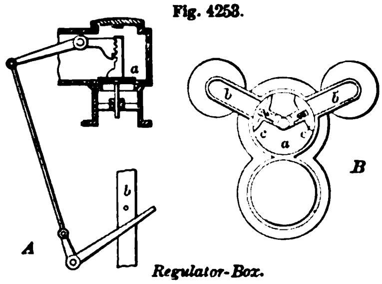
Fig. 4252.



Worm-Wheel Adjustment for Regulator.

Reg'u-la'tor-box. A valve-motion contrived by Watt for his double-action, condensing pumping-engines (*A*). A spindle passes through one side of the box, on which a toothed sector moves as a center, working a rack fixed to a brass valve *a*, which is accurately ground to its seat. The plug-tree *b* is provided with a pin which trips the lever, whose upper arm is connected to the toothed sector, so that the reciprocations of the plug-tree open and shut the valve.

Fig. 4253.



Regulator-Box.

In locomotives (see *B*) a pipe conducts steam from the steam-drum to the regulator *a* connected with the cylinders by two pipes *b b'*, which are opened or closed by the valves *c c'*, operated by a rod running longitudinally of the engine and turned by a lever within reach of the engineer.

The *regulator-cock* admits oil or tallow for lubricating the faces of the regulator.

Reg'u-lus. (*Metallurgy.*) The relatively pure metal which sinks to the bottom of a crucible or a furnace in the fusing and refining process. The slag or scoriæ floats upon it, and is skimmed off or conducted in another direction.

The term is not now often used, except when applied to antimony.

Re-heat'ing-fur'nace. (*Metallurgy.*) A reverberatory-furnace, resembling a puddling-furnace, in which blooms or piles of sheared or scrap iron are reheated for rolling or rerolling. A *balling-furnace.*

Rein. 1. (*Saddlery.*) A strap or cord by which a horse is driven or controlled. The ends of the rein are fastened to the bit-rings, as, —

Driving-rein.	Check-rein.
Bearing-rein.	Gag-rein.
Safety-rein.	Overhead-rein.

The Scythians hung the scalps of their enemies to their bridle-reins. The Red Indians do the same. Attila is similarly represented.

The Japanese bridle-rein is often of silk.

2. (*Architecture.*) A *springer* or lower *voussoir* of an arch, which rests upon the *imposts.*

3. A rope of twisted and greased raw-hide.

Reins. The handles of a blacksmith's tongs, on which the ring or *coupler* slides.

Re-in-force'. An additional thickness imparted to any portion of an object in order to strengthen it, as, —

1. (*Ordnance.*) The enlarged portion of a cannon, extending from the *base ring* to the *chase.* It is formed in casting, or by shrinking on a band of metal.

The *first reinforce* is that nearest the breech, where the metal is thickest.

The *second reinforce* extends from the termination of the first to a point forward of the *trunnions.* These distinctions are obliterated in American guns of the later patterns.

The *Armstrong gun* (English) is built up of coils and reinforces around a steel tube.

2. A strengthening patch. (See PATCH.) It may be an additional thickness sewed around a cringle or eyelet-hole in a sail or tent-cover; a piece pasted around the buttonhole of a paper collar, etc.

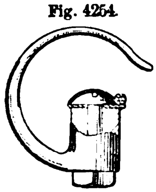
3. A patch on a tube, boiler, tank, etc.

Re-in-force'-ring. (*Ordnance.*) A flat molding at the breech end of the reinforce.

Rein-hold'er. (*Menage.*) A clip or clasp on the dashboard of a carriage, to hold the reins when the driver has alighted.

Rein-hook. (*Harness.*) A hook on a gig-saddle to hold the bearing-rein.

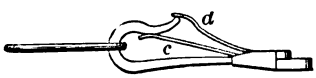
Fig. 4254.



Check-Rein Hook.

Rein-slide. (*Harness.*) A slipping loop on an extensible rein, which holds the two parts together near the buckle, which is adjustable on the standing part.

Fig. 4255.



Rein-Snap.

Rein-snap. (*Harness.*) A spring hook for holding the reins. In the example, one spring *c* retains the ring in the hook, and the other, *d*, forms a mousing to keep anything from accidental engagement with the point of the hook. See also SNAP-HOOK; HARNESS-SNAP.

Reis'ner-work. Inlaid work on the principle of the BUHL (which see). Reisner was a skillful practitioner of the art about the time of Louis XIV. He principally used woods of contrasted colors, while Buhl used metals and tortoise-shell by preference.

Imitations of this and buhl are now made by stamping instead of cutting out with the saw. At Birmingham, devices are stamped from sheet-brass and applied to papier-maché, the intervening depressions being filled up with successive coatings of black Japan varnish. See also BUHL; MARQUETRY; PARQUETRY; INLAYING, etc.

Re-joint'ing. (*Masonry.*) Pointing, as of walls.

Re-lay'. (*Telegraphy.*) A subsidiary electromagnetic circuit made and broken by the primary circuit. By means of the relay-magnet, a current too feeble to produce sensible mechanical effects at a distance is made to set in action an auxiliary current competent for the work. Invented by Professor Joseph Henry. — PRESCOTT, *History of the Electric Telegraph.*

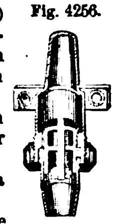
Re-lay'-mag'net. (*Telegraphy.*) A small electro-magnet requiring but a weak current to charge it, and having an armature to which is attached a lever ending in a platinum point, which impinges against a back stop whenever the armature is attracted by the electro-magnet. This back stop and armature form part of the circuit of a local battery to the sounder or register. If the main-line current arriving at an office is too weak to work the sounder or register, the relay is placed in the main circuit and operates to close a local circuit to the sounder or register whenever its armature lever is attracted against its back stop. This device, indispensable on long lines of telegraph, was invented by Professor Henry. See MORSE INSTRUMENT.

Re-lief'. 1. (*Sculpture.*) The prominence of a sculptured figure from the plane surface to which it is attached. According to the degree of prominence, it is known as *alto* or *high relief, mezzo* or *demi-relief,* and *basso* or *low relief.* See RILIEVO.

2. (*Fortification.*) The total hight of the parapet above the bottom of the ditch.

Re-lief'-valve. 1. (*Steam-engine.*) A valve belonging to the feeding apparatus of a marine-engine, through which the water escapes into the hot-well when it is shut off from the boiler.

Fig. 4256.



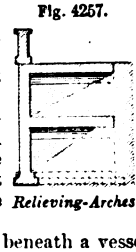
Relief-Valve for Beer-Engine Pipes.

2. A valve so arranged as to open outward when a dangerous pressure or shock occurs, to allow escape of water.

3. A valve to allow access of air to a barrel from which liquor is drawn.

Re-liev'ing-arch. An arch at the back of a revetment or retaining wall, to relieve the pressure of the bank upon the wall, and act as a tie or interior buttress. Arches of this description have their axes and the faces of their piers at right angles to the face of the bank. The front end is usually closed by a vertical wall. The arches of two stories are shown in section, with the retaining wall, and a talus of soil occupying a part of the space beneath each.

Fig. 4257.



Relieving-Arches.

Re-liev'ing-tack'le. (*Nautical.*) *a.* A tackle temporarily attached to the end of the tiller, to assist the helmsman in bad weather, and act as a guard in case of accident to the tiller ropes or wheel.

b. A tackle from a wharf passed beneath a vessel when careened, and secured to the opposite side, to

act as a guard against upsetting and to assist in righting.

Rel'ish. (*Joinery.*) The projection of the shoulder of a tenoned piece beyond the part which enters the mortise. See TENON.

Rem'bérge. (*Vessel.*) A long, narrow, low rowing vessel of war, formerly used by the English.

Rem'blai. (*Fortification.*) The elevated portion of earthworks formed by the disposition of the *déblai*, or excavated materials.

Re-lief'-line En-grav'ing. The process of Mr. Palmer of England, about 1840, in which a blackened copper plate is covered with a ground of a definite thickness of sulphate of lead, wax, and resin; a tracing or photographic image is transferred to the *ground;* the ground is cut away by gravers or etching-points, so as to make lines down to the metallic surface, which is blackened so as to enable the effect of the work to be seen. The plate then receives a coating of graphite, and an electro-cast is made, forming a raised surface from which to print.

The hight of the little ridges in the cameo cast in copper is equal to the depth of the ground through which the design was cut. In the broad spaces — the lights, where the lines are at a considerable distance apart and there is a danger of ink attaching itself to the plate in inking — wax is dropped upon the ground before *blackleading*, so as to make elevations at those points which become depressions in the electro-cast.

This process was adopted by Jewett and Chandler of Buffalo for many years in making the cuts for the Patent Office reports, and is still practiced by Mr. Chandler in making the cuts forming the illustrations of this Dictionary and numerous other works.

Re-lief'-pro'cess. See PHOTO-RELIEF PROCESS.

Rem'e-dy. (*Coining.*) The allowance at the mint for deviation from the exact standard fineness and weight of coin. In England the *remedy of the mint* is: Gold, 12 grains per pound in weight; $\frac{1}{16}$ of a carat in fineness. Silver, 1 dwt. per pound in weight; 1 dwt. per pound in fineness. Copper, $\frac{1}{40}$ of the weight, both in weight and fineness.

The remedy of United States gold coin is, double-eagle, one half grain; smaller gold coins, one quarter grain.

On coin in bulk, $\frac{1}{100}$ of an ounce in 5,000 gold pieces of the denominations $20, $10, $5, $2.50; $\frac{1}{100}$ of an ounce in 1,000 gold pieces of the values $3 and $1.

The remedy on United States silver coin is $1\frac{1}{2}$ grains to the piece. Or, on coin in bulk, $\frac{3}{100}$ of an ounce in 1,000 silver pieces of the values $1, 50 c., 25 c.; $\frac{1}{100}$ of an ounce on 1,000 dimes. On the minor coins, 3 grains for the 5-cent piece; 2 grains for the 3 and 1 cent pieces.

Re-mon'toir. (*Horology.*) A mechanism designed to render the force which sustains the movement of the escapement perfectly even.

Re-mon'toir-es-cape'ment. An escapement in which the scape-wheel is driven by a small weight raised by the clock at intervals of thirty seconds, usually; or by a spiral spring on the scape-wheel arbor, wound up a quarter or half turn at the said intervals.

Rem'o-ra. (*Surgical.*) An instrument to retain parts in place; as one to keep the intestines from protruding at the inguinal ring after the operation of castrating, or one to maintain a fracture in place or a luxation reduced.

Ren'der. 1. (*Nautical.*) To pass through the block; said of a rope. To *reeve.* To *rack* a tackle is to seize the parts together and prevent *rendering.*

2. To try out lard or tallow.

Ren'der-ing. 1. (*Plastering.*) The first coat of plaster on brick-work. It is followed by the *floating* coat and the *setting* coat, the latter of *fine* stuff.

The first coat is sometimes termed the *pricking-up* coat. When on lath it is said to be laid. *Rendered* and *set* is complete two-coat work on brick or stone.

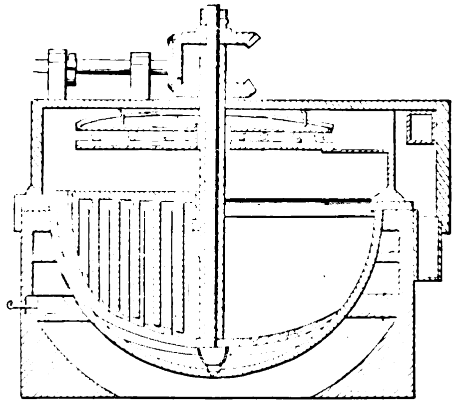
2. The process of trying out oil or lard from fat. See RENDERING-APPARATUS; LARD-TANK.

Ren'der-ing-ap'pa-ra'tus. An apparatus for extracting oil and lard from fatty animal matters. The object to be attained is to separate the purely oleaginous part from the cellular tissue inclosing it. In household economy this is effected by simply heating the fat, previously cut into small pieces, in an open vessel over the fire; this separates the greater part of the purely oily matter. The scraps, called *cracklings*, are freed from the remainder by straining and pressure.

Somewhat more complicated arrangements are introduced when the process is conducted on a large scale, in order to more perfectly extract the oily matter with economy of labor and material.

Black's apparatus consists of a pan set in a furnace, which has two flues, the lower one communicating with the fireplace by means of apertures,

Fig. 4258.

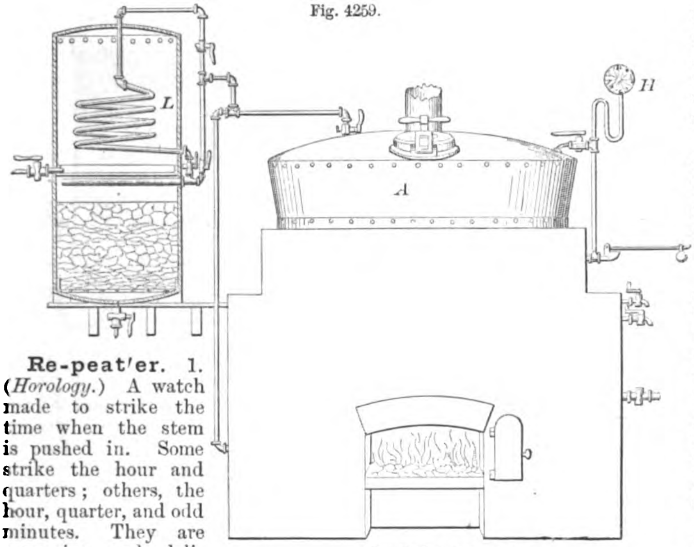


Rendering-Pan.

which may be closed when desired by dampers. The pan has a perforated false bottom, and in the space between the bottom and false bottom is arranged a rotary stirrer. Above the false bottom is a hollow rotary shaft provided with arms. The pan has a tight cover, to which are suspended two plates, the upper one being provided with gutters. The interior of the pan communicates with a condenser which is connected with a drain or sewer. The vapors are condensed by means of cold water supplied by perforated boxes.

Gray's apparatus (Fig. 4259) consists of a closed tank or kettle *A* having a jacket covering the part which comes in contact with the fire. The space contains water, which is heated so as to render the lard in the kettle. The vapors and gases which escape from the lard during the process of rendering are carried through a coil *L* in a condenser, and afterward through a gas-purifier, or they may be conducted into the furnace and burner. A gage *H* indicates the amount of steam-pressure; try-cocks at different hights are provided for drawing off the lard in a fluid state. See also LARD-BOILER; LARD-TANK.

Fig. 4259.



Rendering-Apparatus.

Re-peat'er. 1. (*Horology.*) A watch made to strike the time when the stem is pushed in. Some strike the hour and quarters; others, the hour, quarter, and odd minutes. They are expensive and delicate, owing to the assemblage of so many parts within so limited a space.

Some *repeaters*, in addition to their announcement of the hour when called on, will strike the hours and quarters as they recur. A *striking* watch merely has not the faculty for *repeating* when called on so to do.

Alarms are also attached to watches. The machinery is somewhat similar to that of the alarm-clock.

James II., in person, heard arguments on interfering applications for patents for repeating-watches (Barlow *vs.* Quare), and decided in favor of Quare (1676). Priority of invention belonged, however, to Barlow, who employed two pins to strike the hours and quarters, while Quare afterward effected this with one only.

The smallest repeating-watch ever known was made by Arnold for George III., to whom it was presented on his birthday, June 4, 1764. Although less than six tenths of an inch in diameter, it repeated the hours, quarters, and half-quarters, and contained the first ruby cylinder ever made. Its weight was that of an English silver sixpence. Arnold made it himself, and also the tools employed in its construction. The king presented Arnold with 500 guineas ($2,500) for this curious watch, and the Emperor of Russia afterward offered the maker 1,000 guineas for a duplicate of it, which Arnold declined.

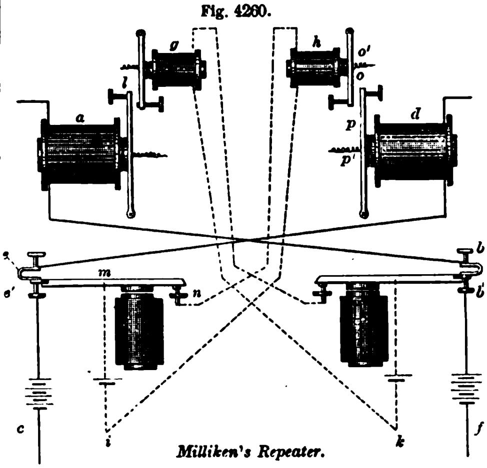
2. (*Fire-arms.*) An arm which may be caused to fire several successive shots without reloading. In Colt's and other revolvers, the charges are placed in chambers in a rotating cylinder, and brought successively in line with the barrel; while in the Spencer, Winchester, and Henry rifles, and others of that class, a number of the cartridges are inserted in a chamber at the butt or beneath the barrel, and fed and discharged singly by mechanism connected with the lock devices; metallic cartridges only are employed, the case being automatically ejected after each discharge. See FIRE-ARMS; REVOLVER.

3. (*Telegraphy.*) An instrument for automatically resending a telegraphic message at an intermediate point, when, by reason of length of circuit, defective insulation, etc., the original line current becomes too enfeebled to transmit intelligible signals through the whole circuit. The original circuit being divided into two or more shorter circuits, the sounder or armature lever of one circuit opens and closes another circuit by an action similar to that of a *relay*.

Fig. 4260 is a plan of Milliken's. The main-line wire from one direction (west, for example) passes through the relay-magnet *a* and the repeating points *b b'* of the opposite sounder, and thence to the battery and ground at *f*; the eastern line passes through *d*, *e e'*, and to *c*.

The extra local magnets *g h* are so arranged that when either of their armatures is released, it is drawn back by the spring attached to its lever, bringing the latter firmly in contact with the armature lever of the corresponding relay. The dotted lines show the circuits from the extra local batteries at *i k*. If the main circuit be broken in the western wire, the relay *a* breaks the local circuit in the sounder at *l*. The movement of the lever *m* of the sounder first breaks the extra local circuit at *n*, causing the magnet *h* to release the armature *o* which is drawn back by the spring *o'* against the top of the lever *p*, and the eastern main circuit is also broken at *e e'*. The lever *p* is prevented from falling back when the circuit of *d* is broken by the tension of the spring *o'*, which is so adjusted as to be greater than that of the spring *p'*. The apparatus on the right-hand side of the repeater therefore remains quiet while the west is working, and *vice versa;* the current through *d* being always restored before that through *h* is broken, which is effected by the U-shaped spring on the screw *e*.

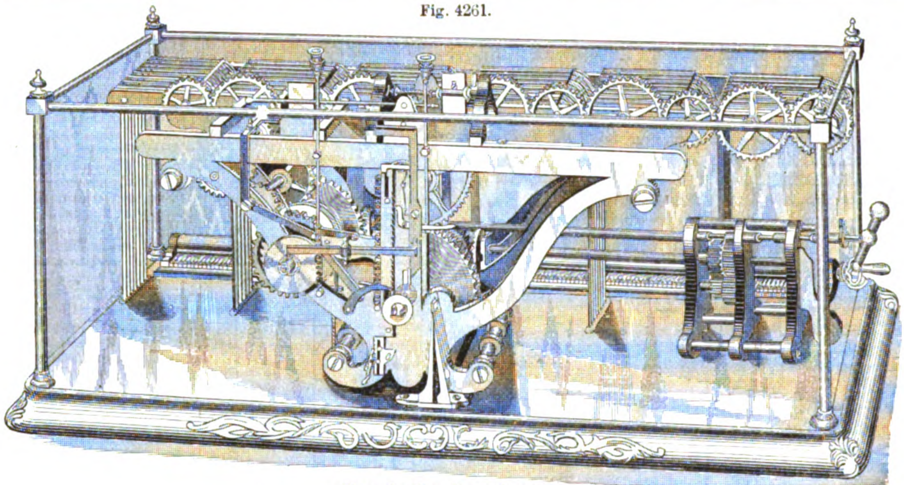
Fig. 4260.



Milliken's Repeater.

Fig. 4261 is a fire-alarm telegraph-repeater. It has a series of large broad-faced circuit-wheels having teeth, in sets of 8, arranged spirally on its periphery. These are faced with platinum, and as the wheels are revolved by clock-work and weight, make contact with springs also armed with platinum and arranged in sets of 8, throwing the current into the line wires to the different stations in order, or to such of them as the operator may desire. Those not wanted are thrown out of circuit by a switch-board. Numerical signals from 1 to 998 may be transmitted. In order that these may be repeated automatically, a series of toothed regulating-wheels, so arranged as to be readily attached or detached, is provided. Each of these has only the teeth corresponding to the particular signal which it represents, and when placed in the train the current is not transmitted through the current-wheels by the springs which make the circuit through it and the circuit-wheels, when the interspaces between the omitted teeth are out of contact with the springs. The times in which these and the circuit-wheels make a revolution are automatically adjusted, so that equal intervals shall elapse between the striking of each tap of the signal, which denotes the units, tens, or hundreds, as the case may be; the

Fig. 4261.



Chester's Fire-Alarm Repeater.

gearing then ensures a complete revolution of the circuit-wheel; the remaining part of the signal, if it consists of more than one place of figures, is struck in a similar way, and the operation is continuously repeated until the regulator-wheel is displaced.

Re-peat′ing-cir′cle. A reflecting-instrument, on the principle of the sextant, for measuring angular distances. The image of one of the observed objects, after being reflected from a mirror on a pivoted arm and again from a fixed mirror, is brought into coincidence with the other seen by direct vision; the *apparent* angular distance is thus doubled, and the graduations of the circle, which are continued all the way around its limb, thus embrace 720° of arc.

It was first invented by Mayer about 1744. Borda, after whom it is frequently called, in 1780, introduced a second arm and vernier, to which Troughton subsequently added a third.

The mean of the readings given by each arm is taken as the true angular measurement, which may be repeated continuously around the circle, bringing a different part of the limb into use at each repetition, thus tending to eliminate errors of centering and graduation.

Notwithstanding the accuracy theoretically obtainable by this principle, there appears to be, says Sir John Herschel, some constant source of error in this instrument which in a large degree counterbalances its theoretical advantages. It has consequently never come into extensive use either in this country or England. See REFLECTING-CIRCLE; SEXTANT; QUADRANT.

Re-peat′ing Fire-arm. One which discharges several successive shots without reloading.

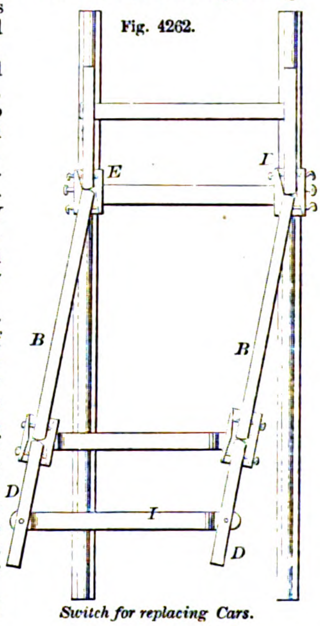
"After dinner was brought to Sir W. Compton a gun to discharge seven times, the best of all devices that ever I saw, and very serviceable, and not a bawble; for it is much approved of, and many thereof made." — PEPYS'S *Diary*, 1662.

In the armory of the Tower of London are several Indian pieces known to be as old as the fifteenth century, and in principle similar to our revolvers. They have the defect of liability to ignite all the charges at once, and were abandoned as dangerous and useless. Specimens of British and French manufacture are in the museums of England and France; and the fire-arms of Collier, an American gunsmith, 1818, and of another American in 1819, have the defects of their predecessors. Colonel Colt is believed to be the first inventor of a really available repeating pistol. (TEMPLE.) His first device was a number of barrels, but he subsequently devised the rotating cylinder breech and single barrel. See also MAGAZINE FIRE-ARM; REVOLVER.

Re-peat′ing-watch. (*Horology.*) One constructed to strike the hours and quarters when the stem is pushed in. See REPEATER.

Re-plac′ing-switch. A device forming a bridge by which the wheels of cars are replaced upon the track. A section is laid upon each track, and has a shoe *E* to which an inclined piece *B* is jointed. The inclined section rests upon another shoe. *D I* are farther extension-pieces which are pushed in below the wheels.

Fig. 4262.



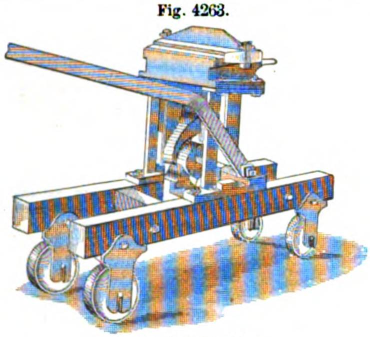
Switch for replacing Cars.

Re-pous-sé′-work. A kind of chasing. It is effected entirely by the hammer. The workman uses a plain flat sheet of silver, having before him a model of the article to be produced. The plate rests upon a soft bed of pitch or other composition, and with a small hammer the workman produces indentations on the inner surface of the plate, corresponding to the design. A small steel punch is, in some cases, employed; and if the relief is accidentally made too high, it is reduced by counter hammering.

Benvenuto Cellini, 1500 – 70, is celebrated in this and kindred branches of the arts.

Re-press′ing-ma-chine′. A machine for repressing brick after being partially dried. Also used for making brick direct from the clay, in warm climates, where brick are used without burning;

Fig. 4263.

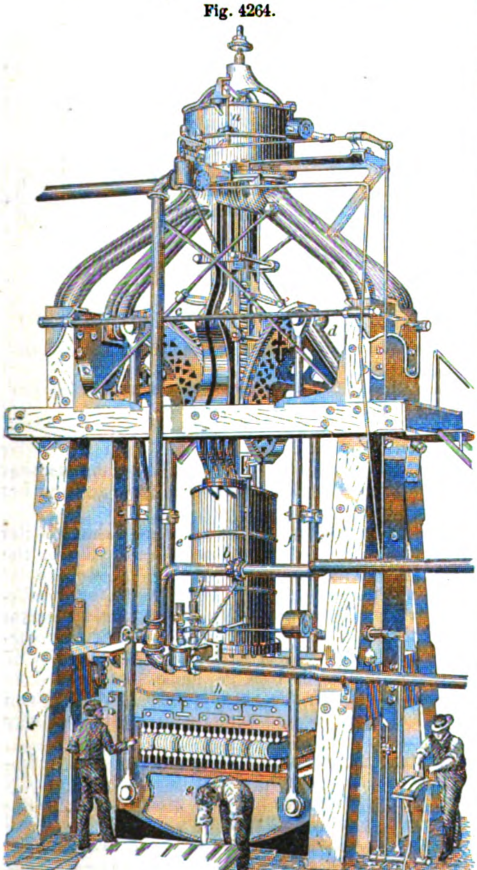


Repressing-Machine.

adobes. In that illustrated, the brick is placed within the mold, the sliding cover which had been pushed aside for that purpose being replaced, the lever is depressed, raising a platen forming the bottom of the mold; on throwing up the lever the reverse movement of the eccentric allows the platen to descend a certain distance, the sliding cover is slipped aside, and a farther upward movement of the lever causes the platen to rise sufficiently to permit the brick to be removed.

Re-press'ing-press. A press designed for compacting bales of cotton, etc., into the smallest possible compass for transportation. Grader's (Fig. 4264) has two steam-cylinders *a b*, the upper one of which is of greater diameter than the lower. The piston of the lower has a ratchet which engages with the toothed arcs *c d*, to whose upper extremities are attached rods *e e' f f'* connected with the platen *g*. Steam admitted below the lower piston causes an upward movement of the segments, which, through the medium of the rods *e e' f f'*, raise the platen and compress the bales placed between it and the immovable bed *h*. If a greater pressure is desired than is thus obtainable, the piston of the large cylinder *a* is caused to descend; a clutch on its piston-rod then engages the teeth on the ratcheted piston-rod of the lower cylinder, and on admitting steam below the upper piston a farther upward movement is imparted to the platen *g* through the medium of the ratchet, arcs, and connecting-rods.

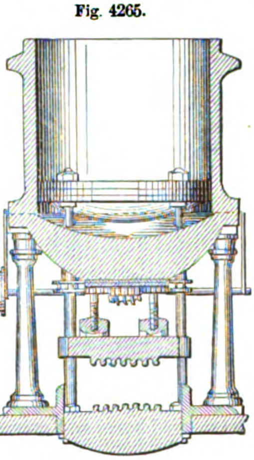
Fig. 4264.



Grader's Repressing-Press.

The power of the press may be varied, — by using the lower cylinder alone; by working the upper cylinder expansively; by working the upper cylinder expansively and the lower under full boiler pressure; and by using full boiler pressure in both cylinders.

Fig. 4265.

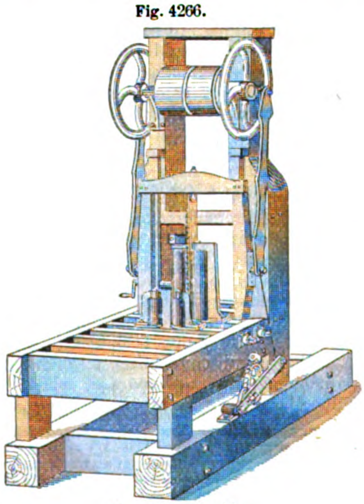


Repressing-Press.

The repressing-press may be of any suitable form and construction, but the steam or hydraulic form shown in Fig. 4265 is compact and effective.

Rere'dos. 1. (*Architecture.*) The wall at the back of an altar or seat. In Gothic churches it is usually in the form of a screen detached from the eastern wall, and is ornamented with niches, statues, etc., paintings, or tapestry. Fine examples occur at Durham and St. Albans, England.

Fig. 4266.



Resawing Machine.

2. A projecting buttress on the back of a fire-place, or a movable plate occupying a similar position. It is called a *fire-back*, and its office is to throw forward the fire, so that it may radiate into the room. Hollinshed calls it a *rere-dorse*.

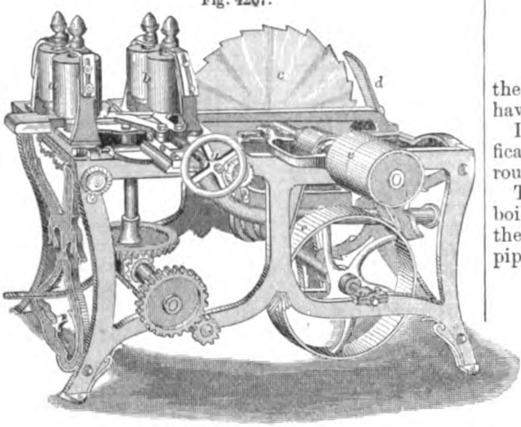
Re-saw'ing-ma-chine'. (*Wood-working.*) A machine for cutting up squared timber into small stuff or boards.

In the machine, Fig. 4266, a reciprocating-saw is employed. The longitudinal feed is effected by the usual vertical rollers, rotated by gear connection with a shaft caused to revolve by a pawl at the end of a lever connected with the journal of the pitman, which causes the reciprocation of the saw-frame.

A hand-crank and screw control the transverse feed of the stuff.

In Fig. 4267, the squared piece to be cut up is drawn between the adjustable feed-rollers *a b*, by which it is presented to the saw *c*; the sword *d* guides

Fig. 4267.



Resawing-Machine.

the severed board and prevents its fouling the operative mechanism. The roller-turning and saw-rotating gears are driven by the band pulleys *e e*, and the transverse movement of the carriage *f* may be effected by turning the hand-wheel *g*.

Re-serve'-style. (*Cotton-manufacture.*) A method of calico-printing in which the white cloth is impressed with figures in resist paste, and is afterward subjected first to a cold dye, as the indigo vat, and then to a hot dye-bath; the effect being the production of white or colored spots upon a blue ground. Also known as the *resist-style*.

Res'er-voir. 1. A pond for containing a supply of water for canal supply, irrigation, or the use of dwellers in cities.

A reservoir erected by Nebuchadnezzar at Sippara was 140 miles in circumference.

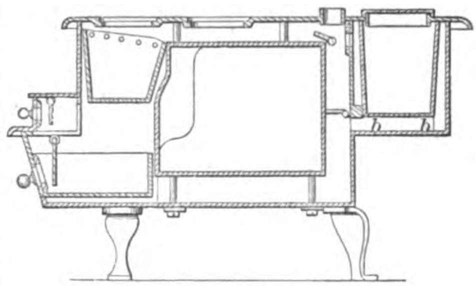
The lake of Mœris, constructed by the Pharaoh of that name to receive the superabundant waters of the Nile at the time of overflow, and afterward yield them for prolonged irrigation, was described by Diodorus Siculus (60 B. C.) as existing till his day. The circuit he gives, 3,600 furlongs, is almost incredible. The canal connecting it with the river was 80 furlongs long and 300 feet wide. Sluices commanded the water-way by opening and shutting.

The reservoir on Mill River, Mass., which burst with immense damage to life and property, May 16, 1874, was an artificial lake between high hills. The confining dam at the lower end was a stone-wall five and a half feet thick at bottom, three feet at the top, and 25 feet high. This wall was about 300 feet long, built of uncut stone from a foundation four feet below the level of the ground at the lower side, and was backed on the upper side with a bank of earth interwoven with branches of trees. The dam had been built eight years at the time of the catastrophe. See DAM.

2. An attachment to a stove or range to hold hot water.

It is heated by proximity to the stove itself or to

Fig. 4268.



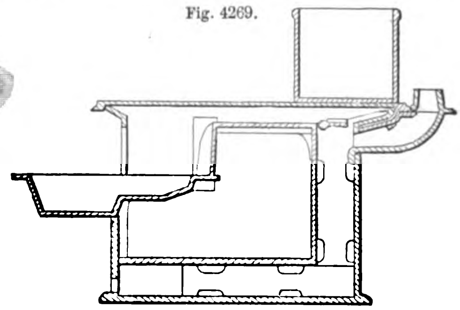
Reservoir-Stove.

the stovepipe. In Fig. 4268, it is behind the stove, having a flue *b b* around and beneath it.

In Fig. 4269, it is on top of the stove. In a modification of the latter form the boiler is made to surround the stovepipe.

The reservoirs of ranges are usually vertical iron boilers, connected by pipes with the water supply of the city. The water from the main passes through pipes in the fire-chamber, or through a water-back,

Fig. 4269.



Stove with Reservoir.

and thence to the boiler. A pipe from the boiler proceeds to the sink to supply hot water at that point, a branch leading to the bath-room and another to the laundry.

Res'er-voir-stove. One having a large boiler attached, to be constantly heated by the fire in the stove. See RESERVOIR.

Re-sid'u-a-ry-gum. Also known as *candle-pitch* or *chandler's gum*. The dark residuary matter from the treatment of oils and fats in the manufacture of stearine. It is darkened by the action of acid, and thence derives its name. It is used in coating fabrics for the manufacture of roofing, and combined with tar and asphate in making mastics and cement.

Res'in. A vegetable product composed of hydrogen, carbon, and oxygen. Distinguishable generally from gum by its solubility in alcohol and insolubility in water, while gums are soluble in water and insoluble in alcohol. There are many varieties of resins, derived from different species of trees. Some are naturally combined with the gums, forming what are known as gum-resins. Both these and the pure

resins are generally termed gums. Resins become negatively electrified by friction. They are largely employed in making varnishes, and some are used as medicines. The most common variety, known as *rosin*, is derived from the distillation of crude turpentine.

Dr Sacc, of Nuenburg, Switz., gives the following summary as to the resins of commerce: —

Copal, amber, dammar, common rosin, shellac, elemi, sandarach, mastic, and Caramba wax can be reduced to powder.

The following will become pasty before melting: amber, shellac, elemi, sandarach, and mastic; the others will become liquid at once.

In boiling water, Caramba wax will melt; common rosin will form a semifluid mass; dammar, shellac, elemi, and mastic will become sticky; while copal, amber, and sandarach will remain unchanged.

Dammar and amber do not dissolve in alcohol: copal becomes pasty; elemi and Caramba wax dissolve with difficulty; while rosin, shellac, sandarach, and mastic dissolve easily.

Acetic acid makes common rosin swell; on all the others it has no effect.

Caustic soda dissolves shellac readily, rosin partly; but has no influence on the others.

Amber and shellac do not dissolve in sulphide of carbon; copal becomes soft and expands; elemi, sandarach, mastic, and Caramba wax dissolve slowly; while rosin and dammar dissolve easily.

Oil of turpentine dissolves neither amber nor shellac, but swells copal; dissolves dammar, rosin, elemi, sandarach, and Caramba wax easily, and mastic very easily.

Boiling linseed oil has no effect on amber and Caramba wax; copal, shellac, elemi, and sandarach dissolve in it slowly, while dammar, rosin, and mastic dissolve easily.

Benzine does not dissolve copal, amber, and shellac, but does elemi and sandarach to a limited extent, and Caramba wax more easily; while dammar, rosin, and mastic offer no difficulty.

Petroleum ether has no effect on copal, amber, and shellac; it is a poor solvent for rosin, elemi, sandarach, and Caramba wax, and a good one for dammar and mastic.

Concentrated sulphuric acid is indifferent to Caramba wax; it dissolves all resins, imparting to them a dark brown color, excepting dammar, which takes a brilliant red tint.

Nitric acid imparts to Caramba wax a straw color; to elemi, a dirty yellow; to mastic and sandarach, a light brown: it does not affect the others.

Ammonia is indifferent to amber, dammar, shellac, elemi, and Caramba wax; copal, sandarach, and mastic become soft, and finally dissolve; while rosin will dissolve at once.

It is not difficult by means of these reactions to test the different resins for their purity.

Gum-resins.

Common Name.	Botanical Name.	Native Place.	Quality, Use, etc.
Amber	....	Prussia, Poland, etc	Found in the mines, rivers, and sea-coasts of Prussia. Used in varnish and for mouth-pieces of pipes.
Ammoniacum	Dorema ammoniacum	Persia, etc	Used as a stimulant in medicine.
Anime or Animi	Hymenæa courbaril Vateria indica	Brazil India	Used for varnish. The Indian kind known in commerce as "Indian Copal."
Asphalte	....	Trinidad, Dead Sea, etc.	Forms a basis of black varnishes, as Japan black, etc. Used with sand for paving material. Affords petroleum or rock oil.
Assafœtida	Narthex assafœtida, etc.	Central Asia	Used as a stimulant and antispasmodic in medicine.
Australian gum-resins	Eucalyptus (various)	Australia Tasmania	Affords resins for varnishes, and produces tannin.
Balata	Achras dissecta	Guiana	One of the Sapoteæ; allied in qualities to gutta-percha.
Benzoin or Benjamin	Styrax benzoin	E. Indian Islands	Fragrant. Used in incense, perfumery, pastilles; affords benzoic acid.
Canada balsam	Abies balsamea, etc	Canada	Becomes solid on exposure to the air. Used to mount microscopic objects, for varnish, and as a cement for optical glasses.
Caoutchouc	Siphonia brasiliensi Ficus elastica, etc Urceola elastica	Brazil East Indies E. Indian Islands	The solidified milky juice of many families of plants. Is very elastic; has the property of uniting with sulphur, magnesia, etc.; is used for submarine coating, etc.; is of the highest value in mechanics and manufactures.
Copal	Hymenæa (various)	W. Africa, E. Indies, S. America	Used for varnish.
Dammar	Dammara australis	New Zealand	Used in making varnish. Obtained from Cowdi pine. Found where the tree has formerly grown.
Dragon's blood	Calamus draco Dracæna draco, etc	East Indies Canaries S. America	Deep reddish-brown color. Used (after being dissolved in alcohol) for staining material for marble, wood, leather, etc., and to color varnishes.
Elemi	....	Tropics	Ointment, plasters, varnish.
Galbanum	Ferula galbaniflua	Levant	Used in pharmacy.
Gamboge	Cambogia gutta Hebradendron Gambogioides, etc	Cambogia, Siam, etc	Yellow. Used as a pigment and as a gold lacquer, etc.
Geranium	Monsonia burmanni	S. Africa	Produces much resin. Found in the sands about the Cape of Good Hope. The resin is produced after the death of the plant.
Gum-dragon	(See Dragon's blood.)		
Gutta-percha	Isonandra gutta	Malay Islands	The solidified milky juice of many species of Sapotaceæ. Being plastic when heated, is used in molding, electro-plating, etc. Is a bad conductor of both heat and electricity.
Indian copal	Vateria indica	India	Called "Piney Varnish." Similar to Animi.
India-rubber	(See Caoutchouc.)		
Kino	Pterocarpus erinaceus	Gambia	Used as an astringent in medicine.
Lac	Ficus religiosa Butea frondosa	India	Resin produced by the puncture of a hemipterous insect on the tree, especially the "Peepul." Sold in commerce as shellac, threadlac, blocklac. Used to make sealing-wax, glass-cement, varnishes, and for bodies of hats, etc.
Mastic	Pistacia lentiscus	Scio	Used for varnish. Employed by dentists. Aromatic, astringent.
Myrrh	Balsamodendron myrrh	Shores of Red Sea	Used as an antispasmodic, stomachic, etc., and in tooth-powder.
Piney varnish	(See Animi and Indian copal.)		
Pitch	Pinus sylvestris	Sweden, etc	The residuum of the distillation of pyroligneous acid from wood-tar.
Rosin	Pinus palustris, etc	N. America, etc	The residue left after the distillation of oil of turpentine from the raw turpentine.
Sandarach	Callitris quadrivalvis	Algiers	Used in varnishes. When powdered, affords pounce.
Scammony	Convolvulus scammonia	Asia Minor	Used as a purgative in medicine.
Shellac	(See Lac.)		
Storax	Styrax officinale	Asia Minor	Soft; unctuous, and used as an expectorant. Incense.

Common Name.	Botanical Name.	Native Place.	Quality, Use, etc.
Storax (liquid).....	Liquidumber	United States	Fragrant; bitter; expectorant.
Tar (wood)........	Pinus sylvestris	North Carolina, Sweden, and Russia	Obtained by slow distillation of the branches and roots of the pine, etc., whilst burning in a nearly closed pit.
Turpentine	Pinus palustris........	America...........	Used in medicine, painting, and as a solvent for resins.
Turpentine (Strasburg)..........	Abies picea............	Europe............	
Turpentine (Venice)	Larix europoea.........	Europe............	
	Gums Proper.		
Gum-arabic........	Acaia arabica et vera...	N. Africa, Asia, etc.	Finest of the gums. Soluble in water.
Gum (British)......	Solanum tuberosum ...	Britain, etc.......	Torrefied potato-starch. Called dextrine.
Gum-tragacanth..	Astragalus tragacantha, etc............	Asia Minor, Persia	For mucilage and as a substitute for gum-arabic.
Gum (various).....	Pyrus, prunus, etc.....	Britain, etc......	Soluble in water. Exudes from apple, pear, cherry, and other trees.

Re-sist′. (*Dyeing.*) A material applied to cotton cloth to prevent the action of a mordant or color on those portions to which it is applied in the form of a pattern.

Resists act mechanically or chemically.

Fat or paste forms a mechanical resist, as it prevents the access of the mordant or color.

Chemical resists act upon the color, and prevent its fixing itself in the fabric.

2. (*Calico-dyeing.*) A process in which those portions of the cloth which are intended to remain uncolored are saturated with a substance which resists the action of the dye when immersed in the dye-vat.

The *resist*, a preparation of copper, imparts a brown tint to those parts to which it is applied, and the cloth is dipped in the dyeing solution, indigo in lime-water, with a proportion of copperas, which deoxidizes and decolorates the indigo; on being removed from the vat the cloth is of a greenish hue, which soon becomes blue by the reoxidation of the indigo on its contact with the air; the parts covered by the resist become charged with blue in the vat, the copper salt parting with its oxygen to the indigo. The blue thus formed has no union with the fiber, and is easily removed by weak acid, while that formed in the spots not touched by the resist remains fast.

In the *china blue* process the figures are printed with indigo thickened with paste, and by alternate immersion in lime-water and solution of copperas the indigo is dissolved and fixed in the spots where so applied by similar chemical reactions.

In the *discharge* process, employed for black and white, or red or chocolate and white, the cloth is passed through red or iron liquor, dried, and dipped in a mordant, — this is termed *padding;* it is then printed with citric acid, thickened with wasted starch, which discharges the mordant, so that when dyed the discharged figures are left white. Logwood is used for black, and madder for red and chocolate.

Re-sist′ance-box. (*Telegraphy.*) An inclosing-box for a resistance-coil.

Re-sist′ance-coil. (*Telegraphy.*) A coil introduced into a circuit to increase the resistance. It has normally a greater resistance than the remainder of the circuit. It is usually of a material of a less conducting power than the main circuit, say of German silver in a circuit of copper. See RHEOSTAT.

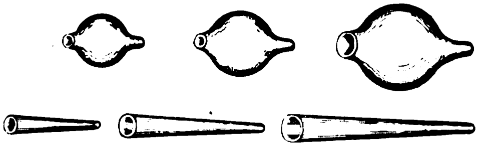
Res′o-na′tor. An instrument invented by Professor Helmholtz for facilitating the analysis of compound sounds. It consists, in its simplest form, of a tapering tube or a hollow bulb, spherical or nearly so in form, having an opening at one side for the air and a tube adapted to the ear at the other. When the instrument is fitted to one ear, the other being stopped, tones above or below the pitch of the resonator will be but imperfectly heard; but if a note be sounded corresponding to the peculiar or proper note of the resonator, it will appear greatly intensified.

Each resonator of this kind is adapted to the detection of but a single tone; but Helmholtz has also devised a compound resonator, consisting of three tubes sliding one within the other, so as to adapt it to notes of different pitch. Another form has been constructed, having holes like a flute, which are opened and closed by the fingers.

If the particular tone to which the resonator employed is attuned is contained in the sound under investigation, that tone will be sounded by the resonator.

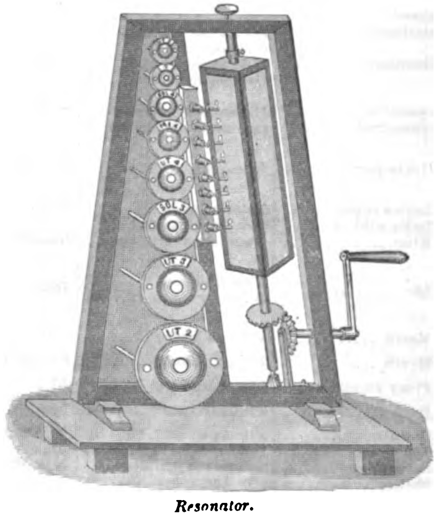
By employing a set of these any sound or sounds may be wholly or partially resolved into elementary notes, proving that those emitted by the voice or by musical instruments are not simple, but compound tones of different intensity and pitch, blending so as to form an apparently simple note when heard by the unassisted ear.

Fig. 4270.



Resonators.

Fig. 4271.



Resonator.

Fig. 4271 is an instrument for illustrating the influence of different musical tones upon the vibrations of flames. A series of organ-pipes tuned to produce the various notes of the gamut are arranged one above the other upon a vertical stand; at the side of this stand are a series of gas-jets. When air is forced into the pipes each flame will vibrate in concord with the pipe to which it is opposite.

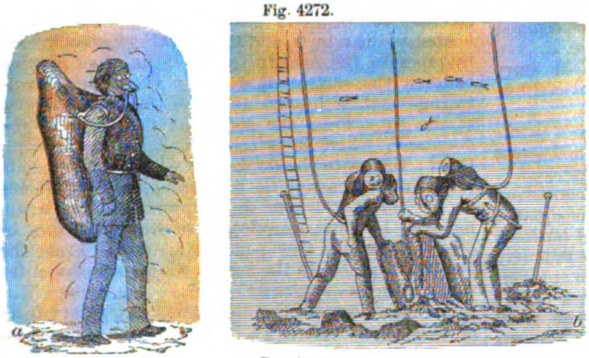
A four-sided mirror, on a vertical axis, is rapidly rotated by means of a crank and bevel-gears, when the reflections of the flames in the mirror present the appearance of a series of teeth as the flames rise and fall.

Res′pi-ra′tor. A device worn over the mouth to exclude injurious matters, such as smoke or dust, from the lungs; or to change the condition of the air by passing it through medicaments or gauze.

Respirators are used by cutlers and other grinders to exclude the dust from the lungs. Such respirators may have magnetic gauze, to attract the passing particles of steel. Respirators for persons having weak lungs have several plies of fine gauze, which warm the air as it passes through. Professor Tyndall's fireman's respirator is attached to a mask, and consists of an iron cylinder packed with cotton wool, glycerine, and charcoal. The wearer is enabled to remain from a quarter to half an hour in an atmosphere of smoke, which he could not otherwise breathe.

Galibert's respirator (*a*) is designed for the use of firemen and others who may be compelled to enter places filled with smoke or noxious gases. It consists of a fire-proofed canvas sack, inflated with air

Fig. 4272.



Respirators.

by a bellows and strapped to the back; this is provided with two pipes leading to a horn mouthpiece, through which the wearer breathes; a nose piece for expiration and goggles to protect the eyes complete the apparatus.

The apparatus of Rouquayrol and Denayrouze (*b*) is used by divers in submarine operations. It embraces an iron or steel reservoir, capable of resisting great pressure, and surmounted by a valved chamber which regulates the amount and pressure of the air inhaled by the workman. From this chamber a valved pipe having a mouthpiece, to be held between the lips, is conducted through the helmet which forms part of the armor worn by the diver. The cylinder is charged with compressed air by an air-pump at the surface, which need not be kept in continuous operation. The valves admitting air from the cylinder to the chamber, and from the latter to the lungs, open and close automatically during the process of breathing.

The cut illustrates a party of divers recovering a chest of gold which had been lost overboard from a steamer in the harbor of Marseilles.

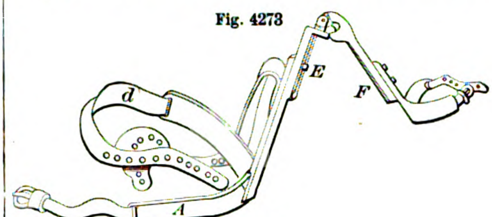
Rest. 1. (*Lathe.*) A device for supporting a piece of work in a lathe or vise.

A lathe-rest is a horizontal bar attached to the bed or shears, for the support of the turning-tool.

A slide-rest supports the turning-tool, and has motion in several directions by means of screws. See LATHE; SLIDE-REST.

2. A support for the muzzle of a gun in aiming and firing. The arbalest or cross-bow and the earlier hand fire-arms were always thus supported, and the long guns of the Moors and Arabs are still univer-

Fig. 4273



Rifle-Rest

sally provided with a device of this kind. In civilized countries the rest is employed by sharp-shooters and in practice-firing. See RIFLE.

It may consist of a stake or picket, whose pointed end is driven into the ground, the gun resting in a crotch at the upper extremity; or, as in some of the European armies, of a device having a screw point, by which it may be attached to a tree or other support.

In experimental firing, an adjustable table or trestle, on which all that part of the gun in front of the trigger-guard rests, is sometimes employed.

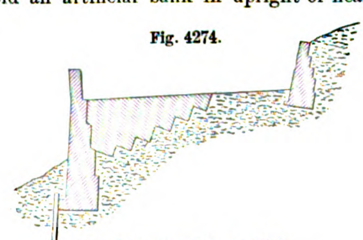
Fig. 4273 is Kinman's rest. It is strapped around the body of the rifleman by the belts *A d*. It has a rigid vertical arm *E* carrying the adjustable pivoted arm *F*. This has a free movement corresponding with the natural movement of the arm, and may be made to bear rigidly on the arm *E*, so as to afford a firm support to the piece in aiming and firing.

Res′tau-rant-car. One adapted for affording meals to passengers on board while traveling. See HOTEL-CAR.

Re-tain′ing-wall. (*Engineering.*) A wall erected to maintain a bank of earth in position, as in sunk fences, faces of earthworks, railway cuttings, sea-walls, etc.

A *retaining-wall* is, strictly speaking, one erected to hold an artificial bank in upright or nearly up-

Fig. 4274.



Retaining and Breast Walls.

right position. A *breast-wall* is one erected against a natural bank, or one whose materials are undisturbed, but whose face has been made by excavation.

The proportions of retaining-walls vary with the character and dip of the material at the back, and also with the degree of humidity of the strata cut by the excavation. They are re-

quired to stand against the lateral thrust and perpendicular weight.

The thickness under average circumstances may be, at the bottom, one third of the hight, diminished by set-offs on the inside. For walls exposed to the wash of water on the outside, and to the percolation of water, a greater thickness is required, say one half the hight.

The maetrial will vary with local and economic considerations, stone, brick, or concrete; of the latter the French form (see BÉTON) may be considered the most perfect.

Re-tic'u-lat'ed Glass. (*Glass.*) A species of ornamental glassware formerly made in Venice and recently revived by Pohl. It is produced by a network of air-bubbles inclosed in the glass and arranged in regular interlacing series. A bundle of small glass rods are arranged cylindrically, fixed by melted glass, and heated till the rods cohere. The bunch is then drawn out to a long cone and spirally twisted. Another bunch is similarly elongated and twisted in the other direction. One of these cones is inserted in the other and the two fused together. Wherever the little rods cross each other a bubble of air is inclosed, and the reticulated appearance is thus given.

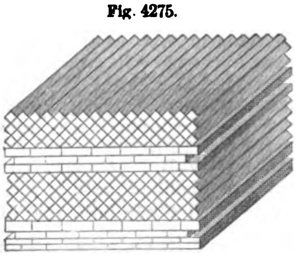
Re-tic'u-lat'ed Mi-crom'e-ter. Invented by Malvasia, about 1660, who constructed a network of silver wires, crossing each other at right angles, and dividing the field of the telescope into a number of equal squares. It is used for measuring small celestial distances. The reticulated micrometer consists of an eye-piece of low power, having stretched across it a number of wires at right angles to and at equal and known distances from each other. The wires are illuminated with the lantern, and the object measured by noting the number of divisions covered by it. See WIRE MICROMETER.

Re-tic'u-lat'ed Work. (*Masonry.*) Masonry formed of small square stones or bricks placed lozenge-wise. See RETICULATUM.

Re-tic'u-la'tion. A method of copying a painting or drawing by the help of threads stretched across a frame so as to form squares.

Re-tic'u-la'tum. A form of masonry consisting of layers of squared stone laid horizontally and obliquely so as to present their edges at the face of the wall, giving an appearance of *network;* hence the name.

Fig. 4275.



Opus Reticulatum.

Layers laid as described usually alternate with courses laid flatwise.

It is a fanciful style of masonry, adopted in ancient Rome, involving great labor, and is not now in use.

Re-tired' Flank. (*Fortification.*) A flank bent inward toward the rear of the work. For instance, the addition of such flanks, partially closing the *gorge*, changes a *redan* to a *lunette*. See LUNETTE.

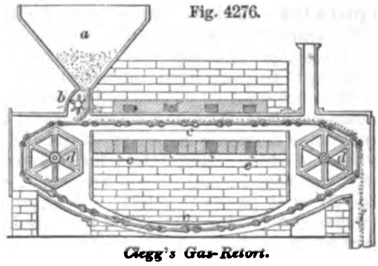
Re-tort'. A vessel in whose chamber an object is subjected to distillation or decomposition by heat, a neck conducting off the volatile products.

1. The retort of the pharmacy or laboratory is a vessel of glass, platinum, porcelain, or other material, and its various uses may be understood by consulting Muspratt, Morfitt, and Ure.

2. The retort of the gas-works is a cylinder or segment of a cylinder, and is formed of clay or of iron. The results are carbureted hydrogen, which passes off with various impurities which are eliminated by water, lime, copperas, etc.; and coke, which forms a valuable fuel. See GAS.

Clegg's *revolving-web retort*, for making coal-gas (Fig. 4276), has a hopper *a* from which the coal, in small fragments, is delivered by a feed-wheel *b* on to an endless web *c* made of plate iron, passing around two drums *d d*, whose revolution causes it to travel at a slow, fixed rate, so that the coal may be exposed a sufficient length of time to the heat of the flues *e e* from a lateral furnace by which the retort is heated.

Fig. 4276.



Clegg's Gas-Retort.

On reaching the pipe *f*, which is made air-tight by a suitable door or by dipping into water, the coke is discharged from the web.

Retorts for gas are now frequently made of clay, instead of iron, and are sometimes nearly 20 feet long, being charged from and discharging at each end. See GAS-RETORT.

Fig. 4277 shows the relation of the different parts forming the ordinary gas apparatus. The coal is heated in the retorts, and the resulting gas conducted by pipes to the *hydraulic main*, the pipes dipping beneath the surface of water in the main, constituting what is known as a *seal*, to prevent reflow of the gas. From the *main* the gas passes to the *condenser*, where it is cooled and the tar precipitated; thence to the *washer*, in which the ammonia is removed by passing the gas through water; thence to the *purifier*, where the sulphur compounds are removed by lime, sesquioxide of iron, iron ore, or other material. (See pages 953, 954.) From the *purifier* it passes to the *holder*, where it is stored for use. (See GAS, pages 943 - 957.)

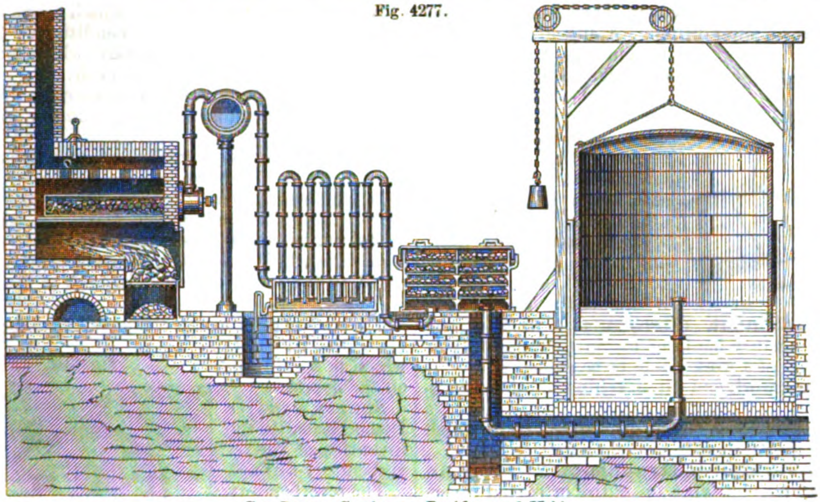
3. The retorts for the distillation of mercury from cinnabar, as erected by Dr. Ure at Landsberg, in Bavaria, resemble gas-retorts.

In the quicksilver works of New Almaden, in California, the ore is roasted in closed chambers with luted covers. At Idria, in Austria, the mode is a true furnace process, the ore being above the fire, the volatile results, both of combustion and sublimation, being conducted to condensing-chambers. In the Palatinate, retorts of pottery are used, their necks being luted into receivers containing water. See MERCURY-FURNACE.

4. The retort for silver amalgam is shown at *a* (Fig. 4278). It is commonly made twelve inches diameter inside, with a hood at the mouth having lugs to catch the clamp which fastens the door. The whole retort is set on cast-iron bearers in an arch, with the fire-grate under it. The neck of the retort passes through the back wall and connects with the condenser. The condensed quicksilver filters through a bag fastened on the end of the pipe, and is received into a tray. A cast-iron front, with closed doors, prevents the fumes from passing into the retort-room, and compels them to pass into the flue. Two tiers of amalgam trays may be used in this retort at the same time, one above the other. The bottoms of the lower tier are circular, so as to conform to the shape of the retort.

The iron retort for gold amalgam is a cast-iron crucible-like cup *b*, to which a flat iron top is fastened, a bent pipe of the size of small gas tubing passing out at the center, forming the neck of the

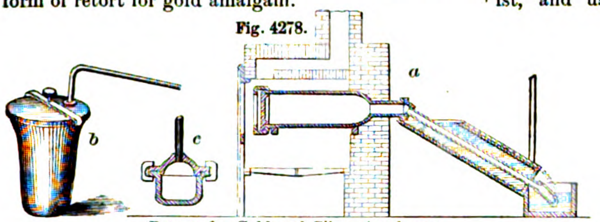
Fig. 4277.



Gas Retort, Condenser, Purifier, and Holder.

retort. Upon the application of heat the mercury is expelled and collected under water at the end of the tube, for future use. *c* is a section of another form of retort for gold amalgam.

Fig. 4278.



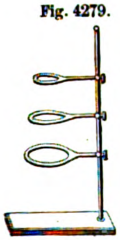
Retorts for Gold and Silver Amalgams.

5. Nitric-acid retorts are cast-iron cylinders, and resemble those for coal-gas, or are made of glass or pottery in a sand pot heated by the furnace fire.

There are many other retorts used in distillation and sublimation, such as those in which carbureted hydrogen and pyroligneous acid are obtained from wood, gas from tar, oil and other materials yielding hydrocarbons. See works on practical chemistry and chemical manipulations.

Re-tort′-scal′er. An instrument to cleanse the incrustation from the inside of coal-gas retorts.

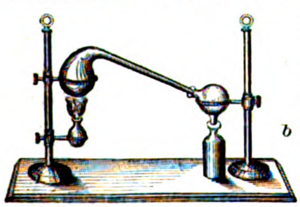
Fig. 4279.



a

It acts mechanically to break away the scale, or is an arrangement for driving air into the red-hot retort to burn away the incrusted matter.

Re-tort′-stand. (*Chemical.*) A device (*a*) for holding retorts or flasks while heat is applied by a spirit-lamp. It consists of a flat plate carrying an upright rod to which sliding rings of various sizes are fitted; these may be held at any suitable hight by clamp screws. A similar upright with sliding rings is frequently added for holding the receiver, as at *b*.

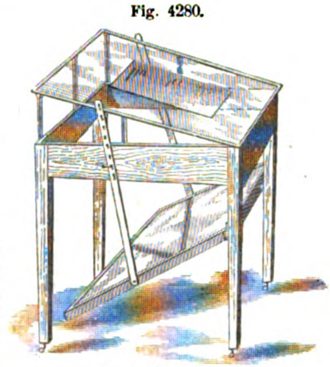


b

Retort-Stands.

Re-touch′ing-ta′ble. (*Photography.*) A glass-top table, or one with an opening to suit the size of a negative, inclined for the convenience of the artist, and used with a mirror below to throw light through a negative for the purpose of retouching. Formerly, india-ink and a hair pencil were used to improve and repair the surface, but a lead-pencil used as a stipple is now the usual instrument.

Fig. 4280.



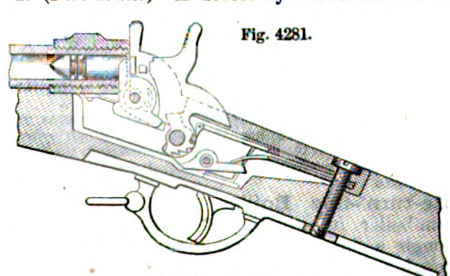
Retouching-Table.

Re-tract′or. 1. (*Surgery.*) *a.* A towel or rubber cloth, which is employed to hold back the flaps while the bone is being sawn off.

b. A hook or hoe-like instrument of metal, hard rubber, or horn, to hold back masses of flesh or anything obstructing the view while operating on deep-seated organs.

2. (*Fire-arms.*) A device by which the metallic

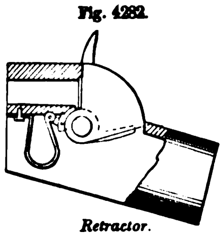
Fig. 4281.



Cartridge-Retractor.

cartridge-cases employed in breech-loading guns are withdrawn after firing. A lug or prong rests behind the flange of the cartridge and withdraws the spent shell when the breech is opened. In Fig. 4282, the positive movement of the notched extractor-plate loosens the shell from the bore, and after passing a certain point a spring comes into play, and gives a sudden impulse to the shell, which throws it clear of the fire-arm.

Fig. 4282.



Retractor.

Re-trench'ment. (*Fortification.*) *a.* A *traverse* or defense against flanking fire in a covered way or other portion of a work liable to be enfiladed.

b. A breastwork and ditch behind another defensive work.

c. An interior rampart or defensible line to which a garrison may retreat to prolong a defense.

Re-tro-ver'sion-in'stru-ment. (*Surgery.*) An instrument for rectifying an entire or partial inversion of the womb.

Sims's uterine repositor consists of a short metallic sounder, rotatable on a long shaft, through which runs a rod, by means of which the sounder may be fixed at any angle after introduction *in utero*, and the uterus restored to its normal position.

Ret'ting, Rot'ting, Rat'ing. (*Fiber.*) Steeping of flax or hemp, for the purpose of loosening the fiber from the *boon* and woody portion by the softening of the gummy portion which binds them.

Flax, after the removal of the bolls and seed by *rippling*, is bound in sheaves and immersed in water, the sheaves being packed loosely and resting on their butts. They are covered with sods, grass side down, or by straw and poles. The water should be soft, and in gentle motion. Fermentation softens the gum, which binds the fibers and loosens the *hare* from the *bark* and *boon*.

The process having continued till the fibers part from the *boon* (the pith or internal woody portion), the bunches are raised, drained for twenty-four hours, and then spread on the grass to dry and get wet alternately; the showers, sun, and air completing the preparation of the fiber for the mechanical treatment, — the *brake* and the scutcher. This exposure to weather is termed *grassing*.

The time occupied in *retting* is from six to twenty days, according to temperature.

Dew retting is accomplished by exposing the flax stalks to the weather, without steeping, the sun, showers, and air rotting the woody portion and washing away the mucilage.

Schenck's retting apparatus, 1851, consists of circular vats, in which the flax is placed, being kept down by a weight while it is swelled by water maintained at a heat of 90° by the introduction of steam. Passing to the acetous fermentation, the mucilage is rendered perfectly soluble and is run off, the flax being then removed and dried. The process takes about sixty hours. The flax is exposed to the air upon frames or dried by steam heat.

Bower's retting process (English) consists in alternately steeping and rolling the stalks, so as to soften and press out the mucilage by the alternate process.

Caustic ammonia, or other salt, is added to the rain water, in which the plant is steeped. (Ammonia, 1 pound; water, at 90° to 120°, 150 pounds.) The process takes about thirty hours.

Another process consists in the repeated application of an alkaline solution in a vessel exhausted of air. This is said to take but a few hours. Heat is probably applied.

The process with hemp is substantially similar to the water-retting of flax.

The stalks in bundles are steeped in running streams until the cellular portion is rotting, the gummy so much softened as to wash away, and the woody so far loosened as to readily fall away from the fiber when the stalk is dried and operated upon by the brake.

Re-turn'-flue Boil'er. (*Steam-engine.*) A steam-boiler in which the heated gases return through a flue in the water space, after passing through a *direct* flue, or alongside of the boiler. See STEAM-BOILER.

Re-turn'-valve. A valve which opens to allow reflux of a fluid under certain conditions. In some cases it is merely an overflow-valve which allows excess of liquid to return to a reservoir.

Re-veal'. (*Carpentry and Masonry.*) The vertical return or side of an aperture, chimney, doorway, or window.

In a chimney it is equivalent to the *jamb*, or, when beveled, the *coving*.

In windows the *reveal* is the outside-return, or the space between the window-frame and the exterior arris.

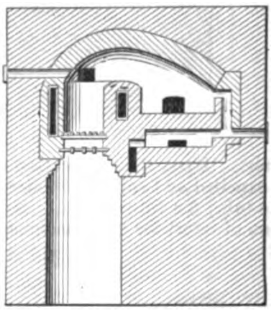
Re-ver'ber-a-to'ry-fur'nace. (*Metallurgy.*) A furnace in which ore, metal, or other material is exposed to the action of flame, but not to the contact of burning fuel.

The flame passes over a *bridge* and then downward upon the material, which is spread upon the *hearth*.

Seneca credits Democritus with the invention of the reverberatory-furnace.

The reverberatory is a very usual form of furnace, and is used in the treatment of many metals. See list under FURNACES; also PUDDLING-FURNACE.

Fig. 4283.

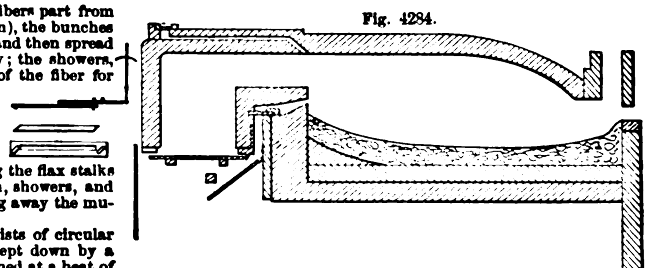


Reverberatory, with Water-Boshes.

Fig. 4283 is a reverberatory, with water-chambers around the fire-box and in the fire-bridge.

In Fig. 4284, air is heated by contact with the walls and introduced into the metal chamber in converging currents the full width of the throat.

Fig. 4284.



Reverberatory with Air-Ducts.

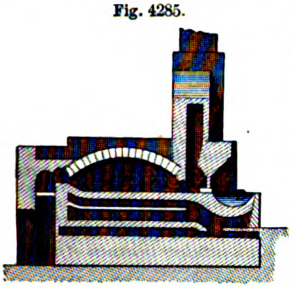
The reverberatory-furnace for copper has a furnace-chamber, hearth, two tuyeres, and two cisterns, into which the molten results of the process are discharged.

The *sole* of the chamber is covered with a composition of clay and pounded charcoal, and the charge of black copper laid upon it. The furnace is filled with wood and lighted, and when the metal is melted, a blast from the two tuyeres *t t* is made to spread over the surface of the metal in chamber *A*, oxidizing the sulphur, lead, and iron. The slags are raked off by the door *D*. Red scoriæ are formed containing suboxide of copper, which affects the malleability of the resulting metal. The operator withdraws a small quantity of metal from time to time, and tests it under the hammer to judge of its condition.

The metal is flowed from the hearth to the cisterns *B B*, and water thrown on the surface, producing a congealed scale of red metal. This is removed, and the process repeated until the metal is all reduced to the form of blistered scales or plates. See CALCINING-FURNACE, Fig. 1023; COPPER-FURNACE, page 618.

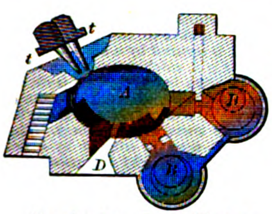
Re-verse'. The back of a coin; in contradistinction to the obverse, or face.

Fig. 4285.



Re-versed′ Arch. An arch with its convexity downward. An *inverted* arch.

Re-versed′ Curve. (*Railway Engineering.*) When a curved part of the track, instead of terminating in a tangent, joins another curving in an opposite direction, the two are said to form a reversed curve.

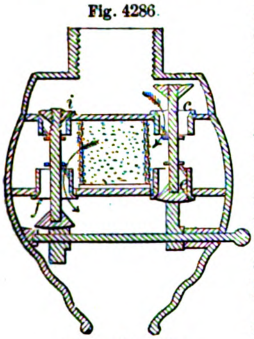


Reverberatory Copper-Furnace.

Re-versed′ O-gee′. (*Architecture.*) The *cyma reversa*, a molding composed of two circular arcs, the upper convex and the lower concave to the surface from which it projects.

Re-verse′-valve. (*Steam-engine.*) A valve in a steam-boiler opening inward to the pressure of the atmosphere when there is a negative pressure in the boiler. A vacuum-valve.

Fig. 4286.

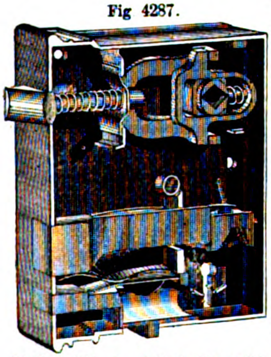


Reversible Filter.

Re-vers′i-ble Fil′ter. One through which the fluid may flow in either direction. In that shown, the filtering material is inclosed in a porous cylinder, and between two diaphragms in the chamber. Valves *c e i f* have their seats in these diaphragms and open in reverse directions; either may act as the inlet or outlet, according to the way the water flows.

Re-vers′i-ble Lock. A lock which may be applied to a door hinged to the jamb of either side, or opening either inward or outward. This involves turning the latch-bolt over, so that its beveled edge may slide freely over the catch, without requiring the knob to be turned in order to close the door.

Fig 4287.



Mallory, Wheeler, & Co.'s Reversible Lock.

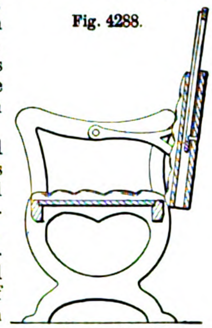
In Mallory, Wheeler, & Co.'s lock (Fig. 4287), this is effected by simply pulling the bolt forward until it clears the notch in the rim, and turning it half round.

Re-vers′i-ble Mouth-bit. (*Menage.*) A bit having a rule joint; when in one position it works the same as the Pelham, while, if reversed, it becomes a stiff-mouth bit.

Re-vers′i-ble Plow. (*Agriculture.*) A plow whose cutting apparatus is capable of being reversed, to throw the furrow slice in either direction, as required. See SIDE-HILL PLOW.

Re-vers′i-ble Seat. One for railway-cars, so as to be laid over on either side, according to the direction in which the car is traveling. In Fig. 4288, the head-rest is padded, and traverses the seat-back, so as to be drawn upward from either side.

Fig. 4288.

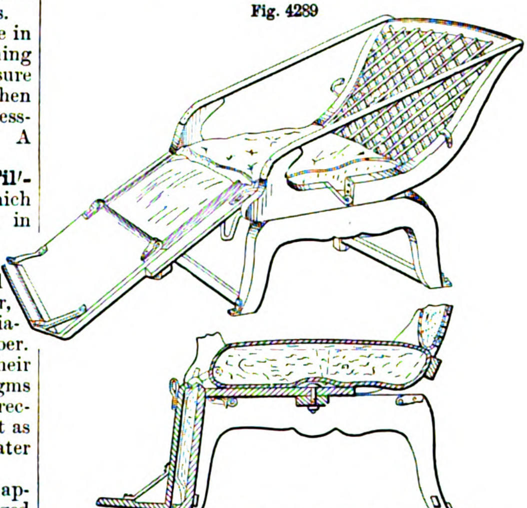


Reversible Car-Seat.

Fig. 4289 has a hinged back, is reversible on its frame, and has hooks and flexible side-straps for supporting the arms of the sitter.

Re-vers′ing. (*Engraving.*) Obliterating engraved lines on plate by means of blows of a bare hammer on the engraved plate, whose back rests on a sheet-lead covering to the anvil. The reaction of the lead causes it to rise in ridges corresponding to the engraved lines,

Fig. 4289

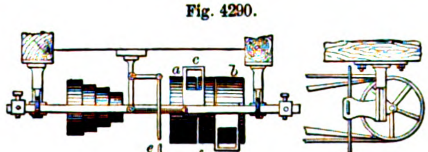


Reversible and Reclining Seat.

and to drive the thin plate before it, filling up the cuts in the face of the plate, and making a corresponding concavity in the back.

Re-vers′ing-coun′ter-shaft. (*Machinery.*) One which may be rotated either way for changing the direction of motion in the machine driven by it. One of the pulleys *a b*, which are loose on the shaft, carries a straight and the other a crossed belt pass-

Fig. 4290.



Reversing-Countershaft.

ing through the forks *c d*; on moving the lever *e* to the right or left, either belt may be transferred to

the fast pulley *f*, causing it and the countershaft on which it is keyed to turn in either direction.

Re-vers'ing-gear. (*Steam.*) The apparatus for reversing the motion of a marine or locomotive engine, by changing the time of action of the slide-valve; the eccentric being in advance of the crank for the forward motion will, if turned to an equal distance behind the crank, produce a backward motion.

Re-vers'ing-han'dle. (*Steam-engine.*) A lever which operates the valve so as to reverse the action of the steam. A *reversing-lever.*

In locomotives, the lever of the link-motion controls the valve entirely, both for forward and reversing motions and for throttling.

In marine engines, the reversing movement is by means of a wheel and worm acting upon a rack.

Re-vers'ing-mo'tion. An appliance by which the motion of the engine is changed from the *direct* to the *reverse*, as in the case of a crank which is caused to turn in a direction contrary to its former motion, or the driving-wheels of a locomotive to rotate backwardly.

The action of the steam is reversed before the piston has completed a given stroke, so that the parts which receive motion therefrom return on their former motion, or *back*, so to speak.

The reversing-apparatus of the locomotive, where it is most used, is the LINK-MOTION (which see).

Another common form is the eccentric-rod, whose gab-hook is attached to one or the other of the wrists on an arm keyed to the rock-shaft.

Re-vert'ing-draft. In steam-boilers, when the current of hot air and smoke returns backward on a course parallel to its former one. In contradistinction to a *direct*, *wheel*, or *split* draft.

Re-vet'ment. 1. (*Fortification.*) A facing to a wall or bank, as of a scarp or parapet.

The material depends upon the character of the work, whether *permanent* or *field* works. In the former the revetment is usually of masonry; in the latter it may be of sods, gabions, timber, hurdles, rails, or stones.

A *full revetment* is carried up the *scarp*, *exterior slope*, and *superior slope*. See PARAPET.
A *demi-revetment* is when a portion only of the *rampart* is revetted.
A *rectangular revetment* is one in which the vertical walls have an equal thickness throughout.
A *leaning revetment* has a wall of even thickness, sloping toward the bank.
A *sloping revetment* is thicker at the base, the back vertical.
A *counter-sloping revetment* has a sloping back and vertical face.
A *hollow revetment* has a vaulted or defensive gallery in the rear.
A *counter-arched revetment* is similar to the hollow, having a gallery with *embrasures* or *loop-holes*.

2. (*Civil Engineering.*) A *retaining* or *breast wall* at the foot or on the face of a slope. See RETAINING-WALL; BREAST-WALL; DIKE; SEA-WALL.

Re-vise'. (*Printing.*) The second proof submitted to the author, in order that he may examine whether the corrections have been made.

The *first proof* is for the office reader.

The second, or *clean proof*, for the author.

The *revise*, for the author.

Re-volv'er. 1. (*Weapon.*) A fire-arm having a revolving barrel or breech cylinder, so as to discharge several loads in quick succession without being reloaded. In some pistols the barrel has a plurality of bores, in which the charges are inserted and from which they are fired; more commonly, as in Colt's, the weapon has a cylinder at the base of the barrel, containing several chambers, generally six, in which the loads are placed, and all are fired through the single tube which constitutes the barrel; in all the rotation is caused by devices actuated by the lock mechanism.

The principle is not new, but it was first made a practical success by the late Colonel Samuel Colt.

Colt's revolving pistol is shown in section at *D*, and the cylinder and revolving mechanism detached at *E*. In general construction it closely resembles the rifle. The barrel *c* is of steel and rifled. It has a socket beneath for receiving the rammer *d* with its lever *d'* and fixtures, and a longitudinal socket and transverse slot to receive and secure the cylinder-pin *e*.

The cylinder *f* is of steel, and has five or six chambers, of the same size as the barrel, or a very little larger, bored through it nearly to the rear end, leaving a sufficient thickness of metal to insure against bursting. Behind and entering each chamber a cavity is made, at the base of which is a screw-threaded orifice, entering the cylinder, into which a cone is screwed.

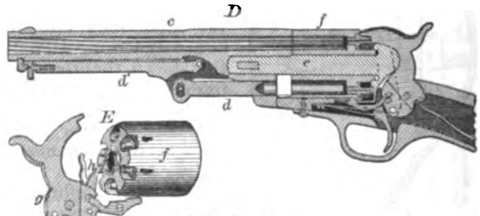
In another hole bored axially through the cylinder, the pin on which it turns passes, one end entering a cavity in the base of the lock-frame, and the other a socket in the enlarged portion beneath the barrel, where it is secured by a key.

On the base of the cylinder *f* is a ratchet having as many teeth, five or six, as the chamber has barrels. The teeth are so arranged that when the hammer is at full cock, a chamber is directly in line with the barrel. On the surface of the cylinder are cut as many small slots as there are chambers. That which happens to be lowest at the time is entered by a bolt which is moved by the action of the lock, and is pressed into the slot by a spring, so that while in this position the cylinder is immovable.

The lock-frame is directly in rear of the cylinder, and contains the firing mechanism.

The sear and trigger are in one piece, as are also the hammer and tumbler *g*, upon which the main-spring acts directly. On the face of the tumbler is a pawl or *hand h*, which successively engages each of the teeth on the rear of the cylinder; and the tumbler has also a projecting pin which at the proper time engages the bolt that locks the cylinder, lifting it out of the slot and allowing the cylinder to rotate under the action of the hand. When the pin no longer acts upon the bolt, it is forced by the spring into the next notch which presents itself.

Fig. 4291.



Colt's Revolver.

The operation is as follows: The chambers having been loaded by inserting a cartridge successively in each and forcing it home by the rammer and its lever, and capping each cone, the hammer, supposed to be resting on one of the cones, is drawn back; this causes the pin on the tumbler to disengage the bolt from the lowermost slot in the cylinder, and the hand engages a tooth and rotates the cylinder $\frac{1}{5}$ or $\frac{1}{6}$ of a revolution; on arriving at full cock the pin is disengaged from the bolt, which then falls into the next slot and locks the cylinder; the weapon may then be discharged by pulling the trigger.

In those pistols which are designed for firing metallic cartridges, the cartridge is inserted at the base of the cylinder, the case being afterward pushed out by a device analogous to the rammer just described.

Fig. 4292 shows a group of Colt's revolvers.

A, the revolver musket for infantry.

B, a revolving rifle for sporting.

C, a revolver-carbine.

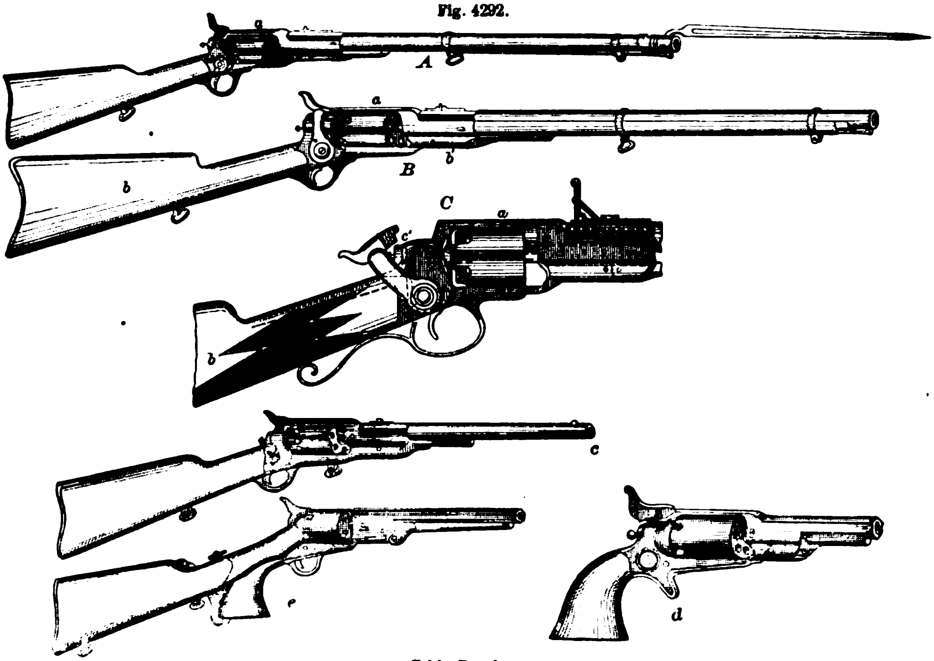
d, a pistol.

e, a pistol mounted on a supplementary stock for shooting from the shoulder.

Colonel Colt obtained his first patent in 1835, but his weapon was not perfected until 1845. On visiting England, he undertook to investigate the origin of repeating fire-arms, and the result of his researches was that arms similar in principle to his own revolver had been invented four centuries before.

In the Tower of London he was shown a match-lock gun, dating back to the fifteenth century, and closely resembling, in the principle of its construction, the revolver of the present day. It has a revolving breech with four chambers, mounted on an axis fixed parallel to the barrel, and on that axis it may be

Fig. 4292.

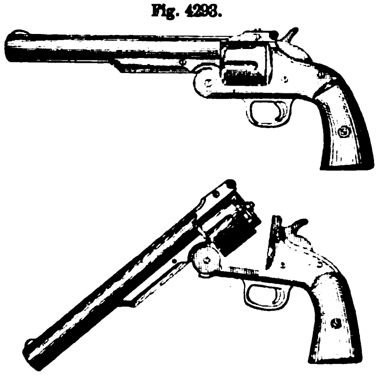


Colt's Revolvers.

turned round, to bring any one of the four loaded chambers in succession in a line with the barrel, to be discharged through it. There are notches in a flange at the fore end of the revolving breech to receive the end of a spring, which is fixed to the stock of the gun, for the purpose of locking the breech when a chamber is brought round into the proper position. The hammer is split at the end, so as to clasp a match, and to carry its ignited end down to the priming powder, when the trigger is pulled. Each chamber is provided with a priming-pan that is covered by a swing lid, and, before firing, the lid is pushed aside by the finger, to expose the priming powder to the action of the lighted match. In the lower armory was a specimen of a repeating fire-arm of a more recent date, though still very ancient, and presenting considerable improvement on the preceding one. It has six chambers in the rotating breech, and is furnished with a barytes lock and one priming-pan, to fire all the chambers. The priming-pan is fitted with a sliding cover, and a vertical wheel with a serrated edge projects into it, nearly in contact with the powder in the pan. To this wheel a rapid motion is given by means of a trigger-spring, acting upon a lever attached to the axis of the wheel, and the teeth of the wheel strike against the barytes, which is brought down, previously to firing, into contact with it, and the sparks thus emitted set fire to the powder in the priming-pan, and discharge the piece. In this instance, also, the breech is rotated by hand.

In Smith and Wesson's revolver (Fig. 4293), the

Fig. 4293.



Smith and Wesson's Revolver.

cylinder is rotated in the usual way by a click operated by the hammer in cocking and firing.

The cylinder is connected with the barrel, which is pivoted to the lower metallic part of the stock, so that by setting the hammer at half cock, raising a spring-catch *a*, and depressing the muzzle, the bottom of the cylinder is turned up to receive the metallic cartridges. When the muzzle end of the barrel is thrown upward, the spring-catch reëngages in the back plate, and the pistol may be fired.

Fig. 4294 shows six revolvers which are interesting in the history of that fire-arm.

a is a matchlock of the fifteenth century, in the Museum of the Tower of London. It has a revolving breech with four chambers, which rotates on an arbor parallel to the barrel. The chamber is turned by hand.

b is an arquebuse, with six chambers, each of which carries its own pan for priming powder. A movable plate covers the powder-pans and exposes them serially to the match as a given chamber comes in line with the barrel. This is an Oriental piece, and was given to Mr. Forsyth by Lord William Bentwick, the governor-general of India.

c is an arquebuse, in the Tower of London, with six chambers in a revolving breech, and a flint lock. This has a sliding plate over the powder-pan. The turning of the breech is automatic.

d is the arm of John Dafts, of London, and has six chambers.

e is Elisha Collier's arm, patented in the United States in 1818. The charge-cylinder has five chambers, and is turned by hand. The cylinder is held between two plates, of which the lower presses the cylinder toward the barrel, and the upper plate closes the chambers. The rod serving to charge the chambers is placed in the stock. The hammer carries a magazine of priming placed in the stock. This gun is No. 1260 of the collection in the Museum of "St. Thomas d'Aquin," in France, where also are several other ancient arms with revolving-chambered breeches.

f is a revolving-chamber flint-lock pistol at Woolwich.

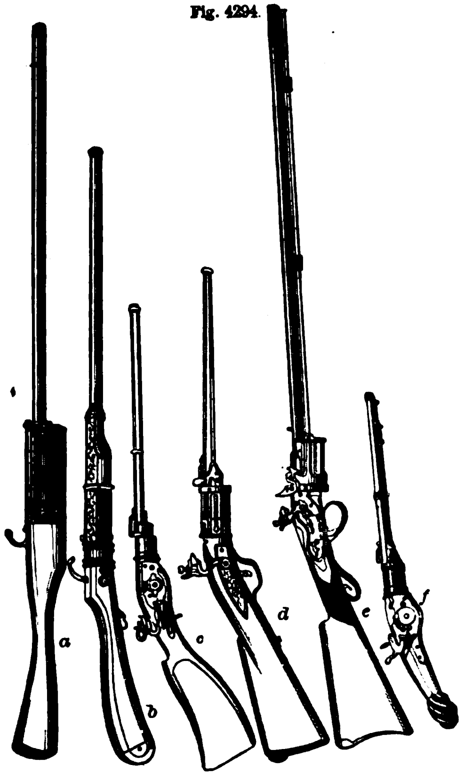
They are thus described in Turgan's "Études sur l'Artillerie Moderne," Paris, 1867. The cylinders are all revolved by hand, and not by special mechanism. Three are with matches, and were made in the beginning of the seventeenth century. One (No. 1251) is a small flint-lock hunting arquebuse: the cylinder has eight chambers. The vent is closed by a sliding cover; a spring with a hook stops the cylinder at the time it is in line with the barrel.

1252 (of the same collection) is an arquebuse with a match; the cylinder has five chambers, and turns upon an axis parallel with the barrel. It has a pan for each barrel.

1253 is a five-charge match arquebuse, having but one pan, of which you renew the priming at each shot.

1254 is a German musket of the middle of the seventeenth cen-

Fig. 4294.



Revolvers (from the Fifteenth Century to 1818).

tury. It has a wheel-lock. It has three chambers, and turns on an axis parallel with the barrel.

1255 is a five-chambered French flint-lock gun of the eighteenth century.

1256 is a gun of the same date, with six chambers.

2. (*Husbandry.*) A hay or stubble rake whose head has two sets of teeth projecting from opposite sides in the same plane. The set in advance having collected a load, the rake is tipped, making half a revolution, discharging the load and bringing the other set of teeth into action. See Fig. 2454, page 1082.

Re-volv'ing. Having a motion in an orbit, as that of a planet around the sun ; the cylinder of a *revolving-cylinder* steam-engine around the shaft ; the *planet-wheel* of the sun-and-planet motion around the sun-wheel.

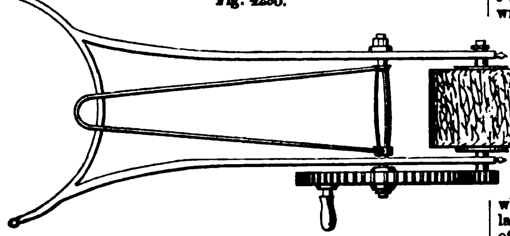
The terms *rotary* and *revolving* should not be confounded, as they are needed in their specific senses.

Rotation on an axis, as a carriage-wheel, a sun-wheel.

Revolution, as cited above.

Re-volv'ing-boil'er. (*Paper-making.*) A boiler for paper-stock or pulp, rotating on trunnions, so as to agitate the contents and expose the stock fully to the hot-water, steam, chemicals, etc. See PULP-BOILER ; PULP-DIGESTER, etc.

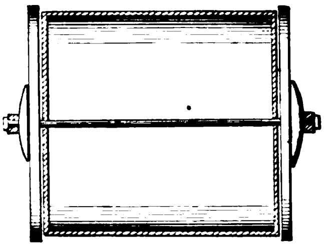
Fig. 4295.



Revolving-Brush.

Re-volv'ing-brush. A mechanically rotated brush for the hair or for sweeping. The example is intended for barbers' use ; the frame has a curved portion resting against the person of the operator, and an elastic loop passing around his neck, and is turned by a hand-crank and spur-gears.

Fig. 4296.



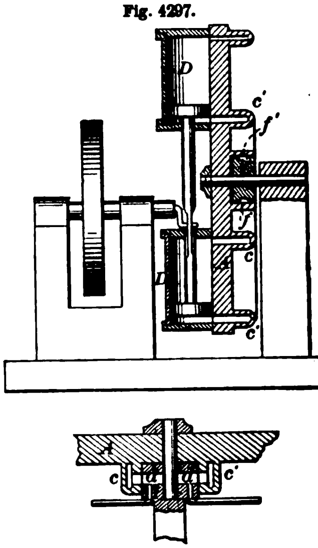
Revolving-Car.

Re-volv'ing-car. One which rolls as it travels. In the example, a cylindrical receptacle is attached to an axle supported in a frame by two wheels, which run loosely on the axle to allow them to turn more easily. Each frame has a tongue, and two or more cars can be attached to each other.

Re-volv'ing-cyl'in-der Steam-en'gine. One whose cylinder is mounted on trunnions and is caused to rotate by the reciprocation of the piston, in contradistinction to the rotary engine, in which the pistons rotate on an axis within a steam drum.

The sectional view (Fig. 4297) exhibits an engine of this class, having a fly-wheel *A* with two cylinders *D D* rigidly attached to it and placed opposite each other in a radial line. These cylinders have a common piston-rod, which is attached at its center to a crank-pin in such a manner that every revolution of the fly-wheel *A* caused by the action of the steam in the cylinders produces two revolutions of the crank.

Fig. 4297.



Revolving-Cylinder Steam-Engine.

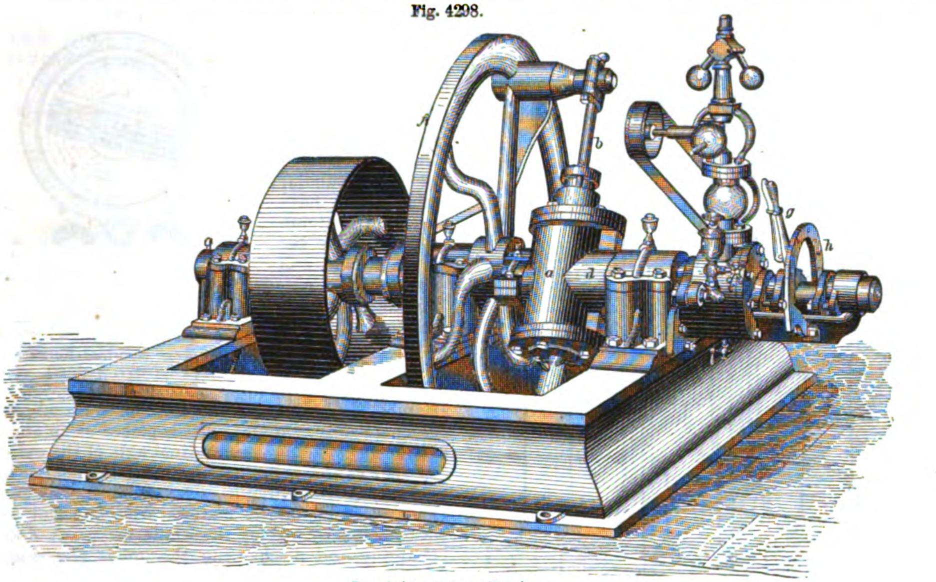
The stationary disk-valve *I*, with ports *d d'* and grooves *f f'*, and pipes or channels *c c'*, control the admission and exhaust of steam.

In Scott and Morton's steam-engine (Fig. 4298), the cylinder *a* is mounted on trunnions *c d*, and the piston-rod *b* is connected to a wrist-pin on the fly-wheel *f*. The trunnion *c* is journaled eccentrically in the hub of the fly-wheel, so that each revolves independently on its own axis. Previous to starting the engine, the piston is placed at half-stroke on one side of the fly-wheel center. Steam is admitted to and exhausted from the cylinder through ports in the trunnion *d*. *e* is the steam-chest.

The valve motion is controlled by the lever *g*, by which the engine is started or reversed, and by moving it back or forth on the arc *h* the lap of the valve is changed.

In Kipp's revolving-engines the exterior cylinder, to which a belt may be directly applied, it being surrounded by a lagging for that purpose, is caused to rotate by the reciprocation of two pistons with duplicate heads in cylinders whose axes are at right angles to each other. The piston-heads *a a'* are con-

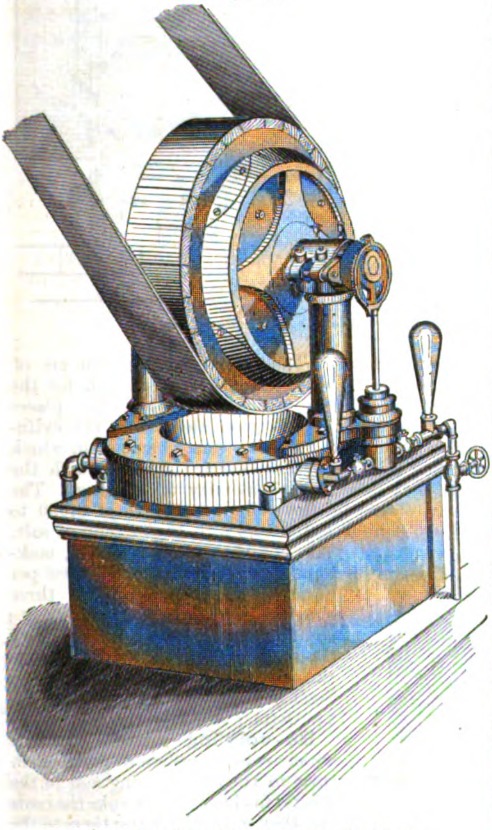
Fig. 4298.



Revolving Steam-Engine.

nected, as are also $b\ b'$, by the pieces $c\ c\ c'\ c'$. Yokes $d\ d'$ connect these with a crank e on the main shaft of the trunk. Steam is

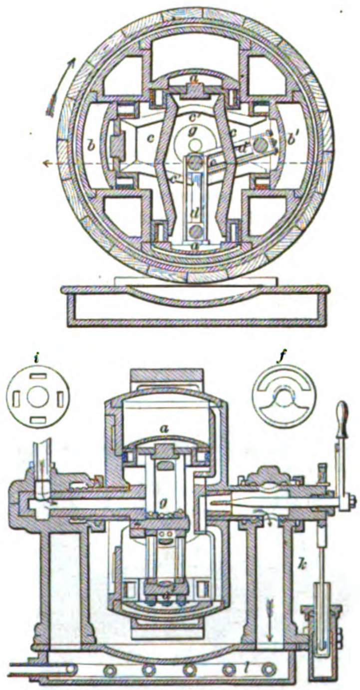
Fig. 4299.



Kipp's Revolving-Engine (Perspective View).

admitted through the valve f to the central space g, which serves as a steam-chest. The arrangement of the ports is shown at i. The drum is mounted on trunnions, through one of which the steam enters, the other serving to exhaust through one of the hollow

Fig. 4300.

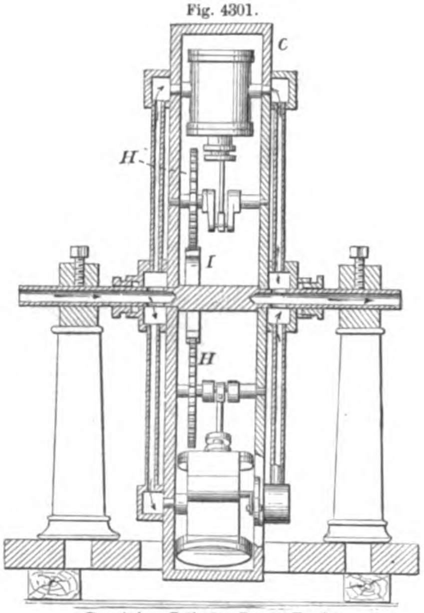


Kipp's Revolving-Engine (Sections).

pillars k into the feed-water heater l; an eccentric on the main shaft also operates the feed-water pump.

In Fig. 4301, the drum C rotates in bearings, the steam passing in and out at the respective trunnions. The cylinders oscillate in bearings in the heads of the drum, and revolve with it.

Fig. 4301.

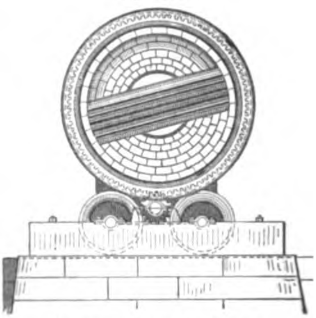


Revolving-Cylinder Steam-Engine.

The reciprocating pistons are connected by cranks to planetary gears *H H*, which mutually and severally engage a fixed sun-wheel *I* on the central axis. Power is transmitted by a belt on the drum.

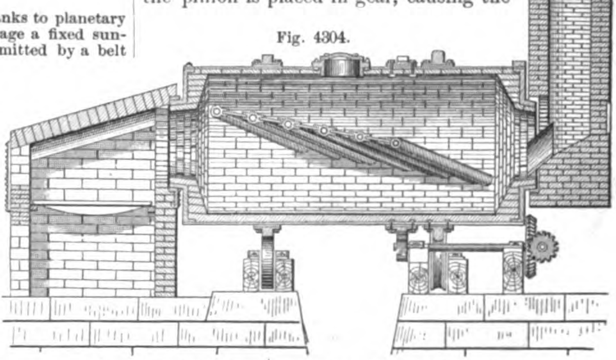
Re-volv′ing-fur′nace. The Brückner revolving-furnace, for chloridizing, desulphurizing, and roasting ores is shown in Figs. 4302, 4303, and 4304. It is designed for roasting ores with salt, and is a horizontal cylinder, constructed of boiler-plate iron and lined with fire-brick. It is 12 feet long and 6 feet in diameter, supported on rollers, on which it is rotated by gearing. One end of the cylinder communicates with a brick fireplace, while the opposite end is let into the stack so that the flame from the fireplace passes through the interior of the cylinder. Within the cylinder there is an iron diaphragm or partition protected by fire-proof material and running longitudinally through the greater part of its length. It is made in sections, which are held in grooves that are formed in the tubular ribs, which have open ends extending outward beyond the side of the cylinder, permitting the passage of air. When the several sections are in place, the entire partition or diaphragm has the form of a rhomb, whose ends are obtuse angles. It is placed at an angle of 10° or 15° with the longitudinal axis of the cylinder, so that as the cylinder containing the charge is revolved, the diaphragm causes a continuous passing and repassing of the material from one end to the other, thereby mixing the whole mass. A door for charging and discharging the ore is placed on the surface of the cylinder opposite the partition. The outside of the cylinder has flanges which rest on the rollers, and a toothed rib, with which the pinion is placed in gear, causing the whole to revolve. The fireplace and fire-flue are of brick or stone, with funnels large enough for the ends of the cylinder, which may fit into their places easily and revolve. Between the end of the cylinder and the stack there is a dust-chamber, in which the fine material that is carried through with the draft may have an opportunity of settling. The charge of ore for the cylinder consists of 3,000 to 4,000 pounds, with from 6 to 10 per cent of salt. The cylinder revolves slowly, making only one or two revolutions per minute; it consumes about three quarters of a cord of wood per day; the chloridation is said to be very thoroughly effected. See also ROASTING-FURNACE; SILVER PROCESS; DESULPHURIZING-FURNACE; SILVER-MILL; SHAFT-FURNACE.

Fig 4303.



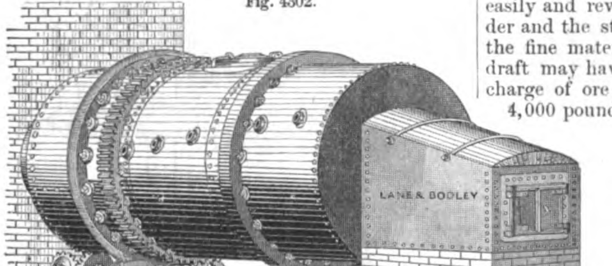
Brückner Roasting-Furnace (Transverse Section).

Fig. 4304.



Brückner's Revolving-Furnace (Longitudinal Section).

Fig. 4302.



Brückner's Revolving-Furnace (Perspective View).

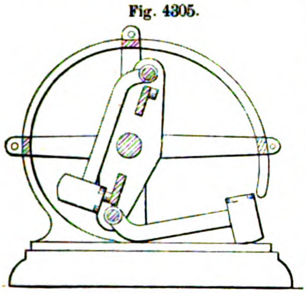
Re-volv′ing-grate. 1. One which exposes different portions in turn to the feed-opening and to the greater fire heat, so as to coke the coals and then gradually bring them to the point where the fire is more urgent.

2. An ore-roasting furnace with a horizontal revolving-hearth. See ROASTING-FURNACE.

Re-volv'ing-ham'mer. A hammer revolving with a shaft.

In Fig. 4305, the apparatus consists of an armature revolved by a crank which carries two hammers, whose handles, hinged respectively upon axes at the ends of the armature, may fold back upon the armature and upon opposite sides thereof in such manner that the hammers will rest upon supports attached to said armature lying within or nearly within the orbit of the axis to which the handles are secured, and the circle described by the armature. A rim or guard of unequal but proper curvature, which lies in the orbit of revolution of the armature, prevents the hammer from being thrown from its support by centrifugal force until it shall have passed beyond a plane projected vertically through the axis of the armature.

Fig. 4305.

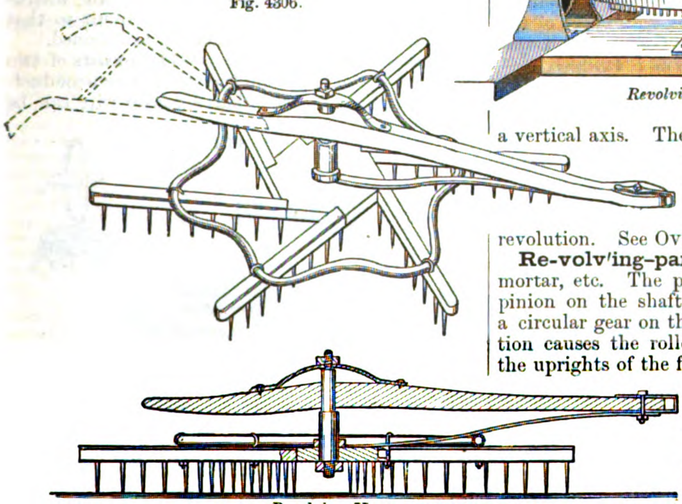


Revolving-Hammer.

Re-volv'ing-har'row. One which rotates in a plane parallel to the earth's surface, to assist the dragging action of the teeth. In Fig. 4306, the beams that hold the teeth are attached at their inner ends to a hexagonal central hub of iron, provided with mortises in each of the six sides. See also HARROW.

Re-volv'ing-light. One character of light as displayed from a lighthouse. It is one of the forms

Fig. 4306.



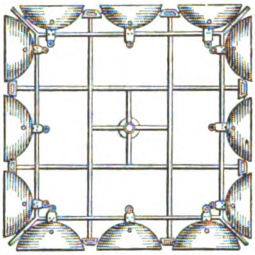
Revolving-Harrow.

of interrupted lights; the others are termed *intermittent* and *flashing*. Each of the three is distinguished from the *fixed*, whose beams are constant. The *fixed*, *revolving*, *intermittent*, and *flashing* are each capable of variation as to *color* and *number;* in the latter respect as *single* and *double*.

The characteristics above cited are variously combined, as, *revolving white*, *revolving red and white*, *revolving red and two whites*, *double fixed*, *double revolving white*, etc., etc.

The revolving light is produced by the revolution of a frame with three or four sides, having reflectors of a larger size than those used for a fixed light, grouped on each side with their axes parallel. The revolution exhibits once in one or two minutes, as may be required, a light gradually increasing to full strength, and then decreasing to total darkness.

Fig. 4307.



Revolving-Light.

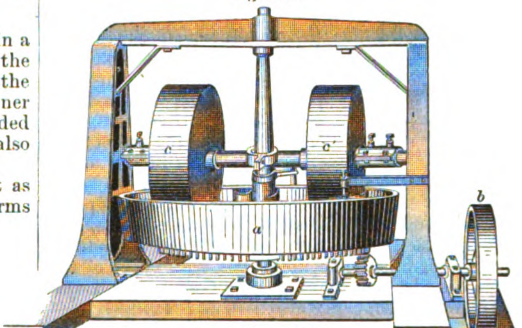
The *intermittent* has a steady light for a short time, and a sudden eclipse, forming a dark interval.

The *flashing* is a revolving light in which the light is always visible, but alternates in power, the light rising and sinking at intervals of five seconds. See LIGHT.

The reflectors are attached to a square reflector-frame, having an upright central shaft on which the apparatus turns. This is supported by a socket below and a bridge-piece above. It is rotated by clock-work and gearing. When the light is alternate *red* and *white*, the lamp chimneys of the lights on the respective sides are of red and white glass. When two white lights alternate with one red, or vice versa, the frame is triangular or hexagonal, and the lights on the respective sides are suitably arranged for the sequence of colors.

Re-volv'ing-ov'en. One having pans which revolve on a horizontal axis, or a horizontal hearth on a vertical axis. The object is to pass the bread once around within the time required for baking, taking off a batch of loaves and putting on a batch of dough at each portion of a revolution. See OVEN.

Fig. 4308.



Revolving-Pan Mill.

Re-volv'ing-pan Mill. A mill for grinding mortar, etc. The pan *a* is caused to rotate by a pinion on the shaft of the pulley *b*, which engages a circular gear on the bottom of the pan. Its rotation causes the rollers *c c'*, journaled in bearings in the uprights of the frame, to revolve and comminute the material beneath, which is directed toward them by curved scrapers.

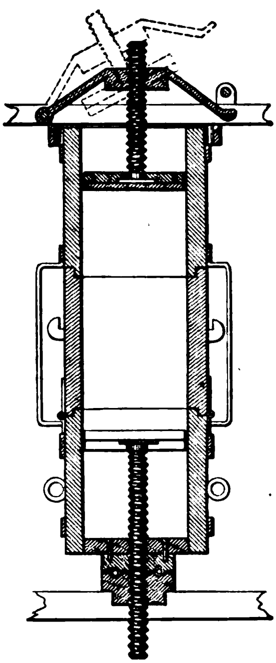
Re-volv'ing-press. One form of baling-press, in which, as the box revolves, screws acting in stationary nuts actuate the followers in the box, approaching or withdrawing them according to the direction of rotation of the box.

The press has usually but a single screw, one example of which is shown under BALING-PRESS (which see).

In the present example, the box rotates on a vertical axis, and has two followers attached to the ends of screws, one right and the other left, which screws pass through fixed nuts, one at the top and the other at the bottom of the frame, so that, as the box is rotated, the followers turn the screws and are thereby made to advance toward or recede from each other.

Re-volv'ing-sun. A pyrotechnic device, con-

Fig. 4309.



Revolving-Press.

sisting of a wheel upon whose periphery rockets of different styles are fixed, and which communicate by conduits, so that one is lighted in succession after another.

Re-volv'ing-tow'er. The revolving tower or turret, for offensive or defensive operations, was the work of Theodore R. Timby, of Saratoga, N. Y. The idea was conceived and a model made in 1841, caveated in 1843, and it was patented to him in 1862.

The original model had a base, revolving-tower, and central lookout, and the specification of 1843 involved the use of steam-power for revolution and for propulsion of the floating structure. The revolving-turret is a feature in the monitors, both as constructed by Captain Ericsson and his successors, and also by Captain Coles of the British navy, who devised a modified form of turret. Some notice has been taken of the subject under ARMOR-PLATING; GUN-BOAT; IRON-CLAD (which see). See also TOWER; TURRET.

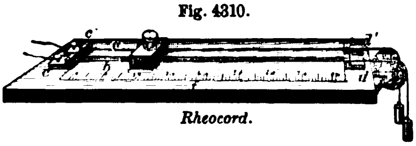
The advantages claimed for the turret over the broadside are,

1. Steadiness of carriage amidships.
2. Hight above water.
3. Greater facility of training and increased field of fire.
4. Protection to gunners, as the port can be turned out of fire.
5. Rapidity of fire, as the gun may be kept trained while the embrasure is turned out of fire.
6. That it admits of greater weight of metal being thrown on one side.
7. Advantage of position, as the gun can be pointed in any direction without regard to the lay of the vessel.
8. Allows a minimum port-hole without interference with range

Rhe'o-cord. An instrument for measuring electro-magnetic resistances. Poggendorff's (Fig. 4310) is well adapted for small resistances.

Two platinum wires *a b* are stretched on a board and held between clamps *c c' d d'* at either end. To the ends *d d'* are attached silken strings passing over

Fig. 4310.



Rheocord.

pulleys and carrying weights, which keep the wires tense. The wires are insulated from the clamps and pass through a box *e* filled with mercury, which slides on the wires and carries a vernier. When the clamps *c c'* are connected with the poles of a battery, the current from *c* passes through the wire to the box *e*, where it is transferred by the mercury to the other wire and conducted to the other pole of the battery. The distance which the current has to traverse along the wires is greater or less, according as the box *e* is caused to approach or recede from *c c'*, and is measured on the scale *f* by an index attached to the box.

The resistance of the whole length of the wires *a b* having been determined, that of each division of the scale is deduced, and one of these divisions may be employed as a unit for calculating resistances either by the differential or substitution methods.

A simple arrangement for measuring greater resistances consists of a number of short metallic bars placed at equal distances apart on a board, in such a way that their ends may be connected by the insertion of brass plugs between them. Each bar is attached to one terminal of a German silver coil of definite resistance. When the plugs are all inserted, a current will pass directly through the series of plates; but when any one or more is left out, the circuit is compelled to pass through the resistance coil or coils connected to the bar or bars thus left out of the short circuit. The sum of their resistances gives the total resistance.

A modified arrangement on the same principle is employed for measuring very great resistances. Half of each coil is in all instances wound in a direction opposite to the other, to neutralize the induction of the coil upon itself.

Rhe-om'e-ter. (*Electricity.*) A term first proposed by Peclet to designate an instrument to measure the force of an electric current. See ELECTROMETER; GALVANOMETER.

Rhe-o-mo'tor. (*Electricity.*) Any apparatus which originates an electric current, whether it be a magneto-electric current or a voltaic battery, a thermo-electric battery, or any other source whatever of an electric current.

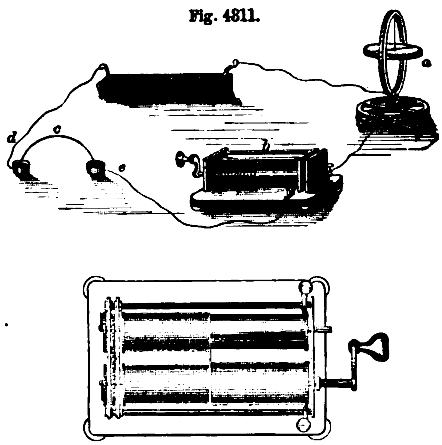
Rhe'o-phore. (*Electricity.*) A term employed by Ampère to designate the connecting wire of a galvanic apparatus as being the carrier or transmitter of the current.

Rhe'o-scope. (*Electricity.*) An instrument for detecting an electric current. See ELECTROSCOPE.

Rhe'o-stat. (*Electro-magnetism.*) An instrument for regulating or adjusting a circuit so that any required degree of force may be maintained.

Wheatstone's rheostat (Fig. 4311) consists of two cylinders, one of brass and the other of non-conducting material so arranged that a copper wire can be

Fig. 4311.



Rheostat.

wound from one to the other by turning a shiftable handle. The surface of the non-conducting cylinder has a screw-thread by which the successive convolutions of wire are isolated. Being introduced into a circuit, the wire is wound on or off the threaded cylinder by which the resistance is determined, the brass cylinder being so large that its resistance is not considered. In the upper figure, the current is

shown as traversing a galvanometer *a*, the rheostat *b*, and the conductor *c*, the resistance of which is to be measured. The whole wire being wound on the brass cylinder, the deflection of the galvanometer is noted, the conductor *c* is withdrawn from the circuit, and the ends *d e* directly connected; the amount of wire on the non-conducting cylinder when the galvanometer indicates an equal deflection, shows the strength of the resistance *c*.

Rhe'o-tome. (*Electricity.*) An instrument which periodically interrupts a current. — FARADAY.

Rhe'o-trope. (*Electricity.*) An instrument which periodically inverts a current. — FARADAY.

Rhi'no-plas'tic Knife. One for performing the Tagliacotian operation for artificial nose. See next article.

Rhi'no-plas'tic Pin. A pin used in securing an artificial to the natural base or remains of the nose.

The operation for the restoration of the nose was introduced by Gaspar Tagliacozzi at Bononia, about 1553. He cites successes of former operations in ingrafting noses, ears, lips, etc. Tagliacozzi obtained the piece for the replacement by dissection from the shoulder or arm of the patient, or a piece from some obliging person who was willing to be tied to the patient for a few weeks till the graft united, and might be severed from the original proprietor.

Liston introduced the plan of cutting the piece from the forehead of the noseless. This plan had been previously practiced among the Koumas of India, among whom the loss of the nose was inflicted as a penalty for various crimes. The brutal punishments or revenges of Europe, a few centuries since, included various mutilations, pruning off the salient members, especially those of the head, and sometimes, as in the case of Abelard, organs whose loss no skill could remedy, and whose imitation would be but an aggravation.

The "Notary's Nose," by E. About, is an amusing account of the operation for grafting an artificial nose upon the face of a man, M. L'Ambert, who is related to have had his fine Roman nose cut off in a duel with a Turk. A vagabond cat having eaten the amputated organ, the patient is reduced to a choice between the East Indian and Italian methods. The former consists in cutting a triangular piece out of the skin of the forehead, the apex at the bottom, at which point the portion retains its attachment to the brow. The flap is then turned down and twisted half round, so as to bring the epidermis outside, and its edges are sewed to the corresponding outline of the wound. The Italian method is to cut the flap from the arm, to which it is left attached at one point to keep up a vital circulation; the piece is sewed to the outline of the wound, and the arm is bound to the head till the junction is perfected.

M. L'Ambert selected an Auvergnat water-carrier, who consented to allow the flap to be cut from his arm, which was bound to the head of the patient, and so they were united for a month. The interest turns upon the quarrels of the ligatured parties and a supposed connection of the new nose with the bodily conditions of the discharged water-carrier, even after the separation of the parties. The lout becomes dissipated, and the nose is red and swollen; sick, and the nose becomes thin, pale, and attenuated; he enters a looking-glass factory and absorbs so much mercury that the notary's gold spectacles become rotten at the bridge by amalgamation; he catches a terrible cold, and "talking through his nose," as the phrase is, has a horrible Auvergnat brogue; finally, the man loses his arm by entanglement in some machinery, and the notary's nose drops off.

Rhi'no-scope. An instrument for examining the posterior nares, — the rear portion of the nostrils. A mirror, ½ to ¾ inch diameter, on a stem about 5 inches long, is introduced into the mouth. On the top of this mirror is a retractor, to hold back the palate, in order to obtain an uninterrupted view. Light is thrown in by means of a reflector, as used in laryngoscopy. See LARYNGOSCOPE.

Rho'dings. (*Nautical.*) The brass boxes for the journals of the pump-break.

Rho'di-um. Equivalent, 52.2; symbol, *Ro.*; specific gravity, 12.1; nearly infusible. It is a white, lustrous, hard, brittle metal, not acted on by acids when pure, and is used for the tips of gold pens.

Rhumb. One of the *points* on a compass-card. The circle of 360° is divided into 32 points or rhumbs, each interval comprehending an angle of 11° 15′. These are divided into half and quarter points. See MARINER'S COMPASS.

Rhus'ma. (*Leather-manufacture.*) A mixture of caustic lime and orpiment or tersulphide of arsenic, used in depilation or unhairing of hides.

Warington, finding that the arsenic was ineffective, and that the sulphide of calcium was the active agent, substituted the latter, *per se*, and found it effective in from 24 to 36 hours in softening the epidermis and loosening the hair.

Rhy-sim'e-ter. An instrument invented by Mr. A. E. Fletcher for measuring the velocity of fluids or the speed of ships. It is on the principle of the *Lind Anemometer* (Fig. 205, page 99), and of *Pitot's Tube* (Fig. 661). It presents the open end of a tube to the impact of the current, which raises a column of mercury in a graduated tube.

Rib. A bent timber or metallic bar forming a principal piece in a frame or structure, as —

1. (*Shipwrighting.*) One of the curved side timbers of a ship or boat, to which the wooden planking and the interior sheathing is trenailed or pinned. So called from their resemblance in form and object to the ribs of the human body, which are articulated in the spine and inclose the thoracic cavity.

In wooden vessels of considerable size, timber of the required dimensions and form cannot be procured to make a rib of one piece, so it is made in sections scarfed together. These are known as the *first*, *second*, and *third futtocks*, and terminate in the *top-timber*. In iron vessels, a bar of the proper size is bent into the required form.

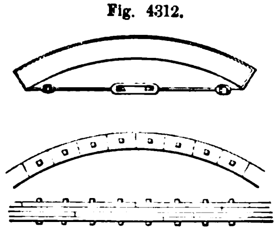
2. (*Carpentry.*) *a.* A timber arch to support a plastered ceiling.

b. A projecting or tracery molding on a vaulted ceiling.

c. A curved member of an arch center.

The rib of a bridge or roof may be of iron or wood, having an arched form and springing from abutments. The rib of a centering is of wood, and forms a part of a frame whose construction depends upon the span and expected weight.

Fig. 4312.



Built Ribs.

Built ribs, constructed on the method devised by Philibert de l'Orme, are made of several layers of planks set on edge, breaking joint, and connected by bolts. The figures exhibit a side elevation and plan, and an elevation of a rib constructed of straight-edged planks.

Laminated ribs are made of layers of plank laid flatwise and bolted together. See ARCHED BEAM, Plate III. See also ROOF, Plate LII.

Various other names have been given, as —

Decorating rib.	Ridge-rib.
Diagonal rib.	Round rib.
Intermediate rib.	Transverse rib (cross-springer).
Nerve.	Wall-rib.

3. (*Bookbinding.*) One of the ridges on the back of a book which serve for covering the tapes and for ornament.

4. (*Machinery.*) An angle-plate cast between two other plates, to brace and strengthen them; as be-

tween the sole and wall-plate of a bracket. See BRACKET.

5. (*Mining.*) A pillar of coal left as a support for the roof of a mine.

6. One of the extension rods on which the cover of an umbrella or parasol is stretched. They are made of whalebone, steel, or cane.

Ri-ba-do'quin. (*Weapon.*) A cross-bow for throwing large darts.

Rib'band. (*Shipbuilding.*) *a.* A longitudinal strip of timber following the curvatures of the vessel and bolted to its ribs to hold them in position and impart stability to the skeleton. A number of these are fastened at different distances from the keel.

b. Square timbers of the slip fastened lengthways in the bilgeways, to prevent the timbers of the cradle slipping outward during launching.

Rib'band-lines. (*Shipbuilding.*) Oblique longitudinal sections of the hull.

Rib'band-shore. (*Shipbuilding.*) A strut to support the frame of a ship while building. Their heads rest against the ribbands and their bases on the slip or dock.

Ribbed Arch. (*Engineering.*) An arch consisting of iron or timber parallel ribs springing from stone abutments.

Rib'bing-nail. (*Shipbuilding.*) A nail with a large round head with rings.

Rib'bon. 1. (*Fabric.*) A narrow fabric used for trimming.

Ribbons are of various materials, textures, and qualities. Among these are the following: *chiné, ferret, galloon, love, lustring* (lutestring), *ribbon velvet, sarsnet, satin, taffety,* etc.

The ribbon manufacture is largely carried on at Coventry, in England, and at Saint-Etienne, in France. A great number of the improvements in the different branches of the manufacture are due to the Swiss and Germans, among others the bar-loom, brought from Switzerland, in 1756, by M. Flachat, of Saint-Chamond, and the economical processes for fining velvet, introduced in 1775, by Roland de la Platiere.

The application to the bar-loom of the Jacquard machine, and of the various improvements derived from it, have resulted in the production of an admirable working instrument, with which a skilled workman is able to make everything, from simple taffetas to elaborate portraits. The ornaments vary considerably in style and arrangement. Sometimes these are purely fanciful compositions, — Byzantine, Indian, Oriental, Chinese; at others, of birds and animals, more or less approaching nature. The commonest ornaments, and generally the most successful, are borrowed from flowers. Buds, corn-ears, — fruits even, — are all suitable for composition. Birds, and some species especially, lend themselves very readily to the fancy of the designer, but quadrupeds which are able to find suitable place in an ornament are rare.

Whatever may be the nature of the design, a practical application is given to it by the card-setter, who transfers it, while enlarging the size, to a checkered sheet. This sheet assists the stamping-out machine to prepare the cardboard sheets for the Jacquard machine. The warps are made under careful supervision, and the threads composing them consist of organzines thick enough to support the strong tension necessary to the weaving. The warping requires an extreme attention, especially in the case of ribbons which are to include different kinds of web and different colors of warp. Each warping-mill is composed of a "bank," a frame slightly inclined and arched, fixed, at its two extremities, into a wooden frame. It bears a variable number of bobbins, among which are divided the organzines destined to form the web. Parallel to the bank is placed a vertical divider, on which each warp revolves when it is made. The workwoman, with her left hand, moves a crank, which transmits the motion to the divider, and with her right hand she guides the passage of the threads between the glass teeth of a kind of large toothed comb. The warps prepared in the divider are then rolled by large bobbins, called blocks, belonging to the master weaver, who is intrusted with the making of the ribbon. The threads of weft are not twisted and doubled like the organzines of the warp, but are more or less twisted, according to the nature of the tissue desired. To produce plushes in various designs, imitating either fur or the feathers of birds, especially of the peacock, they imprint on a warp the ornament they wish to reproduce, only on a wider scale, and weave it in satin; and by means of the shortening of the threads, caused by weaving, the figure is formed more or less exactly as the imprint was well or badly calculated. This satin, worked with thick silk threads, after being woven, is placed in the hands of women, who cut every length of the threads with little special tools worked with the hand. The plush then is raised or left flat according to the nature of the thread employed, and the close or loose texture of the satin. The most satisfactory results are thus obtained. Among charming combinations may be mentioned one representing, on taffetas, a peacock embroidered in relief, accompanied, on each side of the ribbon, with a plush border, happily imitating the beautiful iris eyes which glitter at the end of the peacock's feathers. A large quantity of ribbons are bordered with bands of imitation fur.

The finishing workshops, common to all the manufacturers of Saint-Etienne, give the last figuring to the different kinds of ribbons which are to receive them. Most of these figures are impressed by rolling; thus moire is obtained by passing the stuff between cylinders ranged with various cuttings. Satin, on the contrary, between smooth cylinders, the action of which compresses the threads of the warp, and gives them the polish peculiar to this beautiful material. In some special cases, the ribbons, before being rolled, are passed through a bath of starch or gum. A rigid inspection of the completed products, both on their return from the houses of the workmen and before their sale to the purchaser, weeds out all defective pieces.

Ribbons for hand-stamps are tapes saturated with an oily pigment, which becomes impressed upon an object when the stamp is brought down upon the two, which are placed in contact beneath it. It is an inky ribbon, and is used as a substitute for inking the face of a stamp.

2. (*Fiber.*) A continuous strand of cotton or other fiber in a loose, untwisted condition. A sliver.

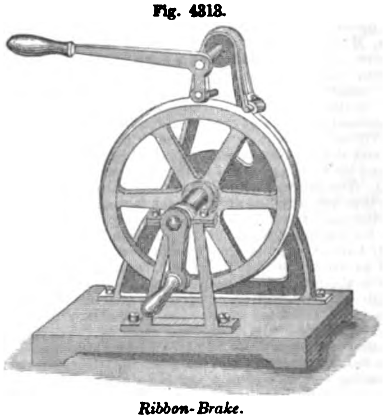
3. (*Carpentry.*) A long, thin strip of wood or a series of such strips connecting a number of parts.

4. (*Metal-working.*) A long, thin strip of metal, such as a watch-spring; a thin steel band for a belt or an endless saw; a thin band of magnesium for burning; a thin steel strip for measuring, resembling a tape-line in its size and functions.

5. (*Nautical.*) The painted moldings on a ship's side.

Rib'bon-brake. A brake having a band which nearly surrounds the wheel whose motion is to be

Fig. 4318.

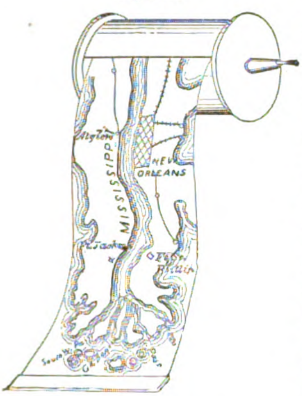


Ribbon-Brake.

checked. One end is made fast and the other is attached to the short arm of a bent lever, by means of which it may be at once applied to the greater part of the periphery of the wheel, exerting a frictional pressure proportionate to the force applied to the lever.

Rib'bon-loom. The ribbon-loom first appeared at Dantzic in 1586, and the inventor is said to have been strangled to prevent the spread of what would throw so many mechanics out of employment. It was prohibited in Holland for that reason in 1623. It is first noticed in England in 1674. In 1780, the mode of ornamentation (watering) by pressing between figured steel plates was adopted. Steel cylin-

Fig. 4314.



Ribbon-Map.

ders were afterward substituted. See NARROW-WARE LOOM.

Rib′bon-map. A map printed on a long strip which winds on an axis within the case.

Rib′bon-saw. A thin and narrow endless band of steel, one edge of which is serrated. It is stretched over two drums, such a distance apart that there is a certain length of straight saw-band between them. Motion is communicated to one of these drums, which causes the band-saw to travel with it by friction. Owing to the small width and thickness of the band, it is capable of cutting the wood to almost any curve required. See BAND-SAW.

Rib-vault′ing. (*Architecture.*) Vaulting having ribs projecting below the general surface of the ceiling to strengthen and ornament it. When the ribs radiate from a central boss or pendant, it is termed *fan-vaulting* or *fan-tracery vaulting*.

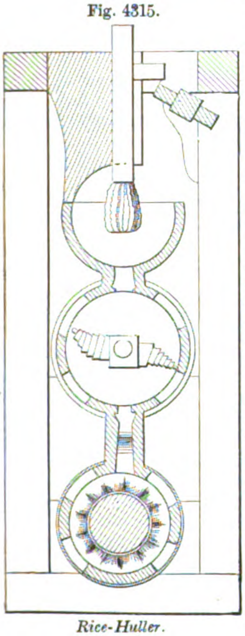
Rice-hull′er. Rice is a native of Asia, in whose warm climates it has been grown from time immemorial. Its introduction into Africa and America is comparatively recent.

The watered rice-fields of "the East" (India) are noticed by Aristobulus.

Rice was introduced into Europe by the Spanish Saracens. The same is true of cotton and sugar.

Rough rice, as it is termed in America, or *paddy*, its name in the East Indies, has an outer husk, and a thin cuticle which adheres to the pearly grain with great tenacity.

Fig. 4315.



Rice-Huller.

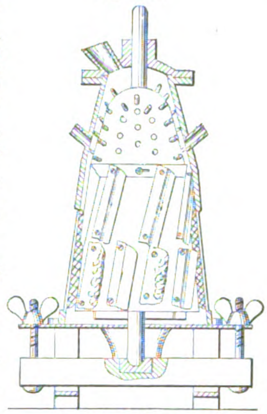
The old method of removing the hulls of rice was by pounding in mortars. These were made of pitch-pine and held about a bushel. The work was performed by the slaves of South Carolina and Georgia in addition to the day's work, a certain amount of hulling being performed by each before regular work and after it.

Machinery was constructed by Lucas, about 1780-90, which was driven by tide-power, and operated iron-shod pestles in cast-iron mortars of the capacity of five bushels each. Steam-power was subsequently introduced.

Fig. 4315 is an example of the application of machinery to the pestle and mortar huller. The grain, after a rough preliminary grinding between stones, is passed to the mortar, and is beaten by the ribbed pestle. From the mortar it passes to a horizontal cylindrical chamber having wire gauze at the sides, and containing a rotating cylinder with corrugated curved arms. From the latter the rice passes to the polishing-cylinder.

In another form of machine the cuticle is removed in a whitening-machine, which consists of a stone of coarse grit mounted like a grindstone and rotating in a sheet-iron casing, which is punched full of holes, the roughnesses projecting inward. The casing is large enough to allow a space of about one inch all round the stone, and a door in the casing allows the rice to be placed therein. The stone is rotated about 250 revolutions per minute, and a slow motion is allowed to the casing. The roughness of the stone and the casing and the mutual attrition of the grains on each other, together with the heat evolved, loosen and remove the cuticle, which passes out as a red powder through the holes in the casing.

Fig. 4316.



Rice-Huller.

Ewbank's rice-huller (English patent, 1819) recites the following series of processes:

1. The *paddy* is cleaned by sifting to remove dust and dirt.

2. The husks are rubbed off between millstones set at a suitable distance apart.

3. The grain is cleaned of its husks by a fanning-mill.

4. The grain is then pounded in mortars to remove the red skin.

5. It is placed on a screen of three distinct grades of fineness.

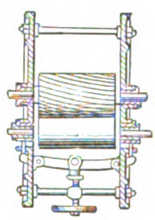
a. The upper screen allows all to pass through but the unhusked grains.

b. The second screen detains the whole rice.

c. The third screen detains the broken grains, but allows the dust to fall through.

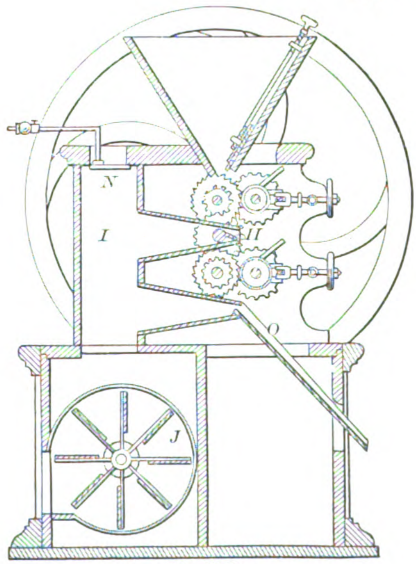
The grains unhusked in the process are conducted back to the mill.

6. The whole hulled grains are taken to the polishing or whitening machine, which consists of two cylinders placed concentrically. The exterior cylinder is stationary, and the revolving inner cylinder is covered with sheepskin having the wool on and placed on the outside. The action of the wool, the inner surface of the outer casing, and the attrition of the grains on each other, remove the remaining portions of the cuticle and polish the grain.



Wilson's rice-huller (English patent, June, 1827) specifies an inclined cylinder with inwardly projecting spokes and a slow rotation and an axial shaft with radiating spokes and a rapid rotation. The arms of the shaft occupy the spaces inter-

Fig. 4317.



Rice-Huller.

vening between those of the cylinder and conversely The rice enters at top, and is driven around in the inclined annular space, following a spiral course to its eventual discharge at the bottom.

The same plan has been adopted of late years in the United States in HOMINY-MACHINES (which see).

In yet another machine wire cards within a wire cylinder are used.

In one sorting-machine the revolving cylindrical inclined wire screen has sections with meshes of gradually increasing size. This, in connection with a blast, sorts the matter from the huller into five kinds, — *chaff*; *flour*; *small* fragments of less than half a grain; *middlings*; grain less than *prime*, but larger than *small*; *prime* unbroken grains.

Fig. 4316 is a machine which has a cone with pins, beneath which is a frustum with elastic scourers within a roughened case of conformable shape. The rough rice is fed in at top, and passes the grinding and abrading surfaces.

In Fig. 4317, the rice from the hopper passes between several pairs of rollers, in which a fluted metallic and a rubber-covered roller are placed opposite to peel the rice, which passes between them. Below each pair is a suction spout *H*, which draws the hull and chaff into the chamber *I*, allowing the grain to descend by its superior gravity. *J* is the fan which draws the chaff from the grain. *O*, the spout down which the grain descends. *N* is a valve for regulating the draft.

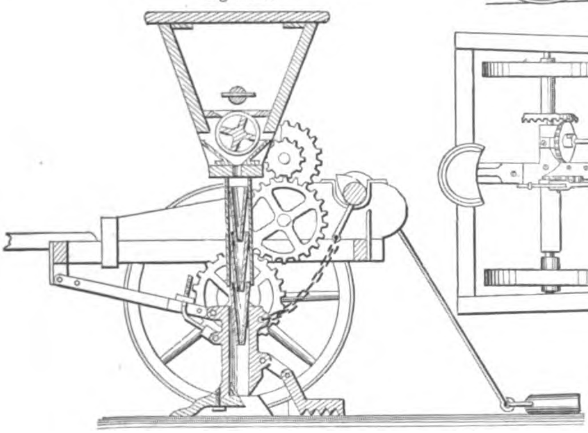
Rice-mill. A mill for removing the husk of paddy.

Rice-pa'per. A kind of paper introduced into England about 1803 by Dr. Livingstone, and named from its supposed material. It was understood to be a sort of dried pulp of rice.

It is, however, made of the pith of a leguminous plant, the *Aralia papyrifera*, which grows wild in abundance in the island of Formosa. The stem is cut into lengths of 8 or 10 inches, and the pith pushed out, much as elders are cleared of pith. This is cut into a continuous spiral ribbon, about 4 feet long, which is spread out and flattened into sheets.

Rice-plant'er. (*Husbandry.*) An implement for sowing rice. The character of the land renders

Fig. 4318.

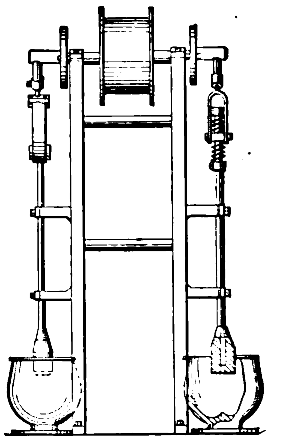


Rice-Planter.

necessary a somewhat different arrangement from the grain-drill. The seed falls through the tubular standard of the plow and is scattered by a deflecting board. The plow is followed by the coverer, which consists of a plate cast with serrations or ribs upon its lower surface. The plow is concave on its lower side, and is adjustable in horizontal inclination.

Rice-pound'ing Ma-chine'. A pestle and mortar for removing the cuticle from rough rice. The pointed elevations within the mortars prevent the pestles from crushing the particles of rice, and also cause them to spread from under the pestles, thereby producing an agitation and mutual friction of the particles.

Fig 4319.



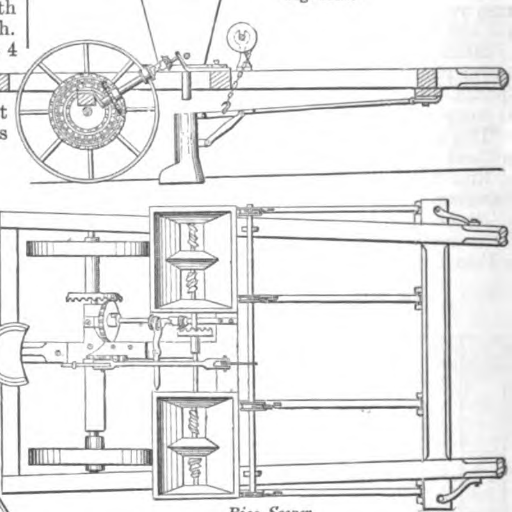
Rice-Pounder.

Rice-sow'er. (*Husbandry.*) A drill for planting rice. Fig. 4320 shows a side elevation and a top view. The seed-slides in the bottom of the hopper are worked by gearing from the main axle, and the seed drops down the conductor in the rear of the share, which opens the furrow.

Rick. (*Husbandry.*) A structure of hay or grain sheaves, having an oblong plan and a top with sloping sides to shed rain. A *stack* is round in plan, at least in the United States.

Ri'co-chet'. (*Military.*) A mode of firing with small charges and small elevation, resulting in a bounding or skipping of the projectile. In firing at a fortification, sufficient elevation is given to just clear the parapet, so that the ball may bound along the terre-plein or banquette without rising far above its level.

Fig. 4320.



Rice-Sower.

It is used with effect on hard, smooth ground against bodies of troops or such obstacles as abattis; and also upon water, either with round shot or rifle balls. It was introduced by Vauban at the siege of Philipsburg, in 1688.

Ri'co-chet'-shot. (*Gunnery.*) A bounding or leaping shot, fired at low elevation with small charge.

Rid'dle. A sieve with coarse meshes, used in preparatory separation, as: —

1. The *riddle* of a grain-separator which removes the coarser material, such as broken heads, straw, etc., from the grain; the latter is afterward separated from the chaff by the *sieves*, aided by the blast; and subsequently from the cheat and cockle by the

screen. Increasing fineness of meshes,—*riddle, sieve-screen.*

2. The coarse iron sieve which separates cinders from ashes, the larger pieces of ore from the smaller, gravel from sand, etc. See SIEVE; SIFTER.

3. (*Wire-working.*) A board with sloping pins which lean opposite ways, and between which wire is drawn in a somewhat zigzag course, to straighten it. (See WIRE-STRAIGHTENING.)

4. (*Founding.*) A coarse sieve (half-inch mesh), used to clean and mix the old floor-sand of the molding-shop.

5. (*Hydraulic Engineering.*) A kind of weir in rivers.

Rid'dlings. (*Metallurgy.*) The middle grade of broken ore which is obtained by sifting. The sizes are, *knockings, riddlings,* and *fell.* The *knockings* are the large pieces of spar and ore which are picked out. The *riddlings* remain in the sieve; the *fell* is the smallest, and falls through.

Ri'der. 1. (*Mining.*) A deposit of ore overlying the principal lode.

2. (*Shipbuilding.*) *a.* A rib within the inner sheathing, bolted through the latter into the main ribs and planking, for the purpose of stiffening the frame. The riders extend from the keelson to the orlop-beams.

b. A second tier of casks in a hold.

c. A rope which crosses another and joins it.

Ridge. 1. (*Carpentry.*) The upper horizontal edge or *comb* of a roof.

2. (*Fortification.*) The highest part of the glacis proceeding from the interior angle of the covered way.

Ridge-beam. (*Carpentry.*) A beam at the upper ends of the rafters beneath the ridge. A *crown-plate.*

Ridge-drill. (*Agriculture.*) One adapted to sow seed along a ridge which has been *listed up,* by backing up one furrow against another.

Ridge-fil'let. 1. (*Architecture.*) The fillet between two channels of a pillar.

2. (*Founding.*) The runner or principal channel.

Ridge-hoe. (*Agriculture.*) A form of cultivator for tending crops in drills.

Ridge-plow. (*Agriculture.*) A double mold-board plow, used in throwing land into ridges for certain kinds of crops.

Ridge-rope. (*Nautical.*) *a.* A rope leading from the *knighthead* to the upper part of the *bowsprit-cap,* for the safety of the men walking out upon the bowsprit in rough weather.

b. The center rope of an awning.

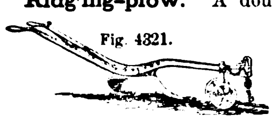
c. A safety line extended from gun to gun in bad weather.

Ridge-tile. A semicylindrical tile for covering the comb of a roof. It is 12 inches long, 10 wide, $\frac{5}{8}$ thick, and weighs about $4\frac{1}{2}$ pounds. Sometimes called a *crest-tile.*

Ridg'ing. The covering of the ridge of a building by ridge-tiles of a saddle shape.

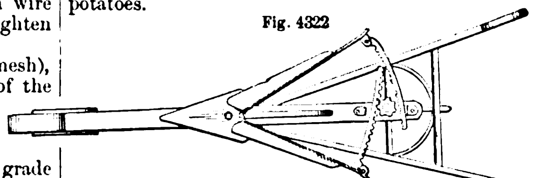
Ridg'ing-plow. A double mold-board plow, throwing the earth away and serving to ridge up land for beet-root, potatoes, or other plants sown on the ridge, and for opening water-furrows. These operations are sometimes performed by a single-breasted plow, which has to go up and down the field to accomplish the same work which this plow effects in one journey. When used for setting out land, a marker is attached for indicating the line of the next furrow. By removing the breasts and marker, it may be used for subsoiling; and again, by attaching the hoe-frame and cutters, a horse-hoe is formed, suitable for cleaning land between rows of plants sown either on the ridge or flat. By attaching to the frame of the subsoil body a set of prongs and a share, these plows are adapted for digging potatoes.

Fig. 4321.



Molding or Ridging Plow.

Fig. 4322



Ridging-Plow.

Fig. 4322 shows a ridging-plow, the wings of which are expanded or contracted by segmental racks and a pinion.

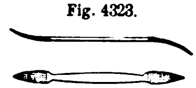
Rid'ing-bitts. (*Shipbuilding.*) Two strong upright timbers near the bows of a ship, to which the cable is secured; they extend through two decks, are connected by a cross piece and braced against the strain of the cable by horizontal standards bolted to the deck beams.

Rid'ing-part. A protuberance on the inner surface of the joint part of a scissors-blade which forms the touching portion back of the rivet, while the cutting portion is at the point of contact of the edges as they move past each other in closing.

Rif'fle. (*Metallurgy.*) An inclined trough or chute down which auriferous slimes or sand is conducted in a gentle stream, which is broken by occasional slats or by depressions containing mercury, which arrests the gold. See GOLD-WASHER; also list under METALLURGY.

Rif'fler. A file with a side so convex as to operate in shallow depressions; used by sculptors, carvers, and gun-stockers. They are made of various convexities and curvatures to adapt them to varying surfaces.

Fig. 4323.



Double-ended Riffler.

Rifflers are usually made of steel, but sometimes of wrought-iron and case-hardened, so that their shape may be modified to a certain extent by bending on a block of lead with a mallet.

Ri'fle. 1. (*Fire-arms.*) A fire-arm having the bore spirally grooved, so as to impart a rotary motion to the bullet and cause it to keep one point constantly in front during its flight.

Grooved-bored small-arms are said to have been in use as far back as 1498; these, however, do not seem to have been rifled in the proper acceptation of the term, the grooves being straight and intended merely to prevent fouling of the bore and facilitate cleaning. The grooves were made spiral by Koster of Birmingham, England, about 1620. In Berlin is a rifled cannon of 1664, with 13 grooves, and one in Munich of perhaps equal antiquity has 8 grooves. The French Carabineers had rifled arms in 1692.

Père Daniel, who wrote in 1693, mentions rifling the barrels of small-arms, and the practice was apparently well known at that time.

Rifles were early used by the American settlers in their conflicts with the Indians; and their first successful employment in civilized warfare is said to have been by the colonists in the war of the Revolution.

In the Artillery Museum at Paris is a large assortment of old rifles, comprehending a great diversity of grooves and twists. These exhibit straight grooves and grooves of uniform twist. In some the twist commences near the breech; in others, at the middle of the barrel or toward the muzzle. In some specimens, the grooves make from $1\frac{1}{4}$ to 2 turns in the length of the barrel; nearly two thirds have an even number of grooves, and

about three fourths upward of 6 grooves, varying from 7 to 12. Nearly seven eighths have grooves with rounded edges. Much the greater part of the remainder have triangular, but a few have rectangular grooves. None have grooves decreasing in depth from the breech toward the muzzle. This species of groove was introduced by Tamisier, in 1846, but is now general among the shallow-grooved arms intended for discharging expanding bullets. Tamisier also introduced the plan of increasing the twist of the grooves as they approached the muzzle.

With the earlier rifles and until a very recent period, a patch was generally used over the ball, causing it to fit tightly in the bore and take hold of the grooves. This was a somewhat precarious method; and, accordingly, the Brunswick rifle, one of the latest specially adapted for the round ball, was made with but two grooves, into which an annular rib on the ball fitted, compelling it to follow these. Lancaster effected the rotation of the ball by making it and the bore of the gun slightly elliptical in section.

To this succeeded the system invented by Delvigne, and improved by Thouvenet, Tamisier, and Minié, in which an elongated bullet, fitting loosely in the bore, is expanded, so as to fill the grooves. This permitted greater rapidity in loading, and insured the rotation of the projectile. See BULLET, page 401.

Rifling is now generally adopted in small-arms. The number of grooves is usually three. They are made very shallow, and gradually diminish in depth from the breech to the muzzle. The Swiss Federal rifle, introduced in 1848 by Colonel Wurstemburger, has eight grooves with a twist of one turn in three feet. In this the bullet is not expanded, and it has enjoyed a high reputation for accuracy. The caliber is small, .41 inch, the bullet weighing 257 grains, and the powder charge 62 grains. The plan of having studs or ridges on the bullet to engage the grooves has not been extensively adopted for small-arms. The rifle of General Jacobs, East India service, employs a bullet of this class, having four ridges corresponding to the four grooves of the rifle, and used with a patch.

In Murphy's mode, the rifling only extends four inches from the muzzle, and has its pitch left-handed to correct the slight tendency to pull the gun over to the right in pulling the trigger.

The Whitworth rifle has a hexagonal bore; the Westley Richards carbine, an octagonal bore; the Lancaster carbine, an elliptical bore, or it may be described as a spiral of oval section.

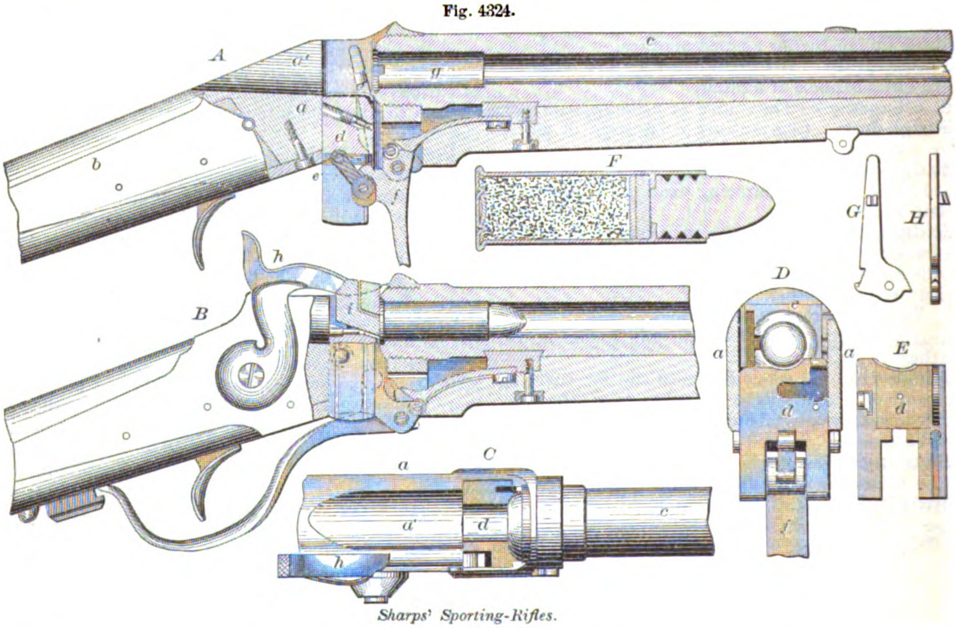
The rifling of gun-barrels in the Remington Works at Ilion, N. Y., is done by a very small cold steel chisel inserted in a long rod firmly attached to a rapidly revolving wheel, which also moves up and down a platform. The barrel is run over this rod and placed firmly in position. As the wheel revolves, the chisel in the rod cuts the rifling in the barrel; and as the wheel advances and retires very rapidly, the twist of the rifling is very elongated.

In breech-loading arms the bullet is of slightly larger diameter than the bore measured from land to land, and *slugs* so as to fill them when driven forward by the ignition of the charge.

See list of breech-loading fire-arms on pages 855–862, and illustrations, Plates XVI., XVII., XVIII. See also BULLET.

Sharps' is one of the very oldest successful guns of the breech-loading class, and the first in which a vertically sliding breech-block was employed. Originally, a paper cartridge was used, the rear end of which was cut off by the sharp forward end of the breech-block in its upward movement; a cartridge having its end closed by a thin combustible paper

Fig. 4324.



Sharps' Sporting-Rifles.

was subsequently substituted for this. At present the metallic cartridge is employed.

In Fig. 4324, *A* is a vertical section of the gun, the parts in loading position; *B*, the parts in firing position; *C*, a top view; *D*, a transverse section, with the breech-block down; *E*, front view of the breech-block, showing in the center the end of the firing-pin, and at the right-hand side the groove occupied by the cartridge-retractor shown by two views at *G H*. *F* is a metallic cartridge in section.

a is the metallic breech-piece, secured to the wooden stock *b*, and into which the barrel *c* screws; *d* is the breech-block, connected by a toggle *e* to the guard-lever *f*, and having a vertical movement

within a slot in the breech-piece *a*. The upper surface of the breech-block has a groove *a'* in line with the barrel, serving as a guide for the insertion of the cartridge into the chamber *g* when the breech-block is depressed out of the way. This is effected by throwing down the guard-lever *f*, as shown at *A*. The cartridge is then inserted, and the guard-lever brought back to the position shown in *B*, the hammer *h* having been previously set at half-cock. On depressing the lever the firing-bolt *i* is automatically moved rearward by a spur on its forward end, so as to clear the point of the bolt from the cartridge shell and rear end of the barrel. The shell is retracted by the same movement.

In order to fire, the hammer is set at full cock, and on pulling the trigger, its face comes in contact with the end of the firing-bolt, which is thrown forward, its end impinging against the base of the cartridge where the capsule containing the fulminate is placed.

The firing-bolt is so adjusted that the hammer cannot come in contact with it until the breech is perfectly closed, thus affording a security against premature discharge. The cartridge shells may be used a number of times. The exploded cap is removed, the shell cleansed, a new cap inserted, a charge of powder poured in, over which is placed a paper wad, and a lubricating wad composed of $\frac{1}{3}$ beeswax and $\frac{2}{3}$ sperm oil, and the bullet pressed home with a ball-seater.

Among the best known and most efficient arms of its class is the revolving-rifle of the late Colonel Samuel Colt, who, by the simplicity and ingenuity of his devices and his unceasing care to insure perfection of workmanship and material, first rendered the revolving system a success, and succeeded in producing a weapon which is known and used throughout the world.

In 1830, Colt invented a device "for combining a number of long barrels so as to rotate upon a spindle by the act of cocking the hammer." His improvement on this plan, which consisted in using a rotating cylinder containing several chambers, all of which discharge through one barrel, was patented in England in 1835, and in this country in 1836.

The rifle (*A B C*, Fig. 4292, page 1929) has a steel barrel with seven flat angular grooves. The lock-frame is provided with a bridge *a* above the barrel, and the stock is in two parts *b b'*, called respectively the butt and tip. It is adapted to receive a bayonet. The tip in some cases is dispensed with.

The rod by which the cylinder is secured to the barrel has a ratcheted disk *c'* near its rear end, which is engaged in the act of cocking, by a hook connected with the tumbler, rotating the cylinder and bringing each chamber successively in line with the barrel.

Fig. 4325 shows Maynard's rifle. It may, at the option of the user, be provided with two rifle-barrels of different calibers and a shot-barrel, one of which may be substituted for the other by simply releasing the pin *a* which, with the fixed pin *b*, connects the barrel with the stock and firing mechanism, removing the first barrel and securing the second by placing the pin *b* in the hook and reinserting the pin *a* after bringing the holes in the flanges, one of which is seen at *c*, and the arm *d* (shown in dotted lines) into line. These operations take but very few moments to perform.

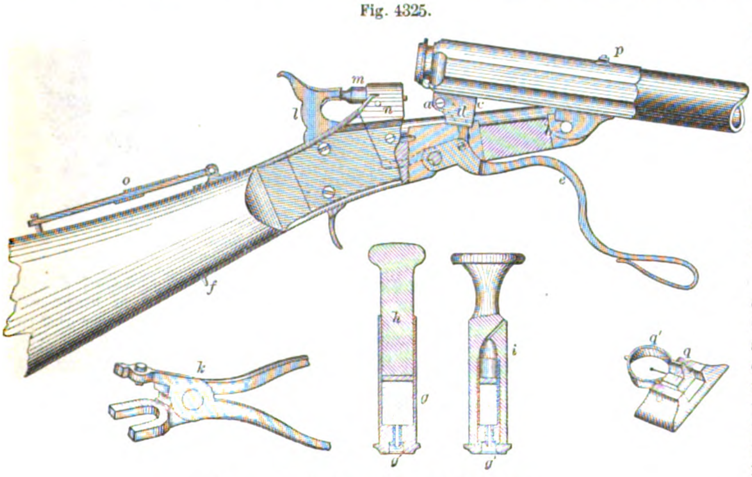
The rear end of the barrel is thrown up for this purpose, and also for loading, by turning forward the lever *e*, which also serves as the trigger-guard. When this is restored to its normal position, it is held by the pin *f* near the small of the stock, and the movement, by means of the arm *d*, draws the breech down into a groove in the metallic part of the stock, where it is in position for firing. Either the forward or backward movement of the trigger-guard *e* places the lock at half-cock, obviating the danger of premature discharge.

The Maynard rifle was perhaps the first in which a metallic cartridge was employed. The report of Major Bell to Colonel Craig, Chief of Ordnance, United States Army, May 16, 1856, describes the firing of Dr. E. Maynard's rifle, charged with a metallic cylindrical water-proof cartridge, and dwells upon the important fact of the coincidence of the axes of the ball and the barrel, obtained by the symmetrical setting of the ball in the metallic shell. The bullet was held in the shell by its exact fit, and without choking the shell upon it. The Maynard coil-primer was then used with it; the nipple and percussion-cap were substituted in 1864; the plunger exploder, in 1873; the Berdan primer, in 1874.

The cartridge cases *g* are of sheet-metal, sufficiently thick to permit their being used an indefinite number of times, and have a thick base, perforated to allow the passage of fire from the primer, which is a cap placed on a nipple slightly recessed within the cavity *g'* of the base. The charge of powder is placed within the case, and with the wad, if one be used, is rammed by the short rod *h*, which also serves for ramming the wad over shot when these are employed.

If ball be used, it is pushed into the case by means of the loader *i*, which has a cylindrical cavity terminating in a hollow conoid fitting the point of the ball and keeping it in truly axial position in the case. The flange at the base of the cartridge enables it to be readily withdrawn from the loader and from the barrel after firing. The device *k* is used for pressing the primer, a shallow, flanged cap, upon the nipple. The cartridge, having been loaded as described, is pushed into the rear of the barrel, which is then depressed by throwing backward the trigger-guard *e* until its loop rests against the stock, the pin *f* entering a hole in the guard. The hammer *l* is drawn back to full cock, and on pulling the trigger the main-spring throws the tumbler forward, causing the hammer to strike the firing-pin *m*, which is projected forward within an aperture in the breech-block *n*, and explodes the primer. The breech-block, backed by the stock in rear of it, sustains the force of the recoil.

Fig. 4325.



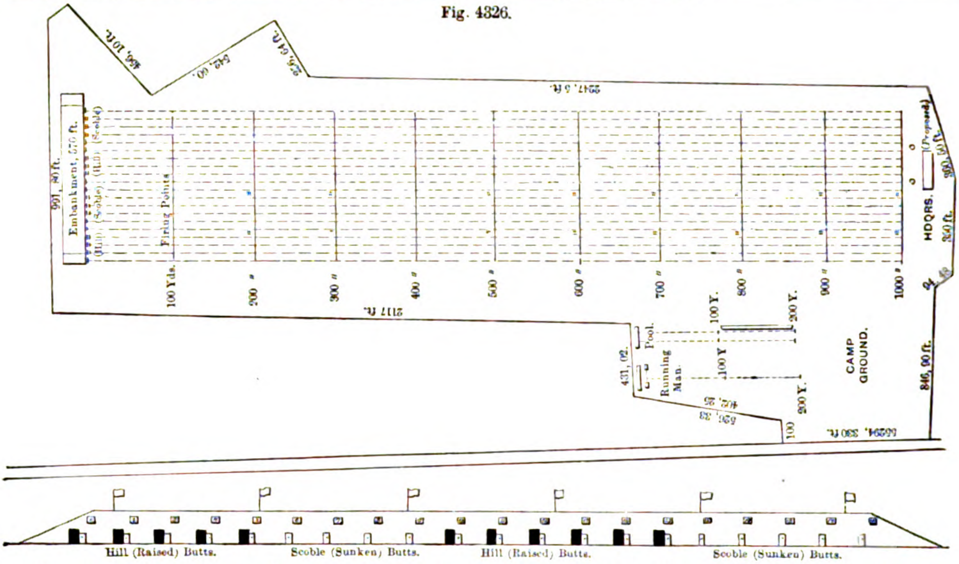
Maynard's Combined Rifle and Shot-Gun.

The rear sight *o*, pivoted on the small of the stock, is a slide-sight, adapted for long ranges, and is turned down when not in use. The block-sight *p* is used for short distances. The front sight *q* is compound, consisting of an ordinary sight and a globe-sight *q'* turning on a common pivot in a slotted base fixed near the muzzle of the barrel.

The barrel being readily detachable, enables the whole arm to be packed within a space not exceeding the length of the barrel, usually 26 inches.

Fig. 4326 shows a plan of the rifle-grounds at Creedmoor, Long Island, and Fig. 4327 is a sketch of the group of marksmen. The figures on the plan give the distances of the different ranges, and the lower view shows the mode of shooting, which was singular enough with

Fig. 4326.



Upper Figure: Plan. Lower Figure: Front Elevation of Embankment, showing Targets as seen from Firing-Points.

Rifle-Range, Creedmoor, Long Island.

some of the party. One man has the toe of his boot for a rest, another his crossed legs.

The shooting at the contest between the American and the Irish teams was the best on record.

The possible individual score was	180
The possible six-team score was (6 × 180)	1,080
The best individual score (Fulton, American) was	168
The American team score was	934
The Irish team score was	931

The best previous shooting at Wimbledon was 1,204 out of a possible 1,440.

Rifled cannon were first successfully employed during the Franco-Austrian war in Italy, 1859. The Lancaster gun had, however, been tried to some extent during the Crimean war.

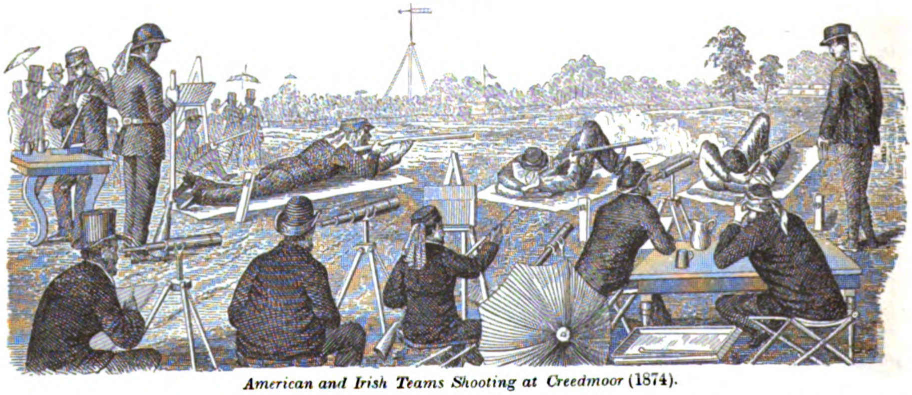
They may be divided into four classes:—

1. Guns in which the projectile is made entirely of hard metal, and of section corresponding to and fitting the bore, but having a small windage; such as the Lancaster and Whitworth, just described.

2. Muzzle-loading guns with balls having studs or ribs fitting the grooves; as the Armstrong and others.

3. Muzzle-loading guns having projectiles with expansible cups or envelopes of soft metal, which are forced into the grooves in the act of firing, so as to prevent windage; as Parrott's, Blakeley's, etc.

Fig. 4327



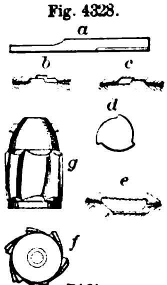
American and Irish Teams Shooting at Creedmoor (1874).

4. Breech-loading guns. In these the projectile has a soft metal coating, which is forced into the grooves in the same way as the leaden bullets of small-arms; *e. g.* the Prussian and Armstrong's.

The grooves of the Armstrong muzzle-loader are made deeper on one side than on the other, as shown in Fig. 4328, *a*; the deeper part is of uniform depth and connected with the shallower part by an incline. The studs on the shot are only half the width of the grooves, and of hight sufficient to allow the shot to enter the bore and pass down freely to its seat, as shown at *b*. When driven forward by the force of the discharge, the studs come in contact with the incline, and are *shunted* over into the shallower part of the groove, against which they bear firmly, causing the shot to leave the bore in a line concentric with its axis, as shown at *c*.

In the Scott gun this is effected by making the

Fig. 4328.



Rifling and Rifle Projectiles.

grooves of gradually decreasing depth from one side to the other (*d*).

The French system, of which the Woolwich is a modification, is shown at *e*.

The Austrian (*f*) in principle resembles this, the grooves being a series of spiral triangles; the projectile (*g*) has corresponding soft-metal ribs, which readily pass down the bore along the deeper sides of the grooves and are shunted over to the shallower sides when discharged.

See also SHELL; BULLET; and specific indexes under ORDNANCE and PROJECTILES.

2. (*Husbandry.*) A strop with a surface of emery for whetting scythes, etc.

Ri'fle-pit. (*Fortification.*) A pit or trench which, together with the excavated earth, forms a defense for a rifleman in an advanced position, where he may pick off the enemy's gunners or defend his own line.

The rifle-pits in the Crimea were holes 4 feet long and 3 feet deep, the parapet of earth crowned by 3 sand-bags having a loophole through which to fire.

The rifle-pits in the United States service were trenches and parapets for systematic advanced defense or attack, and holes scraped in the ground, occupied by sharpshooters who fought *each on his own hook*.

Rig. (*Nautical.*) *a.* The style of masting and sails of a vessel, as *square*, *fore-and-aft*, *schooner*, *lugger* rig, etc.

b. To prepare a *purchase* for use.

c. To furnish the masts and yards with rigging.

d. To thrust out a boom or spar.

Rig'ger. (*Machinery.*) A band-wheel having a slightly curved rim. Fast and loose pulleys are so called in English works on machinery.

Rig'ging. (*Nautical.*) The system of cordage on board a vessel. See MAST; ROPE.

1. The *standing rigging* includes: —

a. The *pendants*; strong ropes over the lower-mast heads, and having thimbles for attaching tackle.

b. The *shrouds*; supporting the masts laterally, and having *ratlines* by which they are ascended.

c. The *stays*; supporting the masts forward.

d. The *back stays*; passing from the mast-heads to the channels abaft the masts.

e. *Ratlines*; the steps of the shrouds.

f. *Slings*; by which the centers of the yards are secured to the masts.

g. *Trusses* and *parrals*; for connecting the yards to the masts.

h. *Gammoning*; the lashing chain which secures the heel of the bowsprit.

i. *Martingales*; the stays of the jibboom and flying jibboom.

j. *Guys*; lateral jibboom stays.

k. *Slings*; by which the yards are suspended. Also, —

Heel-chains.	*Ridge-ropes.*
Crupper-chains.	*Horses.*
Man-ropes.	*Stirrups.*
Foot-ropes.	*Flemish-horses*, etc., etc.

See under the respective heads.

2. The *running rigging* comprises: —

a. The *halyards*; by which a yard or *gaff* is raised.

b. The *lifts*; for raising and lowering the ends of the yards.

c. The *braces*; for trimming the yards fore and aft.

d. The *sheets*; by which the lower corners of a sail are extended.

e. The *clew-garnets* for the courses, and *clew-lines* for the upper sails; by which the *clews* of the sail are drawn up to the yard in the process of furling.

f. The *tacks*; ropes to confine the foremost lower corners of *courses* and *stay*-sails.

g. *Bowlines*; attached to the edges of a square sail, and hauled forward on the weather side, when the ship is on a wind.

h. *Buntlines*; ropes attached to the *foot* of a square sail to raise it when taking it in.

i. *Downhauls*; by which fore-and-aft sails are drawn down.

k. *Brails*; ropes used to gather a fore-and-aft sail up to its gaff, for furling.

l. *Reef-tackles*; by which the *earings* at the ends of the *reef-bands* are drawn up to the yard in reefing.

m. *Signal-halyards*; by which flags are raised to the mast-head or peak.

n. *Outhauls*; ropes used for extending the clews of a boom sail.

o. *Inhauls*; for rigging in the jibboom, studding-sail booms, etc.

p. *Leechlines*; lines attached to the leech-ropes of sails and passing up to blocks on the yards to haul the *leeches* by.

q. *Slablines*; lines by which the feet of the mainsails or foresails are hauled up.

r. *Spans*; ropes connected by both ends to the object, the purchase being hooked to the bight.

s. *Tripping lines*; used to unring the lower topgallant yard-arm when striking it or lowering it on deck.

t. *Tyes*; ropes made fast to yards and passing through the masts. By tackle attached to the other ends of the tyes the yards are hoisted.

u. *Vangs*; to steady laterally the peak of a *gaff*.

Right-hand Rope. One laid up and twisted *with the sun*. Left-hand rope is called *water-laid*.

Right-line Pen. A drawing-pen.

Ri-li-e'vo; Re-lief'. The prominence of a sculptured figure beyond the plane surface to which it is attached.

Alto-rilievo, or *high relief*, is the most prominent, the figure being sometimes only attached at a few points to the plane surface.

Mezzo-rilievo, *demi* or *half relief*, has a prominence of about one half the thickness of the figure.

Basso-rilievo, *bass-relief* or *low relief*, has but slight projection, as in the ornaments of friezes, medals, coins, etc. See the above.

The rilievo work of the ancient Egyptian sculptors did not project beyond the general line of the face, but was executed in a sunken panel, so that the highest relief was only flush.

Rim. A marginal portion of an object, generally circular.

1. (*Vehicle.*) *a.* The circular wooden portion forming the periphery of a wheel. It consists of bent portions or of sawed pieces called *fellies*. It is encircled by the *tire*, and is connected by *spokes* to the *hub* or *nave*.

b. The peripheral portion of a car-wheel attached by *spokes* or *web* to the *boss* or *nave*.

2. (*Nautical.*) *a.* The extreme edge of the top.

b. The circular, notched plate of a capstan or windlass into which the pawls drop.

3. The elliptical bows of spectacles in which the glasses are set.

4. The projecting margin of a kettle by which it is suspended in a furnace.

Rim'base. 1. (*Ordnance.*) A short cylinder at the junction of a *trunnion* with the gun. It is an enlargement or shoulder to the trunnion which forms the journal to the piece in elevating or depressing. See CANNON.

2. (*Small-Arms.*) The shoulder on the stock of a musket against which the breech of the barrel rests.

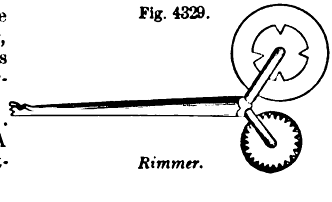
Rime. The *rung* or *round* forming the step of a ladder. A specific tool for making it is known as a *rimer*. The best tools are the drawing-knife and spokeshave to round up the *rived* timber.

Rim'er. 1. A boring implement for enlarging holes. See REAMER.

2. (*Fortification.*) A palisade.

Rim-lock. A lock having an exterior metallic case which projects from the face of the door, differing thus from a *mortise-lock*.

Fig. 4329.



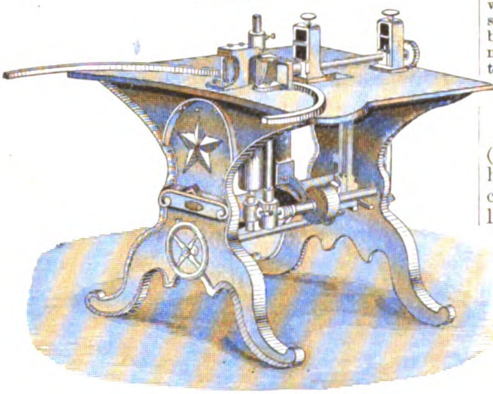
Rimmer.

Rim'mer. (*Domestic.*) A device for cut-

ting and ornamenting the edges of pies, etc. The example has a handle provided at one end with a rotary cutter secured to an irregular or ornamental roller and corrugated wheel, and at the other end with a butter-cutter or print.

Rim-plan'ing Ma-chine'. (*Wood-working.*) A machine for planing simultaneously one curved and one flat surface of a wheel-felly. The felly is carried circularly round by vertical feed-rolls operated by a screw and worm-wheel assisted by a horizontal feed-roll, which also holds the work down to the table. Vertical and horizontal knives, adjustable as to

Fig. 4330.

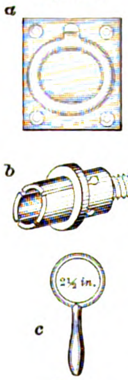


Rim-Planing Machine.

depth of cut, take off a shaving of the desired thickness from the periphery and side as the work passes between them.

Ring. 1. A hoop of metal used as a means of attachment, of the nature of a link, as in the *ring-bolt*, *lap-ring*, the ring on a neck-yoke, etc. In other cases, as a means of assembling, as the *key-ring*, *split-ring*. Other applications are common and obvious.

Fig. 4331.



Rings.

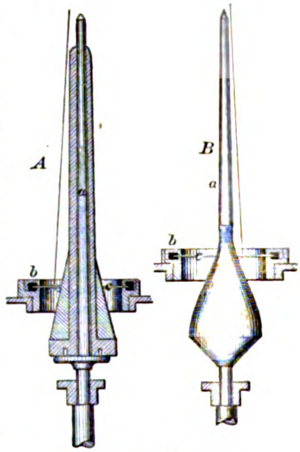
2. A kind of handle for drawers, etc. It is hinged above, and falls into a groove when not in use, so as to be flush with the surface. *a*, Fig. 4331.

3. (*Nautical.*) The appendage by which the cable is attached to the anchor by means of the shackle on the end of the chain-cable, called the anchor-shackle. See ANCHOR.

Ring and Trav'el-er Spin'-ning-frame. Jenks's *ring*-spinner is a modern machine. It is employed, like the throstle, for spinning warp-yarns; it makes a cop resembling that made by the mule, and, like the latter, its bobbin is adapted for the shuttle. The spindles are arranged vertically in the frame, and project through apertures in a horizontal bar. A flanged ridge around each aperture forms a *ring*, and affords a track for a little steel hoop called a *traveler*, which is sprung over the *ring*. The traveler guides the thread on to the spool. As the spindles revolve, the thread passing through the *traveler* revolves it rapidly, and the horizontal bar ascending and descending alternately winds the yarn regularly upon the spools.

Potter's ring and traveler (Figs. 4332, 4333) is designed for spinning all staples, its use not being confined exclusively to cotton. *A* is a spindle with one head bobbin; *B*, a cop-spindle; *a* represents the revolving-spindle; *b* the ring, which is hollowed out so as to form an annular groove. The traveler *c* is a straight or curved bar extending across the central opening of the ring, and while revolving around the spindle is balanced upon the yarn, which is kept at a uniform angle with the spindle, whether winding upon the bare spindle or upon a full bobbin, consequently maintaining a uniform tension and lessening the liability to breakage.

Fig. 4332. Fig. 4333.



Ring and Traveler.

Ring-bit. (*Menage.*) A bit having a ring-cheek, whether loose or otherwise.

Ring-bolt. (*Nautical.*) A ring passing through an eye in the end of a bolt which is secured to the deck or side of a vessel or on a wharf. It is used for attachment of a rope or tackle. On each side of a port it is used for hooking the train-tackles by which the gun is maneuvered.

Ring-chuck. A hollow chuck (*b*, Fig. 4331) whose grasping end is capable of being contracted by a ring, so as to hold firmly the object to be turned. The screw end fits the mandrel of the lathe-head.

Ring-dogs. Two dogs attached to a ring for hauling timber. See DOG.

Ring'er. 1. (*Mining.*) A crow-bar.

2. A chiming or bell-ringing apparatus. See Fig. 648, page 271.

Ring-gage. 1. (*Road-making.*) A ring (*c*, Fig. 4331) 2½ inches wide in the aperture, used for determining the size of broken stone under the Macadam system of road-making. Telford and Macadam, the English engineers who reduced the making of roads to a system, adopted the size of 2½ inches extreme limit as the best for the purpose.

2. (*Jewelry.*) A conical piece of wood or a tapering metallic slip, having marked upon it a series of sizes of rings, according to an established gage, or actual parts of an inch in diameter.

3. (*Ordnance.*) A circular steel gage used in inspecting shot and shells. They are made of two sizes for each caliber, the larger being a trifle more and the smaller a trifle less in diameter than the true caliber of the projectile. All shot received must pass through the larger gage, but are rejected if they pass through the smaller.

Ring'ing-en'gine. A simple form of *pile-driver* in which a ram weighing about 800 pounds and moving between timber guides is attached to one end of a rope passing over a pulley. The other end of the rope branches out into a number of ropes, each held by one man, in the proportion of one man to each 40 pounds of weight in the *ram*. They lift the ram about three or four feet, and let go on a given signal. The number of blows is from 4,000 to 5,000 per day. See also PILE-DRIVER, Figs. 2717, 2718, pages 1702, 1703; and specific index under HYDRAULIC ENGINEERING.

Ring-lock. A kind of puzzle or letter-lock in which the bolt is surrounded by a number of mova-

ble rings, having grooves which must be ranged in a straight line with one another before the bolts can be drawn.

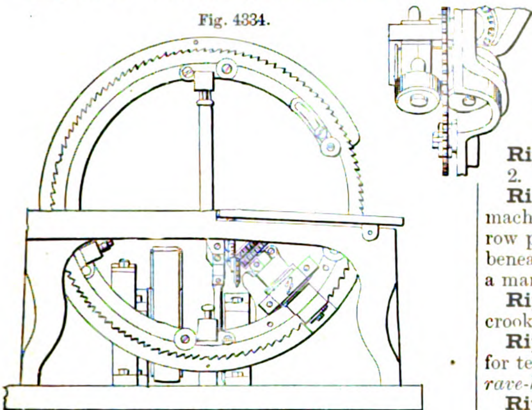
Ring-mi-crom'e-ter. A metallic ring fixed in the field of a telescope, and used to determine differences of declination between stars from the differences of time occupied by them in traversing different chords, either of the inner or outer periphery of the ring. A circular micrometer.

Ring-rope. (*Nautical.*) A rope secured to a ring-bolt in the deck to secure the cable or a purchase, or to check the cable in veering.

Ring-sail. (*Nautical.*) A small, light sail set on a mast on the *taffrail.*

Ring-saw. One having an annular web. The

Fig. 4334.



Ring-Saw.

example shows one driven by friction-rollers and directed by guide-rollers.

Ring-spin'ner. (*Spinning.*) See RING AND TRAVELER SPINNER.

Ring-tail. (*Nautical.*) An additional sail set abaft the spanker or driver, to extend its area in light winds.

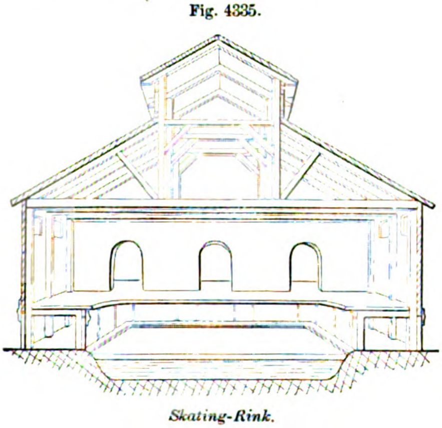
Ring-tail Boom. (*Nautical.*) A spar to rig out on the spanker-boom to set the ring-tail.

Ring-tum'bler. (*Locksmithing.*) An annular-shaped tumbler in a lock.

Ring-wall. (*Metallurgy.*) The inner lining of a furnace.

Rink. A skating-pond. That shown is under cover, and has doors in the foundation, which allow access of external air when required.

Fig. 4335.

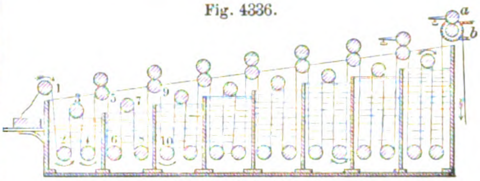


Skating-Rink.

Rins'ing-ma-chine'. (*Cotton-manufacture.*) An apparatus for removing impurities or surplus color from cotton cloth or prints.

The stuff is drawn alternately over and under a series of rollers 1, 2, 3, 4, etc., through tanks *a b c d*, and finally passes be-

Fig. 4336.



Rinsing-Machine.

tween the rollers *a b*, by which it is partially dried. The tanks successively increase in hight from the left to the right hand side of the apparatus, the water overflowing from one into the other, so that a current is caused to flow in an opposite direction to that in which the cloth is moving, the impurities being gradually removed during its progress.

Rip'per. 1. A tool for edging slates for roofing. 2. A tool for ripping seams of garments.

Rip'ping-bed. (*Marble-working.*) A machine for ripping a slab of marble into narrow pieces by passing it on a traversing bed beneath a gang of circular saws arranged on a mandrel. A *stone-saw.*

Fig. 4337.

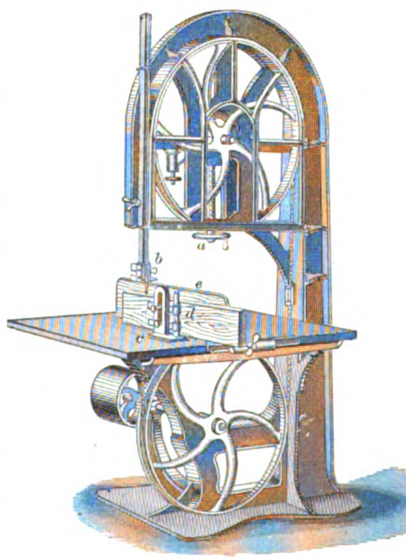
Ripper.

Rip'ping-chis'el. (*Wood-working.*) A crooked chisel for cleaning out mortises.

Rip'ping-i'ron. (*Nautical.*) A hook for tearing old oakum out of the seams. A *rave-hook.*

Rip'ping-saw. A saw for cutting wood lengthwise of the grain. Fig. 4338 illustrates a band-saw adapted for this purpose. The upper pulley is journaled in yielding bearings, adjustable in hight by the screw *a*, to impart the required tension. In front of the saw is a hinged gate, to prevent injury to the workman in case of slipping or breakage. The guide *b* is adjustable to suit different thicknesses of timber. The ripping-gage *c d* is

Fig. 4338.



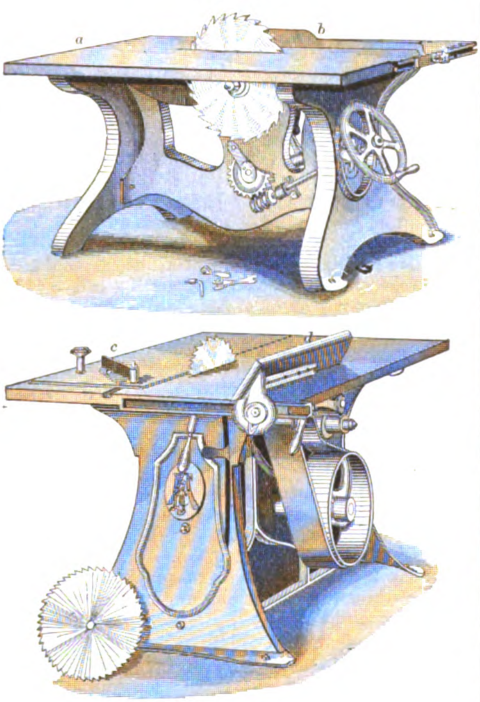
Ripping-Saw.

screwed to the table, and, by means of a thumb-nut, is adjusted to cut square or beveling, and the work is held firmly against the fence *e* by springs adjustable by thumb-screws.

Circular rip-saws differ principally in regard to the modes of hanging and the provisions for feeding and guiding the timber. In *a*, Fig. 4339, the guiding is effected by the fence *b*, which is moved parallel to the saw and held by a parallel-motion device at the end of the table.

The lower figure has a corresponding fence *c*, to be

Fig. 4339.



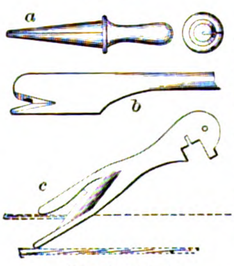
Ripping-Saws.

used for ripping, and a guide *e*, which can be moved transversely of the table, and is pivoted, so that the timber may be presented at any angle to the saw, which can thus be used for cross cutting.

d is a fence, the face of which is adjustable to any angle with the bed.

Rip'ping-tool. One for following a seam and cutting stitches without slitting the fabric.

Fig. 4340.



Ripping-Tools.

In the examples: —

a is a tool, like a bodkin, with a longitudinal radial blade. The cone spreads the seam open, and the stitches are drawn across the blade.

b is a thrusting tool, whose pointed portion expands the seam, the threads being cut by the sharp edge or angle.

c is somewhat similar to the last.

Rip'ple. An instrument (*a*) with teeth like a comb, through which flax is drawn to remove the capsules and seed therefrom, when the lint of the plant is to be used.

It is a very ancient instrument, having been used in Egypt in the time of the Pharaohs for removing the seed from the *dhura*, a variety of imphee or sorghum which was then cultivated for bread grain. The tombs have paintings *c* representing the rippling of *dhura*.

Fig. 4341.

Ripple and Rippling-Comb.

It was also used in the time of Pliny, for shelling the grain out of the ears of wheat; one mode of thrashing.

The implement (*b*) is placed on a stool, and the seed caught by a cloth spread beneath. The teeth are 18 inches long, ½ inch square at bottom, and tapering at the point.

A handful of flax is grasped by the butts, is spread like a fan, and, being thrown upon the comb, is drawn between the teeth, removing the seed.

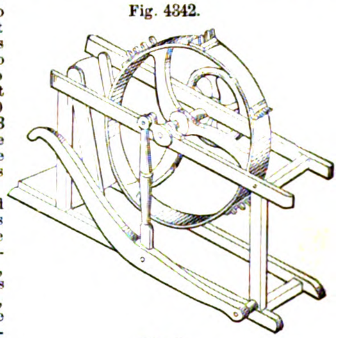
The stalks are then carried to the steeping-pool or watercourse, where it is *retted* or *rotted*.

The ripple is yet used in Japan for thrashing out grain, as it was in Egypt in the time of the Pharaohs.

The *dhura* was cultivated in the Nile country for a time that history telleth not to the contrary, forming the food of the poorest class. It yields a produce of about 240 for one. Hamilton states, in his *Ægyptiaca*, that the thrashed grain is only worth 3*s*. 9*d*. the *ardeb*, which is scarcely 6 cents per bushel. The *dhura* constitutes the chief subsistence of the peasantry in Upper Egypt. It multiplies itself even more quickly than rice.

To the great abundance of food is owing the great increase in population. Diodorus Siculus, who traveled in Egypt nineteen centuries since, states that to bring up a child to maturity did not cost more than 20 drachmas, about 3 dollars. It must be recollected that the value of money has decreased.

Fig. 4342.



Ripple.

The ripple is used in the United States for stripping the seed from broom-corn. In Fig. 4342, the treadle actuates the spiked wheel, which cleans the seed from the broom-corn when it is placed in the chute.

Rip-rap. (*Masonry.*) A foundation of loose stones. The artificial island in Chesapeake Bay, which is thus formed, is named the Rip-raps, and forms one of the defenses of Hampton Roads. Fort Sumter, Charleston Harbor, and Plymouth Breakwater, England, are founded on rip-raps.

Rip-saw. A saw whose teeth and mode of filing adapt it specially for *ripping* boards, that is, sawing them *with* the grain. In contradistinction to *cross-cut*. It has usually eight teeth to three inches. A half-ripper has teeth of modified form, and has three teeth to the inch. See RIPPING-SAW.

Rise. 1. (*Architecture.*) The *versed-sine*, or elevation of an arch above the *springing-line*.

2. (*Carpentry.*) The hight of a step in a flight of stairs; the width of a step is the *tread*.

3. (*Mining.*) A perpendicular *shaft* or *winze* excavated from below upward.

Ris'er. 1. (*Carpentry.*) The upright board of a step. The flat board is the *tread*.

2. (*Mining.*) A shaft excavated upward.

3. (*Founding.*) An opening through a mold, into which metal rises as the mold fills. A *head.*

Ris'ing. 1. (*Nautical.*) A narrow strake in a boat, beneath the thwarts.

2. (*Mining.*) A shaft worked from below, upward. The opposite of *sinking.*

Ris'ing-an'vil. (*Sheet-metal Working.*) A double beak-iron.

Ris'ing-arch. A rampart arch.

Ris'ing-floors. (*Shipbuilding.*) The floor-timbers which rise fore and aft from the plane of the midship floor.

Ris'ing-hinge. One so constructed as to elevate the foot of an opening door, to avoid the carpet.

Ris'ing-line. (*Shipbuilding.*) A curved line on the drafts of a ship, marking the hight of the floor-timbers throughout the length, and thereby fixing the sharpness and flatness of a vessel's bottom.

Ris'ing-main. The vertical pipe from a pump in a well to the surface of the ground.

Ris'ing-rod. (*Steam-engine.*) A rod in the Cornish steam-engine which rises as the cataract piston descends, by means of levers; it then lifts catches by which the sectors are released, and the weights are enabled to open or shut the equilibrium or exhaust valves.

Ris'ings. (*Shipbuilding.*) Thick planks supporting the timbers of the decks.

Ris'ing-square. (*Shipbuilding.*) A square upon which is marked the hight of the rising line above the keel.

Ris'ing-wood. (*Shipbuilding.*) A timber worked into the seat of the floor and into the keel to steady the floor-timber.

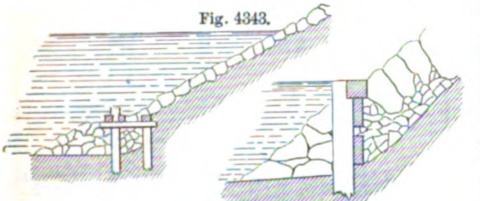
Riv'er-wall. (*Hydraulic Engineering.*) A wall made to confine a river within definite bounds, either (1) to prevent denudation or erosion of the banks; (2) to prevent overflow of the land adjacent; or (3) to concentrate the force of the stream within a smaller sectional area for the purpose of deepening a navigable channel.

The considerations adduced in reference to certain maritime structures (see SEA-WALL; JETTY; QUAY; GROIN; BREAKWATER) do not all apply to river-walls, as the latter are not exposed to the dashing action of the waves from the open sea, nor usually to so heavy a pressure of earth, which is alternately wet and dry twice a day, as in structures on tide-water.

The construction of the dikes of Holland furnishes many valuable suggestions for fluviatile erections, for, in these works, every material has been brought into use which seems to have any importance or usefulness.

Masonry, rubble, concrete, puddle, piles, boarding, fascines, stakes, earth, osiers, and reeds in bundles and growing, each is introduced to perform its part in the work of forming a barrier against the adjacent sea and the interior network of rivers and canals.

Fig. 4343.



River-Walls.

As in the cases cited, the artificial bank may consist of a rubble facing with a foot piling to support it, and having a slope of not less than 3 base to 2 vertical hight, the latter depending upon the exposure, and the rate of the current.

The Piedmontese engineers use prisms of concrete, forming a slope of 45°.

The banks of the Medway, England, are locally protected by a bed of concrete.

Fascines in crosswise layers alternating with gravel, clay, sand, and shingle are used in Holland. See FASCINE.

On the banks of the Rhine, panniers and gabions filled with gravel are employed.

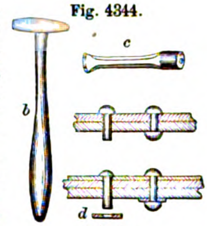
Riv'et. (*Machinery.*) A short bolt with a flat or rose head, employed for uniting two plates or thin pieces of material together. The stub end is swaged to prevent its withdrawal. When used for joining pieces of leather, as in making belting, an annular disk, termed a *burr*, is placed over this end previous to swaging, in order to give a greater bearing.

Rivets are cut from round metal rods, and formed by special machinery.

The *rivet* was the main dependence of the armorer for fastening plates of armor. In Homer's time *welding* and *soldering* were apparently unknown, and plates were attached by mechanical means; rivets, pins, nails, cramps, and dovetails.

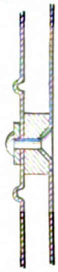
In riveting iron plates together, as in boilers, tanks, etc., the rivet is made red-hot, and while a sledge is held against the head, the end is swaged down by striking directly with a riveting-hammer, or a species of die called a snap-head is interposed. In riveting together wooden surfaces, they may be lined with metallic plate, or washers be placed under the head and the swaged burr, to prevent the indentation of the wood. Machines are also employed for riveting. (See RIVETING-MACHINE.)

Fig. 4344.



Rivets.

Fig. 4345.



Rivet.

In riveting the plates composing the skin of iron ships, it is necessary that the outer end of the rivet should be flush with the plate. A countersink is, accordingly, formed in this side. The operation of riveting is performed by three men and a boy. The latter brings it from the furnace with a pair of tongs and passes it to the holder up, who receives it in a short pair of tongs and inserts it into the rivet-hole from the inside. He then presses against it with a hammer or with a tool called a *dolly*, having its end indented to receive the head of the rivet, while the two men on the outside hammer the other end down so as to fill the countersink.

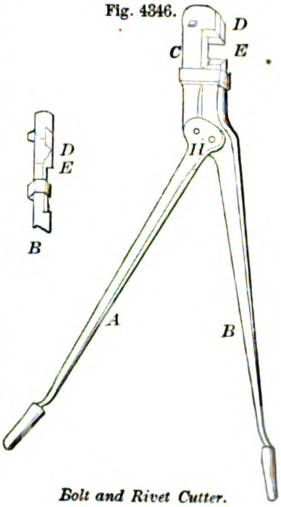
The plates may be put on with either *lap* or *flush* joints, their ends in the latter case butting. The first may be effected by a single row of rivets, the latter requires two. Double riveting requires two rows of rivets when the plates lap, or four for flush jointing. It has more than two thirds of the strength of the original plates, while single riveting affords somewhat over half of said strength.

Riv'et-cut'ter. A jaw tool for cutting off flush the stub ends of rivets or bolts. In the example, the handle *A H* is pivoted to the handle *B* and piece *C*, so that the jaws *D E* are brought together as the handles are compressed.

Riv'et-hearth. A shallow, round fuel-tray, mounted on three legs, and having a circular bellows beneath it for blowing the fire.

It is set up near the place where the rivets are to be driven. One of them is required for every two or three gangs of riveters. The boys who carry the rivets operate the bellows.

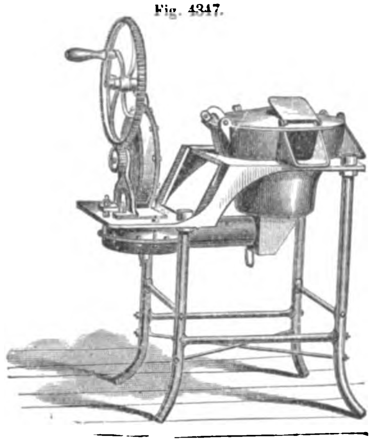
Fig. 4346.



Bolt and Rivet Cutter.

The hearth is formed of a slight iron frame and iron plates; on a separate frame is a small, round bellows, so arranged as to be operated by each mo-

Fig. 4347.

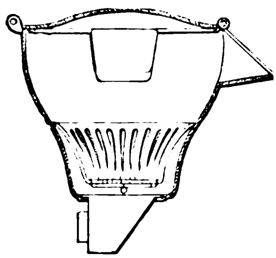


"*Keystone*" *Riveting-Forge.*

tion of the hand, up or down. See RIVETING-TOOLS.

Riv'et-ing-forge. The portable riveting-forge (Fig. 4347) has a pot rotatable by gearing and having three doors, so as to employ three operatives; it contains a grate-like basket, which allows the blast from the tuyere to pass through. At the bottom of the basket is a grate and a comb-raker, operated from the outside. Beneath the grate is the tuyere box. A fan is provided for creating a blast.

Fig. 4348.



Riveting-Pot.

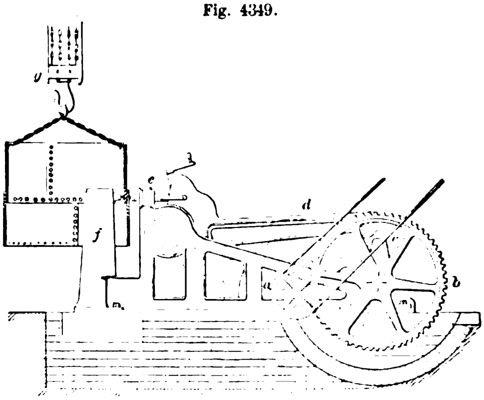
Riv'et-ing-ham'mer. A hammer for swaging a rivet when in position. It has usually a long, flat-faced head, and a narrow peen. *b*, Fig. 4344.

Riv'et-ing-ma-chine'. (*Boiler-making.*) A machine in which the operation of riveting boiler or other metallic plates is performed by steam-power. Its general principle is that of the punching-machine. The first application of steam to this purpose is due to Sir William Fairbairn, of Manchester, England. He employed a movable horizontal die, in conjunction with a fixed die at the head of an iron pillar; the work to be riveted being inserted between the two. The same general construction has been adopted in subsequent machines. Sir William Fairbairn states that the machine was contrived when he had a large number of orders on hand for his double-flued boiler and the men struck. "In this dilemma I was driven to the necessity of supplying the place of the riveters by a passive and unerring workman, which, from that day to this, has never complained, and did as much work in one day as was formerly accomplished by twelve of our best riveters and assistants in the same time. I desired the foreman to reverse the action of the punching-machine, and with proper dies to rivet the plates instead of punching them. In six weeks from that date we had the riveting-machines at work, making tighter joints and executing the work with greater perfection than could possibly be done by the hammer."

Fairbairn introduced many improvements in machinery employed for various purposes, which have been universally adopted. His attention having been drawn to the advantage of iron as a material for building ships, in 1836 he built and successfully launched a small iron vessel. This was one of the very first of its class built in England. In after life he constructed many large vessels of the same material at his shops in Millwall. He was one of the very first to plan and construct buildings of iron. He was chosen to assist Stephenson in the construction of the great tubular iron bridge over the Menai Strait, for the Chester and Holyhead Railway. He was chiefly instrumental in the introduction into general use of wrought-iron plate girders in building operations, as well as in railway engineering. His principal works are on "The History and Manufacture of Iron," "Mills and Mill-Work," and "Iron Shipbuilding." He died August 18, 1874.

The machine illustrated in Fig. 4349 is set in motion by a band on the pulley *a*; on the axis of the latter is a pinion gearing into a large spur-wheel *b*, on whose axis is a cam *c* operating the riveting-lever *d*, the face of the cam being steeled and the

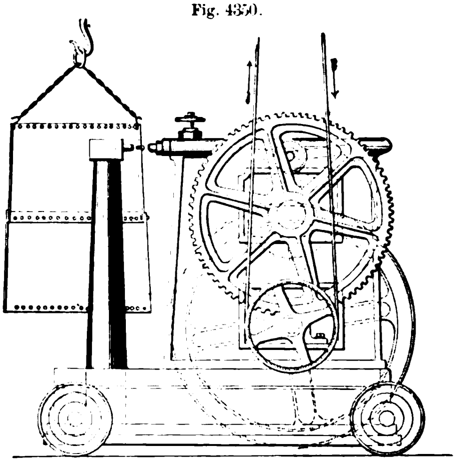
Fig. 4349.



Riveting-Machine.

end of the lever having a roller to diminish the friction. The riveting-lever has a fulcrum in the frame, and acts by its face upon the riveting-tool *e* when punching and by a link connec-

Fig. 4350.



Riveting-Machine.

tion with the tool when retracting, the tool sliding in a socket fixed in the side frames.

The face of the riveting-tool has a depression which receives the end of the rivet and swages it to shape.

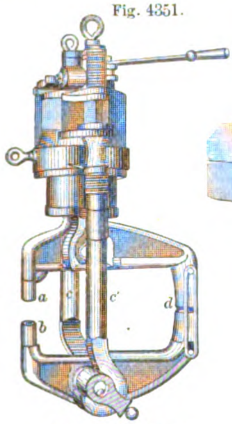
The anvil-post *f* rises from the foundation, and has a riveting-block of the shape of a frustum of a cone. The sections of boiler are lowered from above, by means of tackle *g*, the point at which the rivet is to be placed being adjusted between the punch and the anvil-block. The rivet is placed in the punched holes, the band slipped on to the fast pulley, and the upward motion of the cam raises the lever and swages the rivet.

Fig. 4350 is a portable machine on the same plan. Not being intended for such heavy work, its frame is less massive than that of the foregoing, and the construction and arrangement of its details are slightly different.

In Tweddel's machine (Fig. 4351), the distance between the punch *a* and anvil *b* is regulated, according to the thickness of the plate, etc., by screws *c c′* and links *d*. The whole apparatus is mounted on a truck, and the pressure applied by a hydraulic accumulator operated by a portable engine.

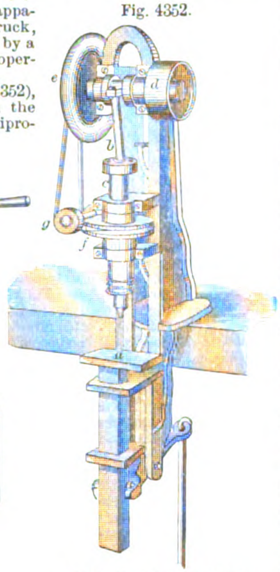
In Adt's machine (Fig. 4352), the work is supported on the table *a*; the punch is reciprocated by a pitman *b*, having a universal joint connection with the spindle *c*, and actuated by an eccentric on the pulley-shaft *d*; the punch spindle is at the same time revolved by a belt on the shaft of the fly-wheel *e*, imparting motion to the pulley *f* through two small change pulleys, one of which is seen at *g*.

Fig. 4351.



Riveting-Machine.

Fig. 4352.

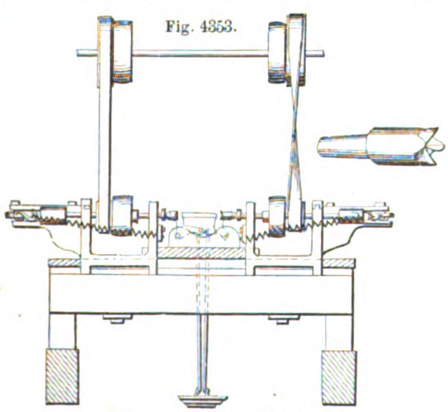


Adt's Riveting-Machine.

In another machine intended for heading caster and hinge pintles, etc., the spring-hammers strike the opposite ends of the pintles simultaneously. The working parts are adjustable to suit rivets of varying lengths.

Fig. 4353 is a machine for riveting hinges. Peculiarly shaped revolving milling-tools spread the pintle when forced against it, and form the head.

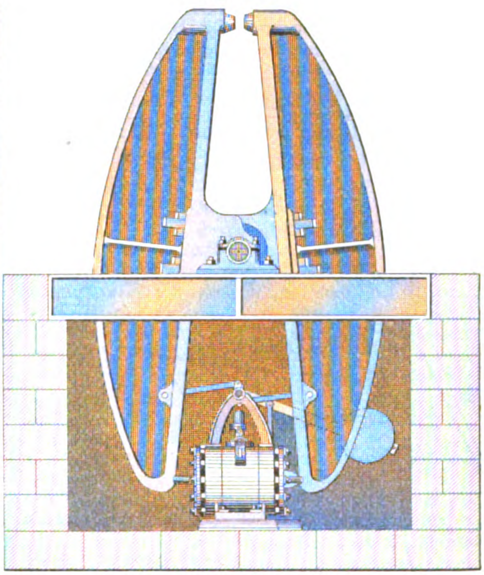
Fig. 4353.



Machine for Riveting Hinges.

McKay and Macgeorge's hydraulic riveter is operated by water from an accumulator under a pressure of 700 pounds to the inch; water is admitted to a small cylinder, causing the dies to close upon the rivet, when self-acting valves admit the water to the large cylinder, which compresses the plates together and finishes the riveting. After allowing the rivet a moment to cool, the handle operating the valves is reversed, when the jaws unclose.

Fig. 4354.



Hydraulic Riveting-Machine.

Riv′et-ing-set. A punch (*c*, Fig. 4344) with a hollow face, used for swaging the heads of rivets. It is more expeditious than the peen of a riveting-hammer, and by making the concavity of any desired shape, the counterpart form is imparted to the end of the rivet.

Riv′et-joint. The results of Mr. Fairbairn's experiments on riveted joints were as follows: —

Taking the coefficient of tenacity of the boiler-plate itself = 100

Then that of an equal length of joint would be —

For double row of rivets .... = 70
For single row of rivets .... = 56

Mr. Fairbairn gives the following table as exhibiting the strongest forms and best proportions of riveted joints, deduced from practice: —

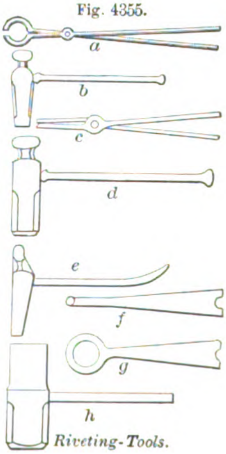
Dimensions in inches.

Thickness of plate.	Diameter for rivets.	Length of rivets from the head.	Distance of rivets, center to center.	Depth of lap for single joints.
.19	.38	.88	1.25	1.25
.25	.50	1.13	1.50	1.50
.31	.63	1.38	1.63	1.88
.38	.75	1.63	1.75	2.00
.50	.81	2.25	2.00	2.25
.63	.94	2.75	2.50	2.75
.75	1.13	3.25	3.00	3.25

For double-riveted joints, add two thirds to the depth of lap given for single joints.

Riv′et-ing-tools. The implements used in riveting metallic plates together. Those used for ship and boiler plates are: —

Fig. 4355.



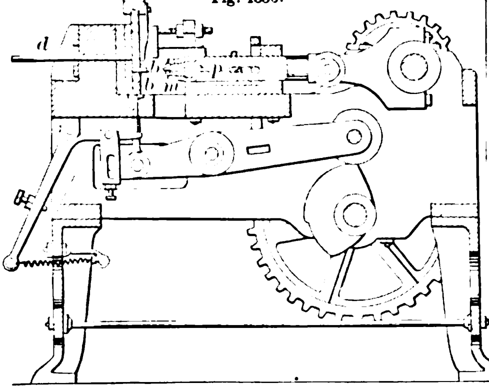
Riveting-Tools.

a, rivet-tongs.
b, riveting-hammer (outside).
c, tongs.
d, closing-hammer (outside).
e, closing-hammer (inside).
f, *g*, dolly.
h, holding-up hammer (inside).

Coppersmiths and other workmen in thin sheet-metal or leather work united by rivets, employ a *rivet-punch* or *rivet* and *burr set*, the work being supported on a stake or plate.

Riv′et-mak′ing Ma-chine′. A machine for making rivets from rod-iron. In Fig. 4356, the rod

Fig. 4356.

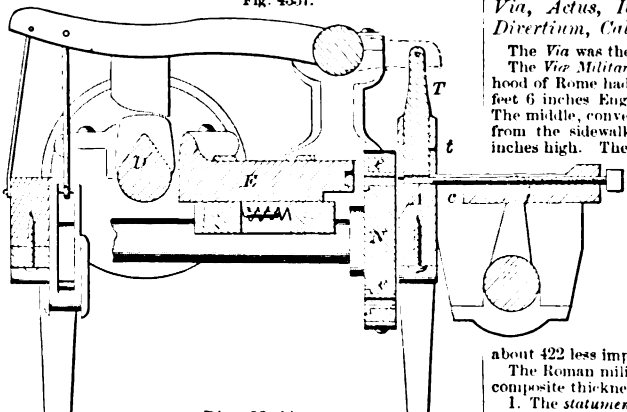


Rivet-Making Machine.

d is fed through a guide-plate into movable dies *b b*, the length of the blank being regulated by a stop. The movable dies have reciprocating motion, and cut off the rod fed into the machine, carry the blank in front of the heading die, and finally serve as the die in which the head of the bolt is formed. As they descend they cut off the length of rod against the face of the guide-plate, and carry it in front of a hollow die *m* that has a horizontal motion, the interior of the die corresponding to the intended form of the shank of the rivet. The stub end of the rivet is formed against the plunger *p*, which also serves to eject it when finished.

Fig. 4357 has a feed-plate *A* into which the rod is fed through an aperture *t*; a blank is cut off by the downward motion of the plunger *T*, which holds and guides it while being forced into one of the apertures *e e* in the die-wheel *N*, by the reciprocating rod *c*, where it is subjected to the action of the header *E*, operated by the same compound cam *D* which actuates the lever carrying the plunger *T*.

Fig. 4357.



Rivet-Machine.

Riv′ing-knife. (*Coopering.*) A tool used in splitting balks for staves, clapboards, shingles, etc. A *frow.*

Riv′ing-ma-chine′. A machine for splitting wood in the direction of the grain; for hoops, staves, splints, as the case may be.

Roach. (*Nautical.*) The upward curve of the foot of a sail, made in order to clear the stays, spars, etc. A piece laced on to fill up the concavity is called a *save-all.*

Road. "The Carthagenians," says an ancient writer, "invented paved roads." The Roman roads were pavements resting on a foundation of rough stones consolidated into one mass by liquid mortar or grout. They extended from Rome to her distant provinces, and facilitated the march of her legions, the transportation of supplies, and the intercourse by couriers and post-carriages.

"The Romans," says Isidore, "make roads almost all over the world, to have their marches in a straight line and to employ the people." Isidore was a Greek architect of the sixth century, and was employed by Justinian to complete the church of St. Sophia at Constantinople, now a Mohammedan mosque.

Twenty-nine great military roads centered at Rome, some of them being carried to the extreme limits of the Empire, which was divided into 11 regions, 113 provinces, traversed by 372 great roads, which, according to the Itinerary of Antoninus, had a length of 52,964 Roman miles.

The first of these great roads was the *Appian Way*, constructed by the censor Appius Claudius Cæcus, 442 A. U. C. (311 B. C.), who is not to be confounded with the decemvir Appius Claudius, 449 B. C., concerned in the tragedy of Virginia, the Roman maiden. The stones were hewn and carefully fitted. It was never excelled by the Romans. Appius constructed it to Capua, 142 miles, and his successors to Brundusium (now Brindisi), another 218 miles. Strabo (d. A. D. 24) gives it the preeminence. It is still entire in many places, though more than twenty centuries have elapsed since its construction. It was properly called "Regina Viarum."

The Via Numicia led to Brundusium; the Via Flaminia to Rimini and Aquileia; the Via Aurelia was along the coast of Etruria; the Via Cassia ran to Modena, between the Flaminian and Aurelian ways; the Via Æmilia extended from Rimini to Piacenza.

The smaller ways were the Via Prænestina to Palestrina (the ancient Præneste); Tiburtina to Tivoli; Ostiensis to Ostia; Laurentina to Laurentum, south of Ostia; Salaria, etc.

Under Julius Cæsar the capital of the Empire was in complete communication with all the principal cities by paved roads. During the last African war a paved road was constructed through Spain and Gaul to the Alps.

These roads connected the capital with Savoy, Dauphiné, and Provence, Germany, all parts of Spain, Gaul, Constantinople, Hungary, Macedonia, and the mouths of the Danube.

On the other sides of the intervening waters these roads were continued in Sicily, Corsica, Sardinia, England, Asia, and Africa.

The Roman roads were distinguished by the names *Via*, *Actus*, *Iter*, *Semita*, *Trames*, *Diverticulum*, *Divertium*, *Callais*, etc.

The *Via* was the best, and had a width of 8 Roman feet.

The *Viæ Militari* and other important roads in the neighborhood of Rome had a double width, 16 Roman feet, equal to 15 feet 6 inches English, and *margines*, or sidewalks, 8 feet wide. The middle, convex portion was paved with blocks and divided from the sidewalk by a curb or low wall, 2 feet wide and 18 inches high. The middle was for the infantry; the margines for carriages and equestrians.

The *Actus* was 4 feet wide, for single carriages.

The *Iter*, for horsemen, pack animals, and pedestrians, was 3 feet wide.

The *Semita* was 18 inches wide, and was called *Trames*, *Diverticulum*, or *Divertium* when it branched across fields. The *Semita* on steep grades was frequently in the form of steps.

The *Callais* was a mountain path.

In Rome were 31 principal streets and about 422 less important ones.

The Roman military roads were made with four strata with a composite thickness of about three feet.

1. The *statumen* consisted of two courses of flat stones laid in mortar.

2. The *rudus*, a rubble of broken stones mixed with one third the quantity of quicklime and well rammed.

3. The *nucleus*, a mixture of brick, potsherds, broken tiles, and one third the quantity of lime; or gravel and the stated proportion of lime laid on while hot from slaking.

4. The *summa crusta*, pavement of not less than six inches thick.

These roads bore uninjured the weight of columns, obelisks, and other immense blocks, weighing hundreds of tons.

The royal roads of Persia ran by the side of the common roads, and were reserved for the uses of the king alone. They were kept in better condition than the common roads, and gave rise to that remark of Euclid, the mathematician, to Ptolemy Philadelphus, at a dinner in the Museum of Alexandria, "There is no royal road to geometry."

The Moguls constructed good roads in India, with a distance-stone at the end of every *koss*. Agra, Lahore, and Cashmere were thus connected. With the death of Aurungzebe these improvements ceased, and the works commenced to decay.

At a comparatively late date the work of improvement of the Indian roads has been pursued with vigor. The Grand Trunk Road connects Calcutta with Peshawur on the borders of Affghanistan.

The military roads of Peru were built, one on the plateau, the other on the shore. The former, for nearly 2,000 miles, crossed sierras, gorges, and rivers, by tunnels, bridges, and ferries. The road was 20 feet wide, faced with flags covered with bitumen, and had milestones. The shore road was built on an embankment, with a clay parapet on each side, and shade-trees. It was supported by piles, in places. Every five miles there was a post-house. Humboldt declares the road magnificent.

We learn from the venerable Bede (A. D. 700) that the Roman roads of England were built at various periods in the second, third, and fourth centuries; the people, criminals, and the Roman soldiery being employed thereon.

The four principal ones were, —

1. Watling Street; from Kent, by way of London, to Cardigan Bay, in Wales.

2. Ikenild Street; from St. David's, Wales, by way of Birmingham, Derby, and York, to Tynemouth, England.

3. Fosse Way; from Cornwall to Lincoln.

4. Ermin Street; from St. David's to Southampton.

In many places the remains are yet visible; in many others the old pavement is below the surface, having been buried by the vegetable growth of centuries, or covered by earth from other natural cause, such as land-slips and watercourses.

Highways were first made public in many parts of England by the Romans. In the time of Edward I. they were ordered to be widened and cleared of trees within 200 feet of the road, for the prevention of robberies. Toll was granted on one in London in 1346. The parishes were made answerable for their condition in 1553. Toll-gates were erected in 1663.

In the sixteenth year of the reign of the frivolous Charles II. a turnpike road was established through Hertfordshire, Cambridgeshire, and Huntingdonshire.

The Simplon road from Geneva to Milan, built by Napoleon, cost the French government 17,000,000 livres ($ 3,250,000).

MacAdam says: "The measure of substituting pavements for convenient and useful roads is a kind of desperate remedy, to which ignorance has had recourse."

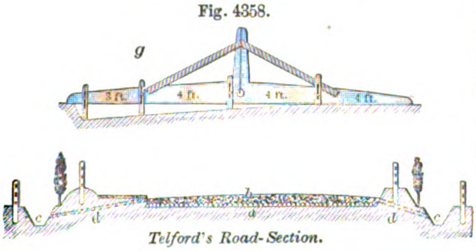
The mode of road-making with broken stone, before MacAdam, was to make a foundation of large stone, on them place stones of a medium size, and finish off with the smallest. MacAdam employs broken stone of as hard a variety as possible, no stone to exceed six ounces in weight. A ring is used to test the sizes. It has an interior diameter of 2½ inches.

The convexity of a road of 50 feet width may be 1 foot when settled; 6 inches more should be allowed in making.

MacAdam, by the authority of the Parliamentary Commission, substituted in one street for the rounded stones or bowlders a bed of broken stone laid as a convex rounded roadway. His ideas were laughed at by professional road-makers, but after a trial of the new scheme, the paving of London was torn up, broken, and spread *à la Macadam*. The country districts soon followed the example. MacAdam was made Surveyor-General of the Bristol Roads; he was reimbursed for his expenses, and received the additional sum of £2,000 as a recognition of his services.

The section (Fig. 4358) illustrates a plan successfully adopted by Telford on the Glasgow and Carlisle, the Holyhead, and other roads. It consists of a foundation *a* of paving-stones laid broad end downward on the leveled surface of the natural earth and covered with broken stones *b* to the depth of about six inches. These wedge in between the interstices of the foundation, forming a smooth and compact surface. *c c* are ditches, and *d d* pipe-drains.

Fig. 4358.



Telford's Road-Section.

The National Road from Baltimore, across the Alleghanies and extending to Illinois, is 650⅜ miles in length and 80 feet in width. It is macadamized for a width of 30 feet.

Road-bed. 1. (*Railway Engineering.*) The bed or foundation on which the superstructure of a railway rests. The substructure of the way consists of the embankment, bridges, piling, ballast, etc., and supports the superstructure, which consists of the rails, ties, chairs, frogs, crossings, etc.

2. (*Civil Engineering.*) In common roads, the whole material laid in place and ready for travel.

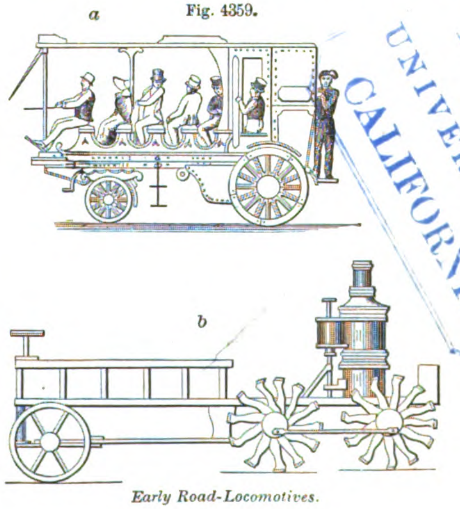
Road-lev′el. A level (*g*, Fig. 4358) for correctly laying off the surfaces of common or macadamized roads. Its lower edge is set horizontally by the aid of a plumb-bob suspended from its upper branch, and the lower limb is provided with offsets, adjustable by means of screws, which are raised or lowered relatively to each other to guide the workmen in forming the desired slope.

Road-lo′co-mo′tive. A locomotive adapted to run on common roads. The idea, conceived by Watt and Dr. Robinson, was first realized by Murdoch, a Cornish engineer, who, about 1786, constructed a small locomotive which ran on the high-road near Redruth. William Symington, in Scotland, and Oliver Evans, in America, also constructed models, though on different plans, of engines designed for this purpose. In 1802, Trevethick and Vivian had one experimentally in operation. After this the badness of the roads and opposition of the turnpike managers, or the diversion of inventive talent to the improvement of railways and their appliances, seem to have frustrated farther attempts in this direction for many years, when the subject was taken up by Griffiths, Brunel, Gurney, and others at various times. See LOCOMOTIVE.

Steam-carriages constructed by some of these inventors plied for a time between various cities and towns in England and Scotland, but failed to become profitable.

One of Gurney's engines, weighing two tons, drew

Fig. 4359.



Early Road-Locomotives.

11 tons upon a good hard country road. The drivers of this locomotive had tires $3\frac{1}{2}$ inches wide.

Hancock's engine (*a*, Fig. 4359) ran for hire with 16 passengers in 1831. The machinery was situated behind the carriage. The fire was blown by a revolving fan turned by the engine. The two hind wheels were drivers, though one was generally disconnected from the engine, except in climbing hills, etc. The weight of the locomotive, with water and fuel, but without passengers, was $3\frac{1}{2}$ tons.

The success of railways, and the difficulties attending the use of locomotives on ordinary roads, caused a cessation of efforts toward their improvement until about the year 1856, when the subject was again revived with a view to the adaptation of such engines to agricultural purposes. Of late years, several varieties have been constructed, which fulfill their intended purpose with considerable success. The more prominent of these are constructed on the general plans of Ransome and Sims, or of R. W. Thomson of Edinburgh, who introduced the flexible rubber tire.

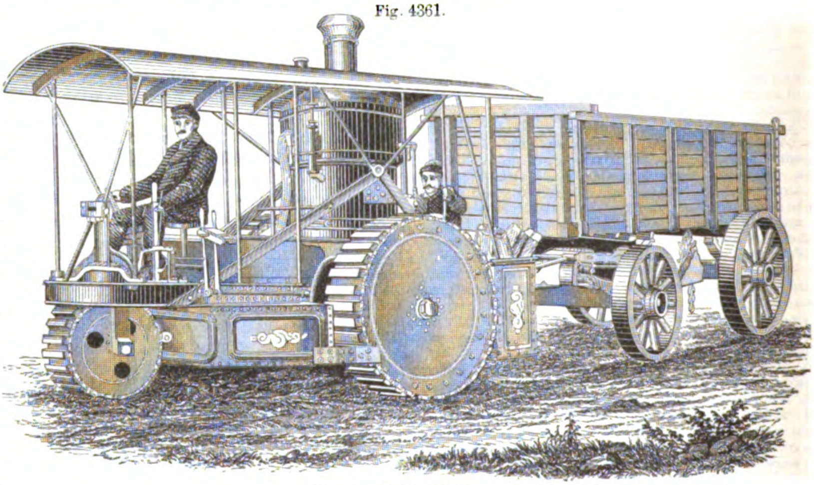
James's (*b*, Fig. 4359), patented in 1867, is one of the earlier of the more recent American efforts in this line. It has coupled drive-wheels, the tread of which consists of segments of a circle supported on separate spokes.

Ransome and Sims's "self-moving engine" (Fig. 4360) is adapted for hauling light loads on common roads.

These engines have a single cylinder. The driver and steersman are placed behind the engine, thus enabling them to communicate with and assist each other. All the apparatus for starting the engine, reversing and applying the brake, are placed close together; and the gearing for communicating the motion to the driving-wheels is so constructed that both wheels are always in gear even when turning a sharp corner.

By an adjustment of the driving-pinions the speed of the engine may be altered from the slow speed of $2\frac{1}{2}$ miles per hour to 4 miles per hour, and *vice versa*. The driving-wheels *a a* are wrought-iron, with cast-iron rims, 10 inches broad. They are furnished with wrought-iron spuds to attach to the rims in case the roads are very sandy and soft. The fire-box of the engine is adapted to burn wood or coal. Coal and water for a journey of from 6 to 8 miles may be stored in the tanks *e f* under and at the back part of the engine; *b*, fly-wheel; *c*, rudder-post; *d*, steering-wheel. This locomotive is also adapted for use as a motor for thrashing-machines, saw-mills, etc.

Fig. 4361.



Thomson's Road-Steamer.

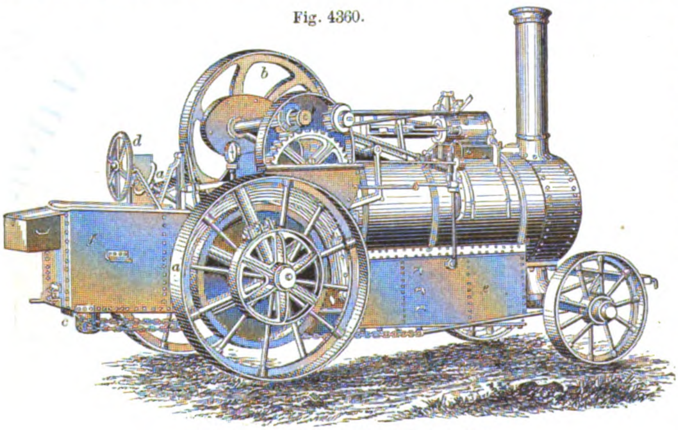
Thomson's (Fig. 4361) has an upright tubular boiler and two small cylinders. The crank-shaft and drivers are connected by gearing.

The great novelty of this engine is in the elastic tires of the wheels, adapting them to pass over loose stones, slippery surfaces, etc. These tires are of rubber, 12 inches wide and $4\frac{1}{2}$ inches thick. The rim of the driver is perforated with a large number of holes, an inch or more in diameter, into which the inner surface of the rubber tire forces itself, to prevent slipping. The outside of the tire is protected from injury, to some extent, by an endless band of steel cross-bars, which yield with the tire to inequalities of ground.

The locomotive is steered by a single pivoted wheel in front, and is able to turn in very small space. By a little change in the machinery, it may also be used as a portable engine. See ROAD-ROLLER.

Road-locomotives are employed to some extent in England and in British India, but have not met with much favor in continental Europe or America. A few are in use in Brazil, and in the United States several kinds are manufactured to order; but the demand for them is, at present, not great. See TRACTION-ENGINE.

Fig. 4360.



Ransome and Sims's Road-Locomotive.

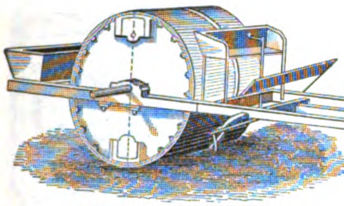
Road-met'al. (*Engineering.*) Broken stone for making or mending macadam roads.

Road-roll'er. A heavy cylinder used for compacting the surfaces of roads.

One of the road-rollers used in the Central Park, New York, weighs $6\frac{1}{4}$ tons, and is adapted to receive additional loading to bring it to 9 or 12 tons. It is composed of two hollow cylinders of cast-iron, set abreast on

a strong wrought-iron axle, making together a length of 5 feet, with a diameter of 7 feet; the cylinders are set in a timber framework, so arranged as to admit of being suitably balanced

Fig. 4362.



Central Park Road-Roller.

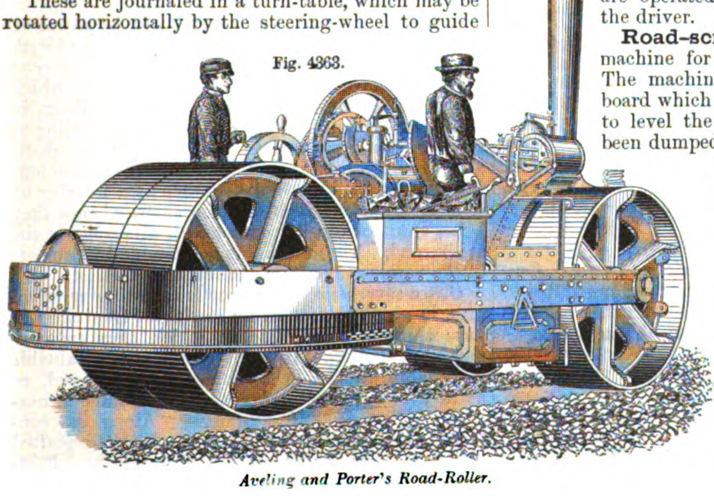
on the journals, and the whole is drawn by eight horses. Apertures are made in the ends of the cylinders, through which the interior cavities, consisting of four separate cells in each cylinder, can be filled with broken stone and gravel, and the weight thereby increased up to 12 tons, as above stated. Two of these large rollers were constructed at the commencement of the work, and have served, until lately with but few repairs, for the entire road-system of the Park.

Steam road-rollers have now been generally introduced with great success.

Aveling and Porter's (Fig. 4363) has two driving-rollers in front, one of which turns loose on the axle to enable the machine to turn short curves. The driving-axle is rotated by chain gearing from the crank-shaft, and similar gearing is used for connecting the steering-wheel with the two large rollers at the rear of the machine.

These are journaled in a turn-table, which may be rotated horizontally by the steering-wheel to guide the machine in any direction. It is built of four sizes, weighing respectively 15, 20, 25, and 30 tons.

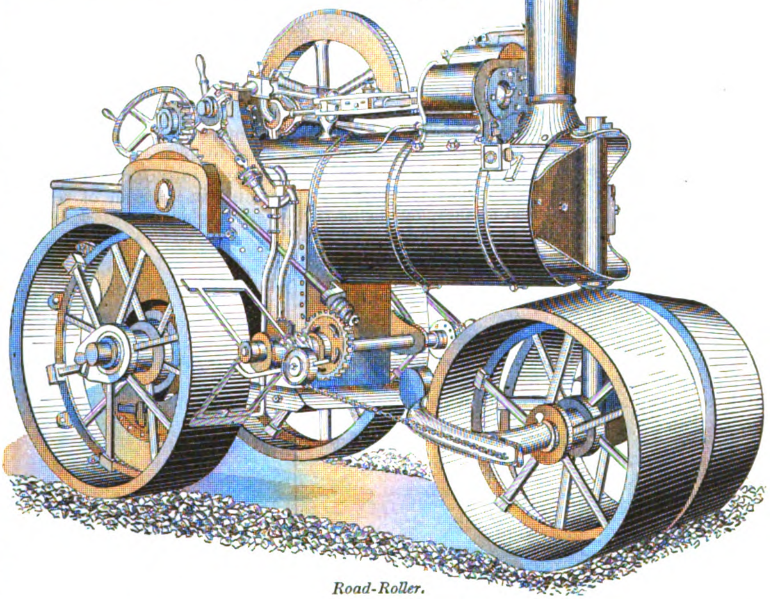
Fig. 4363.



Aveling and Porter's Road-Roller.

The steering-wheels of a differently arranged roller, made by Aveling and Porter (Fig. 4364), are somewhat conical, and are mounted on an axle, whose ends are bent downward, so that the wheels are close together at their lower edges, while between their upper edges a strong upwardly projecting center-pin from the axle passing through flanges at the end of the fire-box serves to support that part of the boiler, and as an axis on which the fore-wheels turn to steer the machine. The steerage is effected by chains connected to the bow in which the axle is journaled, which are operated by a foot-plate worked by the driver.

Fig 4364.



Road-Roller.

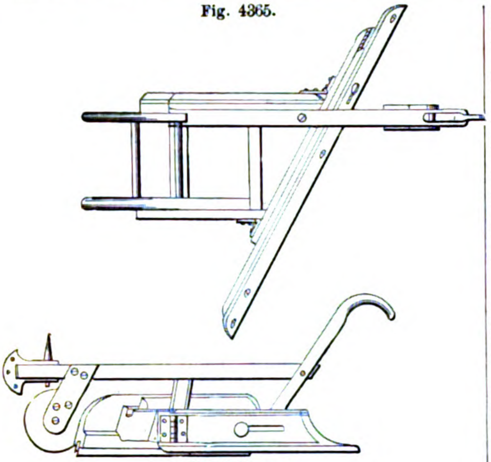
Road-scrap′er. A large hoe, or a machine for leveling or cleaning roads. The machine (Fig. 4365) is an oblique board which is drawn over the road-bed to level the earth or gravel which has been dumped in position. It is also used in rounding-up country roads after plowing a number of furrows on each side.

Fig. 4366 is a common form of scraper for removing earth in road-making, or even in ditching when the sides of the excavation are sloping. A *grading-shovel* or *earth-scraper*.

Fig. 4367 is a machine having shares, scrapers, and roller attached to the frame. It is intended for leveling roads.

Road-steam′er. A lo-

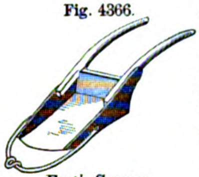
Fig. 4365.



Road-Scraper.

comotive traction-engine for use on common roads. See ROAD-LOCOMOTIVE ; TRACTION-ENGINE.

Fig. 4366.

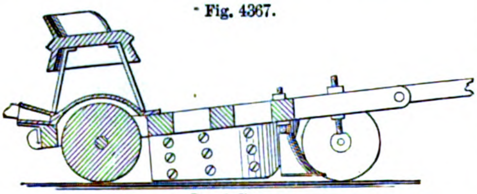


Earth-Scraper.

Roan. (*Leather.*) Sheep-skin tanned with sumach; the process is similar in its details to that employed for morocco leather, but lacks the *graining* given to the morocco by the grooved rollers in the finishing. It is used largely for bookbinding and somewhat for shoes.

Roast'ing. (*Metallurgy.*) A protracted heating of metallic ores to a point below fusion, to expel sulphur, arsenic, carbonic acid, water, etc., and frequently to effect oxidation.

Fig. 4367.



Road-Scraper.

The roasting of ores is conducted in heaps or furnaces.

The operation is (*a*) for the purpose of removing impurities, or (*b*) for converting certain constituents into a more tractable condition, either for succeeding operations or for removal.

1. Sulphur and arsenic are expelled by fire, passing off in fumes. This is termed roasting with iron and some other ores, which are built up into heaps with fuel and then fired.

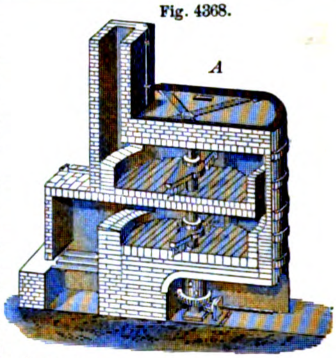
2. The roasting of *tin* ores to get rid of iron and zinc is conducted in a reverberatory furnace. Copper ore is roasted in a similar furnace or smelted to convert the sulphuret of iron into an oxide, when it passes into the scoriæ and is removable as a slag.

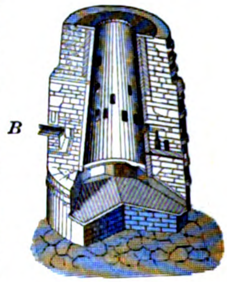
See COPPER ; COPPER-SMELTING ; CALCINING-FURNACE ; ROASTING-FURNACE ; DESULPHURIZING-FURNACE, etc. See lists under METALLURGY ; FURNACE.

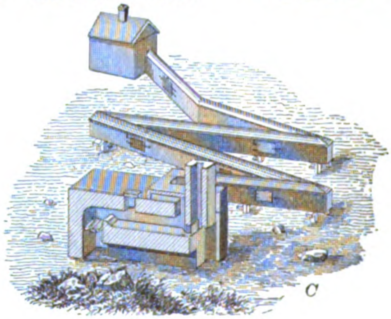
Roast'ing-bed. (*Metallurgy.*) A floor or bed of refractory substance on which ores are roasted.

Roast'ing-fur'nace. (*Metallurgy.*) A furnace in which ore is heated to drive off the sulphur and other volatile particles.

Fig. 4368.







Roasting-Furnaces.

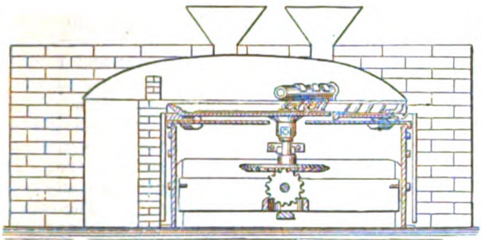
A is Parke's roasting-oven for copper ore, in which the ore is stirred by machinery. The hearth is in two stories, each of which has its own rotary stirrer attached to the central shaft and operated by gearing in the vault below. The hot gases from the furnace pass over the two chambers in turn, and thence to the chimney. The hearths are about 12 feet in diameter. On the other side of the hearth appear the openings at which the working tools are introduced. These are closed by iron doors. The charge is introduced at an opening in the roof of the upper chamber. Each hearth has a charge of 4 tons. The material is raked from one floor to the other, and eventually falls into a vault beneath.

B is a shaft-furnace for roasting iron by means of gases from hydrocarbons. The stack is hooped with iron, and has a central cavity of a truncated cone shape. The cast-iron hearth has three slopes which incline to the discharge-holes, which have doors in which are air-holes. Above the openings leading to the doors is a carrying piece projecting into the shaft. The gases are led in at a tube shown on the left, from which they reach the interior by a number of tuyeres at various hights in the shaft, whence they issue, and, coming in contact with atmospheric air, are burned. The entrance is regulatable by dampers at the various tuyeres of the respective series.

C is a reverberatory furnace for roasting arsenical ores, in which the fumes are conducted from the furnace through a long flue, in which they are condensed in cooling. By such means either valuable materials are saved, or the fumes are suppressed, so as to avoid contaminating the surrounding atmosphere. See ARSENIC-FURNACE. Along the condenser are doors for extraction of the deposited material. See Plattner's "Metallurgischen Röstprozesse," Freiburg, 1836.

Fig. 4369 is a furnace with a rotating hearth, the contents of which are moved by stationary stirrers.

Fig. 4369.

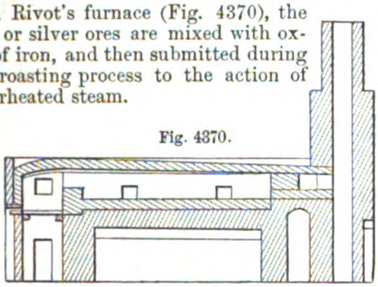


Revolving-Hearth Furnace.

Another form of roasting-furnace has inclined cylinders, through which the ores pass, being heated by the furnace.

In Rivot's furnace (Fig. 4370), the gold or silver ores are mixed with oxide of iron, and then submitted during the roasting process to the action of superheated steam.

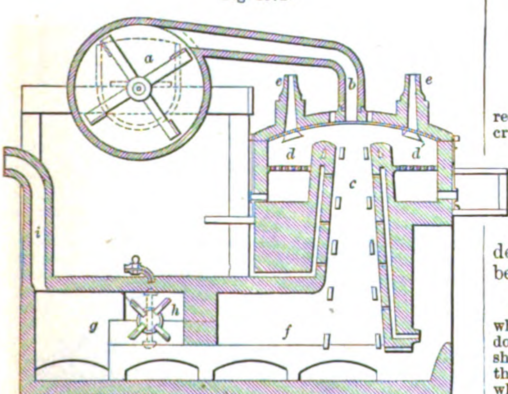
Fig. 4370.



Reverberatory Furnace.

In Whelpley and Storer's furnace, patented January 12, 1864, the ore, in a finely comminuted state, is forced by a fan-blower *a* through the tube *b* into the descending shaft *c* of the apparatus; this has furnaces *d d′* on each side, provided with chimneys *e e*, to the action of which the ore falling from the tube *b* is exposed. The bottom of the horizontal

Fig. 4371.



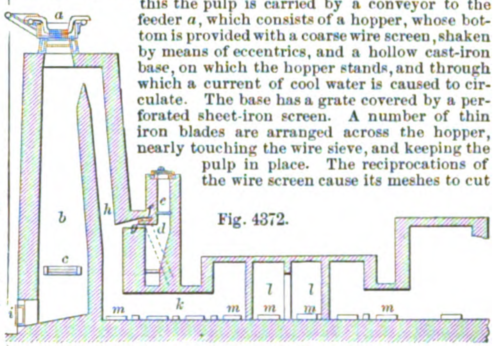
Whelpley and Storer's Shaft-Furnace.

shaft *f* is covered with water, into which the heavier particles of ore fall; the lighter portions are arrested in the chamber *g* by means of a spray of water injected thereinto. A rapidly revolving fan *h* in this chamber withdraws the products of combustion through the up-cast shaft *i*.

Stetefeldt's furnace for roasting silver ores is of the class known as a *shaft*-furnace, in which the powdered ore is calcined while falling through the flame rising from a fire.

The ore, having been crushed by the rock-breaker, is then mixed with salt and pulverized by the stamp battery. From this the pulp is carried by a conveyor to the feeder *a*, which consists of a hopper, whose bottom is provided with a coarse wire screen, shaken by means of eccentrics, and a hollow cast-iron base, on which the hopper stands, and through which a current of cool water is caused to circulate. The base has a grate covered by a perforated sheet-iron screen. A number of thin iron blades are arranged across the hopper, nearly touching the wire sieve, and keeping the pulp in place. The reciprocations of the wire screen cause its meshes to cut

Fig. 4372.

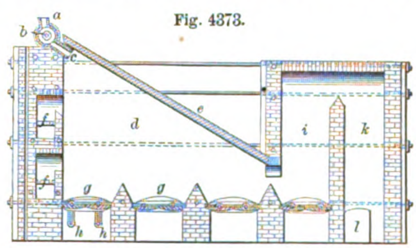


Stetefeldt Roasting-Furnace.

through the pulp, which falls into the shaft *b* in a continuous shower. *c* is one of two flues of a gas-generator, which enter the shaft on each side. The shaft *d* is provided with a light cover and a slide *e*, on which charcoal is burned. The carbonic oxide produced by this is mingled with air introduced through the flue *f*, and passes in a state of ignition through the shaft *g* into *h*, where it heats the shower of falling pulp, which is thus desulphurized and dechloridized, and falls upon the inclined bottom of the shaft, whence it is withdrawn through the door *i*. The fine particles, freed from sulphur and chloridized, which pass through the shaft *h*, are deposited in the flue *k* and dust-chambers *l l*, and withdrawn at intervals. See page 1571.

In Aiken's furnace (Fig. 4373), the stamped ore fed through the aperture *a* is conveyed by the screw *b* into the conductor *c*, and drops into the roasting-chamber *d*: this has an inclined arched top *e*, and is heated by two furnaces *f f*, which open di-

Fig. 4373.



Aiken's Roasting-Furnace.

rectly into the chamber; the doors *g g*, pivoted, and having cranks *h h* by which they may be placed in horizontal or vertical position, serve to discharge the roasted pulp; the waste gases after passing through the ascending and descending shafts *i k* and flue *l*, serve to dry the ore previous to stamping.

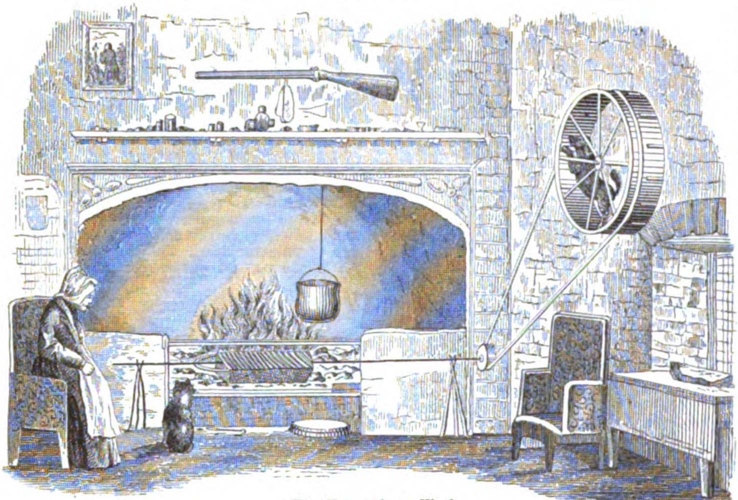
Roast′ing-jack. (*Domestic.*) An old-fashioned device for turning the spit on which meat was roasted before an open fire.

It was driven by a dog inclosed within a tread-wheel from which a belt passed around a pulley on the end of the spit. The dogs employed for this purpose usually belonged to a peculiarly short-legged, long-bodied breed, termed *turnspits*. It is said that there was not unfrequently considerable competition as to which should take his place in the wheel when a joint was to be roasted, the animals well knowing that industry would receive its reward.

In the onward march of improvement, this device disappeared before its younger rival, the smoke-jack, which ate nothing; though within a comparatively recent period it might still be occasionally met with in England.

Its faithful minister, the turnspit dog, is now but rarely seen. The illustration is taken from the castle of St. Briard, on the borders of the Forest of Dean, in Gloucestershire, and forcibly suggests the days when the "roast beef of Old England" still maintained its time-honored supremacy over mutton and such small deer.

Fig. 4374.



The Turnspit at Work.

tunnel and conveyed to the drill-cylinder by a pipe wound on a reel at the back of the apparatus, and so geared as to allow the pipe to unwind when the machine is advancing and recoil it when moving in the reverse direction. By suitably arranged gearing, the boring cylinder may be raised or lowered and adjusted to any required angle. The compressed air is cooled by being forced through water, enabling a higher pressure to be used, and may be diverted from the boring-cylinder to an upright cylinder, from which motion is transmitted to the wheels when it is desired to move the machine. See ROCK-DRILL.

In default of a turnspit dog, — which is not an uncommon animal, but the art of being thus useful has been lost in the family for several generations past, — the spit may be turned by means of a weight and cord acting over a pulley and wound upon a drum, on whose axis is a band-wheel which turns the spit by means of a cord. See BOTTLE-JACK; SMOKE-JACK.

Ro′band. (*Nautical.*) A piece of plaited rope called *sennit*, used for fastening the *head-rope* of a sail to the *jackstay*. A rope band.

Rob′i-net. (*Steam-engine.*) A British term (borrowed from the French) for some of the cocks of the steam-engine, as the *gage*, *brine*, and *trial* cocks.

Roch′ing-cask. A wooden cistern, lined with lead, in which alum is crystallized after having been previously dissolved in water or by the action of steam.

Rock′a-way. (*Vehicle.*) A kind of four-wheeled, two-seated carriage, with full standing top.

Rock-bor′ing Ma-chine′. (*Mining.*) A machine for drilling holes in rock. Low's machine is operated by air compressed in a reservoir at the mouth of the

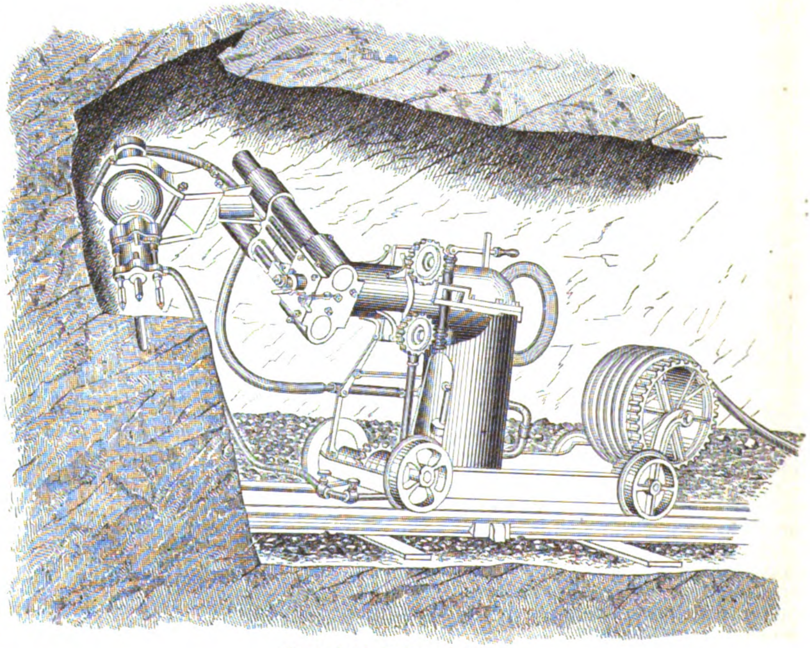
Rock-crush′er. A machine for breaking rock. See ORE-MILL; STAMPING-MILL; QUARTZ-MILL, etc. See lists under MILL; METALLURGY.

Rock-drill. A tool for boring rock by a chisel movement or rotary motion. Fig. 4376 shows several forms of rock-drills, embracing some of the peculiar features of this tool. Many varieties may be found not here shown, but these are representative. See also under ARTESIAN-WELL; WELL-BORING, etc.

a has four cutting edges, arranged radially.

b. The drill-stock has a central cutter and removable, reversible, radial cutters with extended edges. The shanks of the cutters are retained by a sleeve and key in the longitudinal recesses of the drill-stock.

Fig. 4375



Low's Rock-Boring Machine.

c has a central drill and four circumferential reamers to enlarge and trim the hole.

d is a drill of fast and movable flat chisel-formed cutters combined in one stock, in such a way that the movable cutter will be the leading cutter, and, after it has made its stroke, will receive a blow on its top end from the descent of the fast cutters, thereby driving it past them into the rock.

e has a central cutter operating in a tube which forms a sand-bucket.

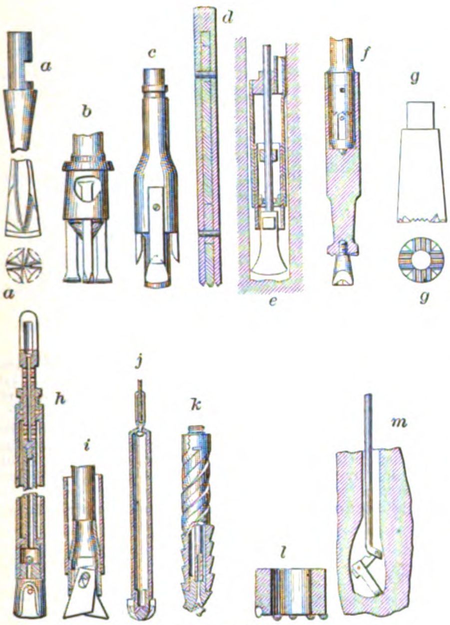
f has serrated sections, a collar and oblique grooves on the stock, so that as the shaft is lifted for a stroke, it is turned, causing the cutting face to descend in a new place, and turning the drill without the revolution of the stock.

g is a rock-drill of tubular form, and has on its face sets of cutting edges so arranged that the edges of one set may strike the rock across the incision made by the edges of the adjacent set.

h is designed to remove broken and pulverized rock from the bore of a well, and collect it in the drill-rod, at the same time discharging the water from the rod, so as to allow the heavier matters to be retained in the rod, until the receptacle there provided for them is filled

i is an expanding drill; when it is drawn upward the cutters

Fig. 4376.



Rock-Drills.

fall together and become contracted to a compass less than the diameter of the pipe within which the drill works; but when it is forced downward the cutters are forced outward in radial directions to a diameter greater than the pipe, and therefore cut a path for the pipe.

In *j* the drill-stock is hollow, and is designed to be provided with hose attachments for the purpose of introducing water under pressure into the hollow part of the drill-stock, in order to have the water issue therefrom through suitable apertures, to free the drill of the boring meal and remove the same by the overflow of the water.

k is a conical-pointed borer, having three curved cutting faces at equal distances around its point, and is connected with the base of a hollow cylinder by a socket-joint; its curved cutting faces take a spiral form and are continued up to the top of the cylinder, thereby forming parallel spiral grooves on the outside of the cylinder; the edges of the spiral grooves act as reamers, the grooves form elevators in which the silt is raised nearly to the top of the cylinder, where the grooves are intersected by openings which admit the silt to the inside of the cylinder, from which it is discharged, when full, by raising the instrument from the well and removing the borer.

l is an annular reamer whose face is armed with black diamonds or sapphires. See DIAMOND-DRILL.

m is a tool for making an enlarged chamber at the bottom of a shaft. It has a pair of chisel bars coupled by pivots and spreading laterally by the weight imposed.

Rock-drill′ing Ma-chine′. The two most important improvements in modern rock-drilling apparatus consist in the use of compressed air as a motor and the employment of diamond points. (See Fig. 1631.) The former is now universally used in operations on a large scale, as at the Mont Cenis and Hoosac tunnels, and is extensively employed in coal-mining, serving to ventilate the shaft besides performing the functions of a motor. The drilling-machines to which it is applied are various, very great improvements having been made within the past 20 or 25 years, previous to which time the old systems of turning the drill, and boring or pounding by hand, held undisputed sway.

In 1849, Clark and Motley, in England, invented a machine-drill, and in 1851, Fowle devised a similar machine, having the drill directly attached to the piston cross-head and provided with an automatic feed-apparatus. To this succeeded the Hotchkiss and Gardner machine. It has an automatic feed, and the drill is air-cushioned to deaden its shock, enabling it to be worked very rapidly without injury to the stationary parts.

The Mont Cenis and Hoosac tunnels gave a great impetus to this class of inventions, among which were a number intended for excavating the whole face of the boring at once. Such were those of Beaumont and Berrens. These were to cut an annular groove of the required circumference by means of drills rotated on a large cylinder-head, the core to be afterward removed by blasting.

Captain Penrice proposed to do away with blasting by studding the cylinder-head, to which a rotary and percussive motion was imparted, with a number of drills, so as to remove the whole face of the rock at the same operation. The smaller class of machines, which simply drill holes for containing a blasting charge, are those now universally employed. Among these are Bergstraem's, employed in Sweden, in which the drill is automatically rotated by a thread on the fly-wheel shaft, turning a gear-wheel on top of the cylinder and connected to the piston-rod; feed is effected by hand.

In Low's, the piston-rod is hollow and has an interior screw-thread by which the drill-holder, fitting therein, is advanced. The piston-rod is guided straight during the forward stroke by a ratchet-wheel, working in parallel grooves, which is partially rotated at each back stroke. See Fig. 4375.

The Burleigh machine, used at the Hoosac Tunnel and Hallett's Point, has a piston-rod extending both ways from the piston; the front end contains the drill, and the upper is hollow to receive the feed-screw; this part has a spiral slot, which receives a feather on the inner rim of a ratchet-wheel, by which a rotary motion is imparted on the up stroke; a ring on the end of the piston-bar also operates the valves, and through an intermediate lever feeds the drill.

In Ingersoll's, the piston-rod projects only in one direction (forward), and is hollow to receive a spiral guide for imparting rotation. The feed-screw works in a socket parallel with the cylinder, and is operated by a rod which passes through the spiral guide, and has a head which, by means of a crank movement, actuates the feeding-ratchet. The motor-valve is operated by plug-tappets at either end of the cylinder. Fig. 4377.

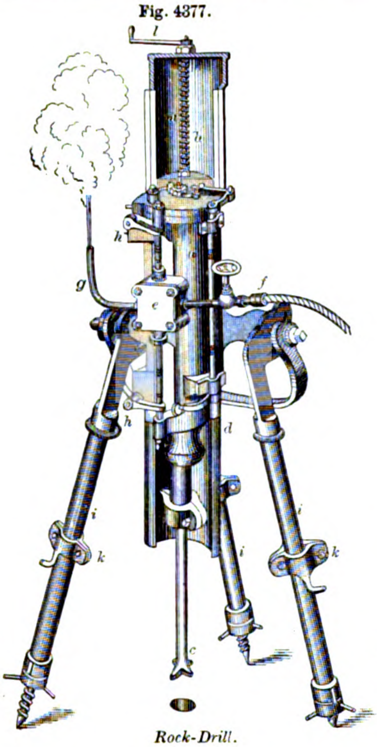
The Haupt drill is supported on four adjustable legs, and is sufficiently light to be moved by two men, and is operated by a single man with 2-horse power of steam; at 30 to 40 pounds pressure it drills a 1⅜-inch hole in hard limestone, at the rate of 5 inches per minute. Compressed air may be used, and the machine has the usual horizontal, angular, and vertical adjustments.

Shelburne's submarine rock-drill, employed for removing the obstructions at Hellgate, is supported on a semi-spheroidal hollow cast-iron base, having three steel feet, which insure its stability on the rock. The drill frame is conical in shape, and is made of wrought-iron, the drill-shaft passing through an opening in its top. The drill is operated by two engines within a water-tight chamber, and supplied with steam from the boiler of a steam-tug; its head is provided with diamond points, performing its work altogether by rotation. Live steam is supplied by a rubber pipe passing through an exterior exhaust-pipe. Electro-magnetic devices are caused to ring a bell when the hole is bored to the required depth, and also when the drill is removed from the hole. When the proper number are drilled, a diver descends and charges them with nitro-glycerine cartridges.

Colonel Von Schmidt, of San Francisco, has proposed to employ for tunneling the Sierra Nevada, in order to supply water to the auriferous gravel-beds of Placer County, an annular diamond-drill, eight feet in diameter, consisting of a large wheel, on whose edge the diamonds are set, cutting a circular groove two inches in diameter, and having a central borer, which drills a blast-hole. The apparatus is to be worked by compressed air; and when a sufficient depth is attained, 3 or 4 feet, it is to be run backward, and the cylindrical mass of rock removed by blasting.

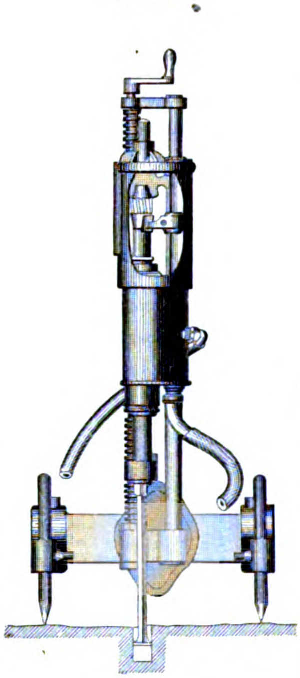
Ingersoll's rock-drill (Fig. 4377) may be worked either by steam or compressed air.

Fig. 4377.



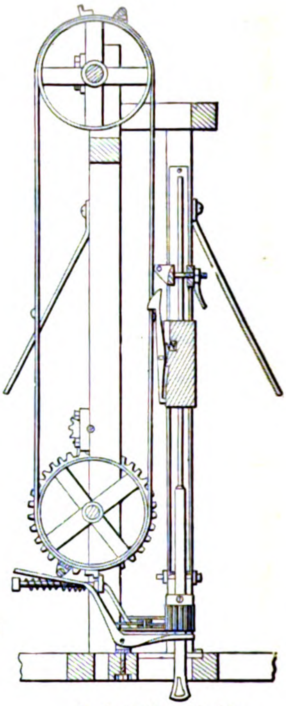
Rock-Drill.

Fig. 4378.



McKean's Rock-Drill (English).

Fig. 4379.



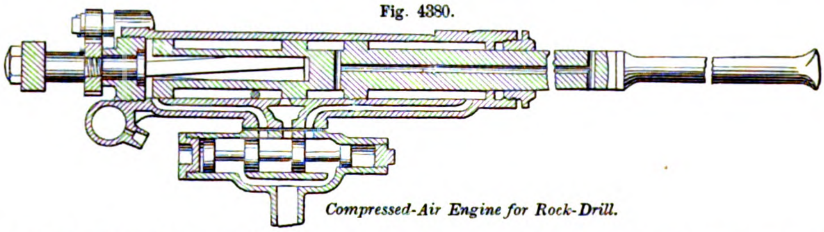
Rock-Drilling Machine.

The cylinder *a* is placed in a semi-cylindrical trough *b* having trunnions journaled in a tripod stand, is advanced by a screw as the hole is deepened, and may be rotated in a vertical plane to drill at any desired angle. The points of the hard steel drill *c* are so shaped as to exert a cutting instead of a crushing action, as the cylinder is rotated during its downward motion by ratchet and pawl devices operated from the rod *d*. *e* is the steam-chest, *f* the induction, and *g* the eduction pipe; *h h*, valve-rod tappets. The legs *i i i* are adjustable in length to suit inequalities of the ground, and are provided with hooks *k*, from which weights are suspended to hold the apparatus down to its work. *l* is a hand lever for turning the feed-screw *m*, in order to raise the cylinder. See also DIAMOND-DRILL, Figs. 1632, 1633, page 697.

McKean's rock-drill is operated by compressed air; the feed is effected by a hand crank and screw, and the drill is partially rotated at each stroke by a bevel-gear engaged by an inclined fin at each reciprocation. The stand is mounted on adjustable steady pins, by which it is leveled. See TUNNEL; SUBMARINE EXCAVATION.

Fig. 4379 is a view of a machine in which the boring is made by vertical strokes. The mechanism may be driven by hand or otherwise. The drill has its downward impulsion by a monkey which is automatically tripped. The drill has partial rotation between the strokes.

Fig. 4380.



Compressed-Air Engine for Rock-Drill.

Fig. 4380 is an air-driven reciprocating drill. The main cylinder, in addition to its ordinary ports, has two ports communicating respectively with the back of the valve of the cylinder and with the back of the advance cylinder. The main cylinder has also a central supply-port in constant communication with the fluid supply. The piston-rod carries three pistons forming two chambers. The forward chamber communicates with the outer air. The hinder chamber contains compressed air. The valve-rod carries four pistons; the two outer forming its operating pistons, and the inner ones the cylinder-valves.

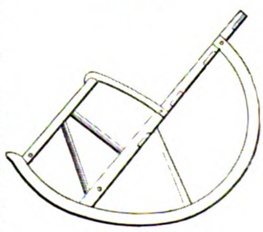
Rock'er. 1. (*Furniture.*) *a.* A curved piece into which the two legs on one side of a chair are inserted.

b. A curved piece beneath the end of a child's cradle.

2. (*Engraving.*) The comb-like steel tool used in making the ground-work of the mezzotint process.

3. (*Metallurgy.*) A trough mounted on rockers, and in which particles of ore are separated from earth by agitation in water.

Fig. 4381.

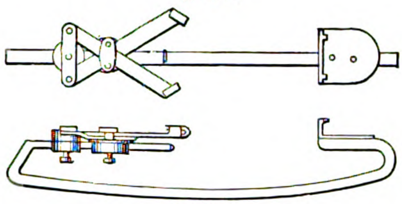


Rocking-Chair.

4. A low-down skate with a rounding sole.

5. (*Chemical.*) The congelation of a liquid is assisted by a slight agitation of its particles, which is effected in the ordinary process of freezing ice-cream by imparting an alternating

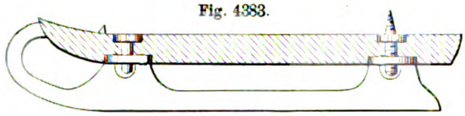
Fig. 4382.



Rocker.

semi-rotation to the vessel containing it. In Fig. 4384, the substance to be frozen is contained in a

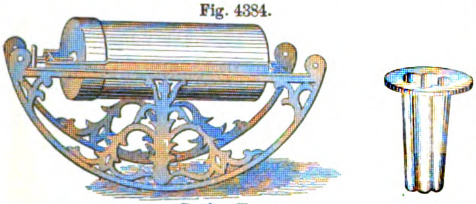
Fig. 4383.



Straight-Soled Skate.

mold, placed within a cylinder mounted on rockers, and is surrounded by a mixture of hydrochloric acid and sulphate of soda.

Fig. 4384.



Rocker-Freezer.

Rock'er-cam. (*Machinery.*) A vibrating cam.

Rock'er-shaft. (*Machinery.*) A shaft which oscillates about its axis, as that of a bell or one supporting a pendulum. More frequently called a ROCK-SHAFT (which see).

Rock'et. 1. A cylindrical tube of paper or metal filled with a compressed mixture of niter, sulphur, and charcoal, which, on being ignited, propels it forward by the action of the liberated gases against the atmosphere.

Rockets have been known in China and India from time immemorial, and have long been employed for war purposes. It seems probable, from the accounts, that they were employed against the forces of Alexander of Macedon at the farthest point of his Eastern advance.

The first European author by whom they are mentioned is Marcus Græcus, who, writing in the eighth century, says that if a compound of niter, sulphur, and charcoal be tightly rammed into a long narrow tube and set fire to, the tube will fly through the air.

They appear to have been employed against the Crusaders by the Saracens, and were probably first introduced by the former into Western Europe. War-rockets were used by the Venetians in 1380, and by the French in 1449. See GUNPOWDER.

Rockets are used for various purposes: —

War; in which the charge may amount to 32 pounds.

Life-saving; to convey a line to a stranded vessel.

Whale-killing; in which the charge may be 2 or 3 pounds.

Signal; fired straight upward, and not differing essentially from the ordinary.

Sky-rocket; a pyrotechnic device common in public displays.

Sky-rockets differ in their terminal display, which is dependent upon the *garniture* contained in a *pot* at the head of the case, and which may consist of *stars*, *golden showers*, *serpents*, *lardons*, *vetilles*, *petards*, *saxons*, *crackers*. See Ure, I. 729, 730.

These and signal rockets are made by rolling a rectangle of thick paper on a former, whose diameter is equal to the interior of the rocket. The paper is pasted at each turn, and additional sheets are added until the required thickness is attained. The *case*, as it is termed, is then *choked* near one end by wrapping it with strong twine, which is drawn tightly so as to compress it at that point, but leaving an opening sufficiently large to admit the *spindle*, on which it is placed for driving. The composition employed in the United States military service consists of about 26 parts niter, 5½ sulphur, and 19 charcoal from hard wood, preferably maple.

The niter and sulphur are pulverized, mixed by hand, and passed through a sieve having about 25 wires to the inch; the charcoal, moderately pulverized, is then incorporated by hand.

The case is placed, choke end downward, in a mold; the spindle, which projects upward about ⅔ the length of the case, having been inserted through the choke-hole; a ladleful of composition is poured into the case, and driven by means of a hollow copper-shod drift, which is struck 25 or 30 blows with a wooden mallet, packing the composition into a solid mass; another ladleful is then poured in and similarly driven; several hollow drifts are used, each shorter than the other, until the case has been charged to the top of the spindle, when a solid drift is employed. When the case has been charged to within about one diameter of its top, the charge is covered with a piece of paper, over which is placed a wad of clay or plaster of Paris.

Into this end a paper cylinder, termed a *pot*, is usually inserted for containing the *garniture* or decorations; it projects about 1½ diameters beyond the end of the case, and is surmounted by a paper cone.

The whole is attached to the larger end of a stick of square or rectangular section, and of such taper that the rocket will balance at a point on the stick one or two inches from the case.

The choked end is primed with a piece of quickmatch, and the rocket is fired from a stand which may be adjusted to any desired angle of elevation.

Desaguliers had proposed the use of rockets in modern warfare, but the first actually employed was introduced by Colonel, afterward Sir William, Congreve, in 1803.

The Congreve rocket consists of a sheet-iron case filled with a composition of niter, sulphur, and charcoal pulverized, and having a head which may be either solid or hollow, to contain a bursting charge, and is closed at bottom with a circular piece of gun-metal, having a central aperture, into which the stick is screwed, and smaller surrounding apertures for the escape of gases. If the shell-head be employed, it is provided with a fuse, so as to burst at or before the time of striking. These rockets were first employed in the attack on Boulogne, in 1806, and again at Copenhagen, in 1807. They were also used at the battle of Leipsic, 1813, by the British rocket troop, an organization which is still maintained in that service.

In Hale's rocket, the stick is dispensed with. As originally made, this rocket, which in external appearance resembles Congreve's, had a central aperture at the rear, through which the propelling gas escaped, surrounded by smaller tangential apertures for imparting rotation. These were employed by the United States army in the Mexican campaign of 1847, having been found to give generally as good results as those to which sticks were attached.

It sometimes, however, happened that immediately after starting one would diverge from a straight course and perhaps turn completely over, returning toward the place whence it was fired.

To obviate this, Mr. Hale placed the tangential directing apertures near the head, instead of at the base of the rocket.

The composition with which they are filled consists of niter, 10 parts; sulphur, 2; charcoal, 3. This is inserted in charges of about 3½ ounces each, which are successively compressed by a screw or hydraulic press, under a force of 20 tons or more to the square inch. A hole is bored axially through the composition, and afterward reamed out conically tapering toward the head.

A few rocket-batteries were organized in the early part of the late war, but most, if not all, of the material was subsequently turned into store. Rockets are, in fact, not adapted for use in a wooded country, not being susceptible of great accuracy of aim; and being diverted from their course by the slightest obstacle, they produce but little effect on disciplined troops, and are only available for firing buildings or frightening cavalry horses.

They were, however, used by the English forces in the war against Theodore, king of Abyssinia, — a lineal descendant, according to the tradition of his country, of the Queen of Sheba.

War-rockets are fired from a trough or tube, which has usually a stop near the muzzle end to detain the rocket until sufficient propulsive power is developed to insure its starting in the proper direction.

The tube is sometimes mounted on a tripod-stand and pivoted, so that the required direction and elevation may be given; or it is mounted on a carriage after the manner of a field-piece, in which case it is sometimes called a rocket-gun.

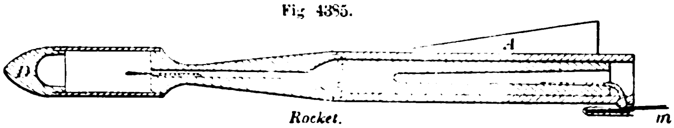
The tube has been made of rods of iron twisted spirally, so as to form a kind of lattice, imparting a rotary motion to the projectile; it has also been proposed to accomplish this object by flanges on the rocket itself.

Ranges.

12-pdr.	6-pdr.	Yards.	12-pdr.	6-pdr.	Yards.
...	7¾°	400	13½°	11¾°	900
...	8¾	500	14	12½	1000
10°	9¼	600	14¾	13¼	1100
11½	10½	700	15	14	1200
12¾	11¼	800	16	14½	1250

When the wind is directly against the direction of flight, half a degree is to be added to, and when directly favorable, the same amount is to be deducted from, the above elevations.

Fig. 4385.



Rocket.

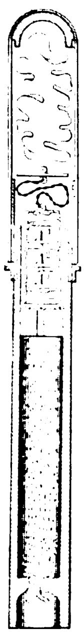
In Hunt's rocket, a stick is dispensed with, rotary motion is imparted by spiral wings on the case or tail-piece A, over which is a bursting charge to separate the head D therefrom at the termination of the upward flight. The rocket is fired by pulling a lanyard m, which draws a slide igniting a friction composition.

Walbach's rocket has wings and a percussion point, and an elbow to secure discharge if the point does not collide. A balancing piece on the threaded tail has spiral projections, which cause it to traverse toward the rear under the impulse of the blazing composition, and preserve the equilibrium as the composition is expended.

Detwiller's rocket has a series of interchangeable cups A^1 A^2 A^3, containing differently colored fires; these are interchangeable, so as to appear in any required succession when the head is exploded, their various combinations forming signals.

Fig. 4386.

Fig. 4387.



War-Rocket. *Signal-Rocket.*

2. The lever whereby the blacksmith's bellows are inflated.

Rock'et-drift. (*Pyrotechny.*) A cylinder of wood tipped with copper, employed for driving rockets. Its diameter is equal to the interior diameter of the case. Several of different lengths are used in charging each rocket, the shorter being employed as the case is gradually filled with composition; the longer have conical perforations to receive the *spindle;* the shortest is solid. Each ladleful of composition is compacted by striking the drift a certain number of blows with a mallet.

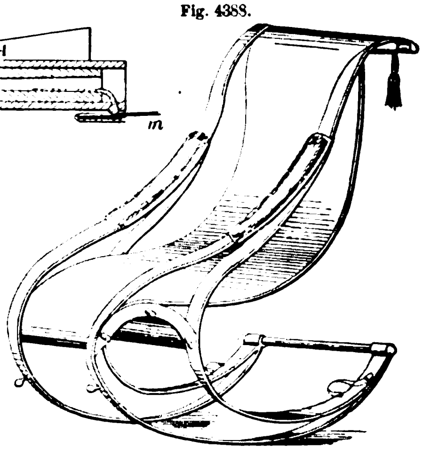
Rock'et-har-poon'. (*Weapon.*) A device for killing whales. It consists of a rocket having a pointed shell at its front end containing a bursting charge exploded by a time-fuse. The body of the rocket contains the propelling charge, and to its rear end is attached a barbed harpoon to which the line is fastened. It is fired from a gun or directing tube poised on the shoulder. See GUN-HARPOON.

Rock-fire. (*Pyrotechny.*) An incendiary composition which burns slowly and is difficult to extinguish. Used for setting fire to ships, buildings, etc. It is composed of 3 parts rosin, 4 sulphur, 10 niter, 1 regulus of antimony, 1 turpentine.

Rock'ing. The motion of a steel *mill* on a copper cylinder intended for calico-printing, when the pattern of the *mill* is to be repeated on the copper a number of times at intervals. See ENGRAVING-MACHINE.

Rock'ing-chair. One on curved pieces which allow a backward and forward oscillation. In Fig. 4388, the side pieces are connected by removable rods at the top under the seat and back of the rockers. Stops with springs attached prevent the chair rocking over.

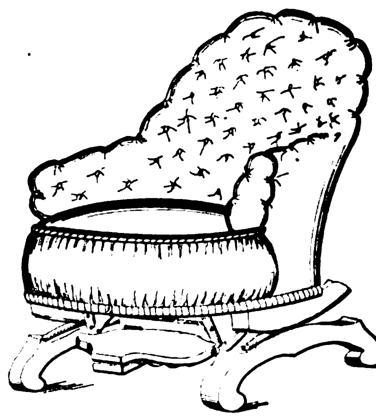
Fig. 4388.



Rocking-Chair.

When the chair (Fig. 4389) is used as a rocker, the leaf, foot-rest, and arms are folded under the seat. To place the chair in a condition to accommodate the body in a recumbent position, it is thrown back until the studs meet the hooks, after which the foot-rest is unfolded. The chair rocks to and fro on the base-piece instead of upon the carpet.

Fig. 4389.



Rocking and Reclining Chair.

Rock'ing-ham-ware. (*Pottery.*) See FAIENCE.

Rock'ing-tree. (*Weaving.*) The axle from which the *lay* is suspended.

Rock-pul'ver-iz'er. A machine or mill for breaking stone for road-bed or ore for metallurgic treatment. See ORE-MILL; STONE-BREAKER; QUARTZ-MILL, etc. See lists under MILL; MINING; METALLURGY.

Rock-shaft. (*Steam-engine.*) *a.* A shaft with tappets which raise the levers of the puppet-valves in a certain class of steam-engines.

b. The shaft, with levers, used for working the slide-valves, the notch of the eccentric rod dropping into a stud fixed in one of the levers; the links of the slide-valve spindle being attached to the opposite lever on the same shaft.

Rock-staff. The lever of a forge-bellows or other vibrating bar in a machine.

Rod. A straight, slender piece of wood or metal, as the ramrod, wiping-rod, rifling-rod, used by gunsmiths and armories.

The coupling bar or lengthening bar of a drill-stock.

A boring-bar; *miser; shell; sludger.*

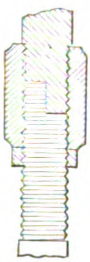
A connecting piece, as that between the cross-head of an engine and a crank. A *connecting-rod.* And so on.

Rod-chis'el. A chisel on the end of a withe or rod, used by the smith in cutting hot metal.

Rod-coup'ling. (*Well-sinking.*) A device for uniting the rods, which carry the tools used in boring Artesian or oil wells, etc., so as to form a continuous shaft.

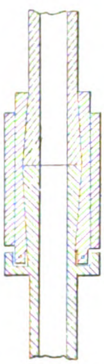
In Fig. 4390, the parts are halved together, screwed into a threaded sleeve, and secured by a jam nut.

Fig. 4390.



Pump-Rod Coupling.

Fig. 4391.

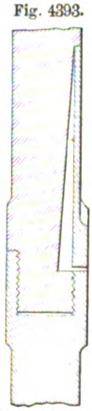


Rod-Coupling.

Fig. 4392.

Boring-Tool Coupling.

Fig. 4393.



Drill-Rod Coupling.

In Fig. 4391, the ends of the pipes have enlargements, and are secured by clamping, wedge-pieces, and an outer sleeve.

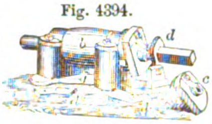
In Fig. 4392, the ends of the rods have annular channels, are clamped by half-cylinders similarly grooved, and secured by a tapering thimble.

In Fig. 4393, a recess in one section receives the end of a spring secured to the other section; the spring is depressed while the screw joint is being tightened, and when released by engagement with the recess prevents revolution.

Rod-ir'on. Rolled round iron for nails, fencing, etc.

Rod, Pin, and Dow'el Ma-chine'. (*Wood-working.*) A device for turning cylindrical dowels, rods, etc., from angular stuff. The frame *a* is secured to a stand, and carries the hollow rotating arbor *b*, to which the cutter-head *c* is clamped by a screw. The stuff is prevented from turning by a collar *d* having an angular aperture, through which, and the central opening of the arbor, it is pushed while being operated on by the revolving-cutter.

Fig. 4394.



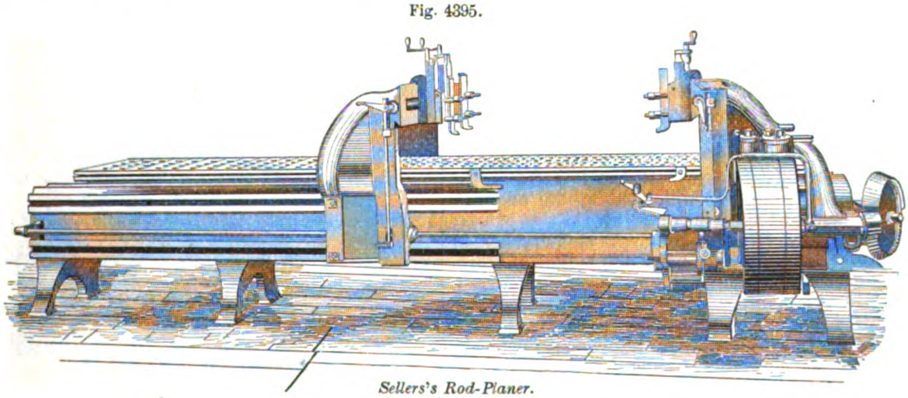
Rod, Pin, and Dowel Machine.

The collars and cutters are of different caliber, adapted to the various sizes of material used and to the required diameter of the finished rod or pin.

Rod-plan'er. A special machine-tool for planing locomotive connecting-rods, guide-bars, and similar work. It has two sets of uprights and cross-heads, with double saddle on each cross-head. The table is driven by spiral driving-gear, so arranged as to move the table at the same speed each way, and taking cut in both directions. The movable cross-head is adjustable to or from the stationary cross-head, so as to adapt the machine to varying lengths of work; say from $3\frac{1}{2}$ to 10 feet. Self-operating feed to the saddle will plane both ends of two connecting-rods at the same time. Also applicable to all kinds of stub-ends for stationary-engine work.

Rogue's Yarn. A worsted thread laid up in the middle of each strand of British dockyard rope, to prevent theft. Differently colored worsteds are used in each dockyard, in order to trace the maker of rope which proves defective.

Fig. 4395.



Sellers's Rod-Planer.

Roll. 1. (*Metal-working.*) One of the pair of cylinders between which metal is passed to draw it into bar, or to flatten it out into a sheet. See ROLLING-MILL.

The largest known to the writer is a pair of iron rolls for Sir John Brown's works at Sheffield, England. These rolls are 15 feet 6 inches in extreme length, and 3 feet in diameter, and each weighs 18 tons. They are used for rolling armor-plates.

2. (*Engraving.*) The cylindrical die in a transferring-press. See BANK-NOTE ENGRAVING. See ROLLER.

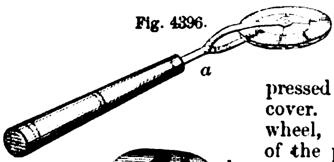
3. (*Wool-working.*) A carding of wool, delivered broadside from the cards, and somewhat compacted in the process. Rolls are prepared for hand-spinning.

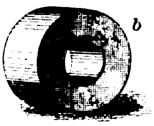
The *doffing-cylinder* of a wool-carding machine has longitudinal bands of cards with intervening spaces. The *doffing-knife* removes the fibers from these bands in *slivers* which are of the length of the doffing-cyl-

inder. They fall into the *roller-bowl*, which rolls and compacts them, bringing them into the condition of *rolls* or *cardings*, which are taken to the *slubbing-machine*.

4. (*Bookbinding.*) A tool (*a*) for hand embossing or gilding where a continuous line or pattern is to be impressed upon a book-cover. It is a brass wheel, whose edge is of the pattern desired, either in single, double, or triple line, or having fillets, interlacing, or scroll pattern engraved thereon. It is mounted in a holder and heated over gas or charcoal. The handle rests against the shoulder of the operator, and the wheel is passed along the place to be embossed. For gilding, the surface is previously spread with *glaire*, and gold-leaf is laid thereon.

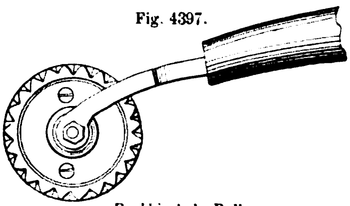
Fig. 4396.





Rolls.

Fig. 4397.



Bookbinder's Roll.

5. (*Metallurgy.*) One of a pair or series of rollers arranged in pairs, between which ores are crushed. That shown at *b* (Fig. 4396) has an interior longitudinal slot to receive the key by which it is held on the shaft.

6. (*Building.*) A strip with a rounded top laid over a roof at the ridge or at lateral joints, to raise the sheet-lead at those points.

7. (*Paper-making.*) A cylinder mounted with blades for working paper-pulp in the tub.

Roll and Fil'let. A rounded molding with a square fillet on its face.

Roll-blot'ter. One having a roller around which sheets of blotting-paper are fastened, and a handle in whose forks the ends of the roller axis are journaled.

Roll-boil'ing. (*Woolen-manufacture.*) A process for giving a luster to cloth by scalding the cloth, while tightly wound upon a roller, in a vessel of hot water or steam. (Hirst's English patent, 1830.)

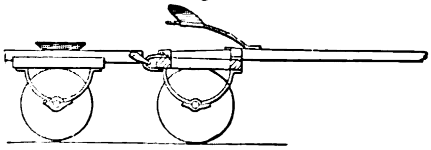
Roll-box. (*Spinning.*) In the jack-frame, the rotary can or cylinder in which the bobbin and carrier cylinder for the rovings revolve.

Roll'er. 1. (*Husbandry.*) A clod-crusher or ground-leveler. An implement of a cylindrical form to roll over arable ground to break clods, cover seed, and press in plants which are thrown out of the ground by frost.

The roller is mentioned as an implement for breaking the clods of arable ground by Googe, in his "Heresbachius," published in 1578.

The ordinary land-roller has a single cylinder

Fig. 4398.



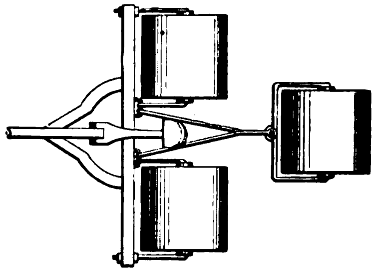
Land-Roller.

made of a trunk of a tree or of *logs* of wood upon a skeleton frame, or is a shell of iron with spokes and having sockets for an axle or gudgeons.

Fig. 4398 shows a double roller, in which the detachable tongue is confined with bands to the frame to which it is bolted. The rear rollers are adjusted and loosely attached to the elongated rear bar of the forward frame.

Fig. 4399 has three rollers on separate axles, the

Fig. 4399.



Land-Roller.

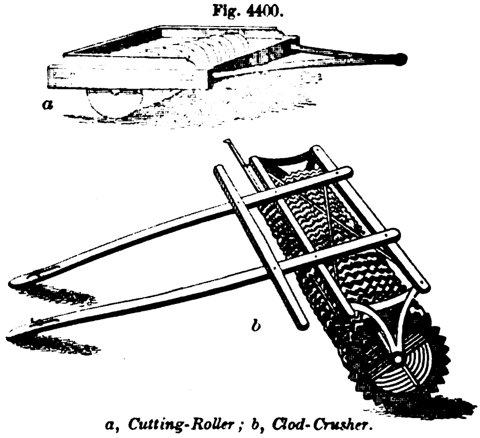
rear one trailing behind, traveling upon the ground left unrolled between the two preceding ones.

Land-rollers are also made of peculiar construction or size for specific purposes in husbandry, as the corn-roller, cane-roller.

The *roller-drill* is one having a roller following the seed-depositing share, to compact the ground upon the seed. Such a roller is a *covering*-roller.

The *cutting*-roller (*a*) has a central axis and a series of circular cutting-plates, divided by intervening collars, which maintain them at the required distance. It is used in preparing ground for tillage, cutting through sods and tangled grass and herbage to prevent choking of the plow. This is also known

Fig. 4400.



a, Cutting-Roller; b, Clod-Crusher.

as a *disk*-roller or a *flanged* roller for restoring meadows.

2. A machine for leveling roads (see ROAD-ROLLER) or for garden-walks.

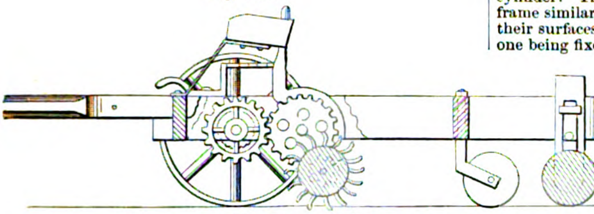
Corrugated or *toothed* rollers have been introduced into land culture, and are known as clod-crushers. This is the normal idea of a roller, but these ridged or spiky cylinders are more effective in breaking than their smooth relatives.

The *clod-crusher* (*b*) consists of a number of segments attached to an iron axle 6½ feet long. The

segments have protuberances which give the knobby character to the roller.

Fig. 4401 is a combined harrow and roller. The harrow is adjustable vertically by a lever and rotated

Fig. 4401.



Harrow and Roller.

by gearing from the axle; it is followed by a roller on the same frame.

3. (*Nautical.*) A cylindrical anti-friction bar which revolves as a hawser or rope traverses against it, and thus saves the rope from wear.

4. (*Ordnance.*) *a.* A cylinder of wood, used as a winch in mounting and dismounting guns.

b. For mechanical maneuvers in the ordnance department, rollers are used for mounting and dismounting cannon, or for transporting them to short distances.

Long and *short* rollers are circular in section, being slightly hollowed out at their midlength, the better to prevent the gun from slipping off. The *half-roller* is semicircular in section, but is similarly hollowed out on top.

5. (*Metal-working*). A circular object in a machine acting as a *carrier*, as a *cutter*, as a *die*, as an *impression-cylinder*, or as a *flattener*, *e. g.*, —

a. The *carrier* has an example in the rotating bearers on which the bed of a printing-machine traverses. It is common in other machines also, as the *drawing* rollers of spinning-machines, the *fancy* rollers and *fly* rollers of *scribbling-machines*, the *tinsel* roller of a *lace-machine*.

b. The *cutter* is shown in some forms of rotary shears and *slitting-machines*, in which the edge of a roller laps past another roller or a plate and makes a shear cut.

c. The *die* is found in the *hub* or roller die of the bank-note engraver's transferring-machine (Fig. 4403). Examples are also to be seen in many kinds of embossing-machines.

d. The impression-cylinder is found in *copperplate* printing-presses, some forms of *printing-machines*, and in *calico-printing machines*.

e. The *flattener* is found in rolling-mills, etc.

6. (*Hardware.*) A broad-faced wheel having gudgeons, and used as an anti-friction device to facilitate transportation of the object resting upon it. A *caster*. May be cited, —

Barn-door roller.	Sash-cord roller.
Chest-roller.	Trunk-roller.

7. (*Music.*) The studded barrel of the musical box or chime-ringing machine.

8. (*Stationery.*) A rolling blotter.

9. The printer's inking-cylinder. A cylinder of wood covered with a composition of glue and molasses, which is poured around it in a mold. The cylinder revolves on an iron axis as the roller runs over the face of the form.

10. Paper-making machines require cylinders of great accuracy, and their preparation involves several processes.

Abradants are dispensed with, and the required accuracy of contact is attained by the friction of the surfaces of the rollers on each other, water being plentifully supplied to prevent their heating and tearing each other.

They are first turned as truly cylindrical as possible in the lathe, and tested for parallelism by a thin copper wire applied around the circumference at various parts. The journals are turned at the same time to insure their concentricity with the cylinder. They are then mounted on their own bearings in a frame similar to that in which they are to be employed, and their surfaces carefully adjusted to each other, the bearings of one being fixed, and those of the other provided with a screw adjustment, so that they may be closed upon each other until their highest points just touch. They are then examined to see how they correspond to each other. Having been turned in the same lathe, their errors are usually alike, that is, they are either both convex or both concave; long rollers generally have the latter defect, in consequence of the middle part of the slide being more worn from turning short pieces of work. When there is a considerable want of correspondence between the two it is reduced by grinding each separately with a lead grinder mounted on the end of a long lever and supplied with emery.

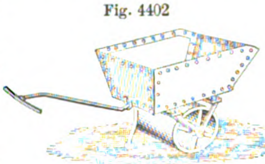
When reduced nearly to correspondence with each other, they are adjusted so as to revolve in contact, and the face of one is marked with chalk lines at intervals of a few inches; the manner of transferrence of these from one to the other indicates which parts do and which do not come in contact. The projecting parts are then farther ground away. When all the lines are transferred with considerable regularity, showing that the two surfaces nearly fit each other, they are adjusted by bringing their highest points into contact, and are then, by belt and pulley connections, caused to revolve in opposite directions and at different speeds, a constant stream of water being meanwhile directed upon them. By this means fresh points on each are continually brought in contact with each other, causing an equal and uniform abrasion, and gradually reducing both to a truly cylindrical surface. As the most projecting parts are gradually brought into correspondence, the two are pressed together by the adjusting screws, bringing a greater proportion of their surfaces into contact, and the operation is thus continued until both are gradually reduced to their true form, care being taken to avoid too great friction between them, which might heat and tear the surfaces. The process is tedious, and requires several days for its completion. See also Fig. 4405.

Sometimes the rollers are ground under a pressure equal to that which they will have to sustain when at work, in order to ensure their not bending when actually required to perform their duty in the machine. In this case the two are driven in the same direction, but with slightly differing velocities.

11. (*Saddlery.*) The broad, padded surcingle used as a girth to hold a heavy blanket in its proper position, generally made of twilled web with leather billets and chapes.

Roll'er-bar'row. A barrow mounted on a wide roller so as to cause no injury to the grass, as the wheelbarrow does, by cutting into the turf with its narrow wheel.

Fig. 4402

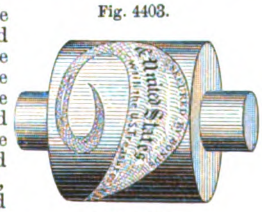


Roller-Barrow.

Roll'er-bowl. (*Woolen-manufacture.*) A device at the delivery end of a wool-carding machine, for rolling the *slivers* detached by the *doffing-knife* from the longitudinal band-cards of the *doffing-cylinder*. The rolling compacts the *slivers* into *cardings* or *rolls*, which are delivered upon an apron, and are removed to the *slubbing-machine*, where they are joined endwise and receive a slight twist.

Roll'er-die. A die of cylindrical form, used in transferring steel-plate engravings for bank-note printing, and also the patterns to the rolls used in calico-printing. The design is first engraved on a plate of soft steel, which is then hardened and subjected, in con-

Fig. 4403.



Roller-Die.

junction with the die of soft steel, to the action of a powerful press, by which the intaglio lines of the plate are transferred in cameo to the die; this is afterward hardened, and serves to transfer the design to a plate, a roller, or to another die.

Roll'er-gin. 1. One in which the cotton is drawn away from the seed by pinching-rollers, in contradistinction to the *saw-gin*. See COTTON-GIN.

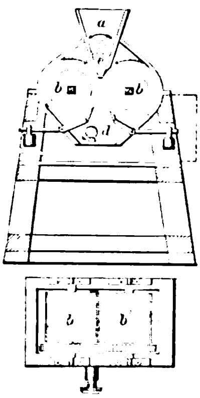
2. (*Hoisting.*) One provided with a roller on which the rope winds, and with a ratchet and pawl to sustain the weight.

Roll'er-lift. (*Printing.*) A small cam to raise the rollers from the ink surface in a power-press.

Roll'er-lock. (*Printing.*) A frame carrying adjustable roller-journals.

Roll'er-mill. A machine for bruising flaxseed, before grinding under edge-stones and pressing. The seeds are placed in the hopper *a*, and are fed downward to the crushing-rollers *b b'* by a small roller *e* within the hopper. The rollers *b b'* are geared together so as to rotate in opposite directions, and are turned by a hand crank on the shaft *d*, which carries a fly-wheel at its other extremity, and also a pulley, which rotates the feed-roll *c*. The crushed seeds fall through a slit into a box beneath the machine.

Fig. 4404.



Roller-Mill.

Roll'er-mold. (*Printing.*) A mold in which composition inking-rollers are cast.

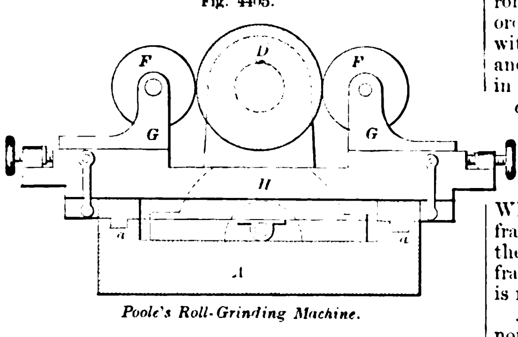
Roll'er-stock. (*Printing.*) The frame upon which composition rollers are cast. It has usually a journal at each end.

Rol'ley. (*Mining.*) A large truck in a coal-mine, holding two corves as they arrive on the *trams* from the workings. A number of *rolleys* are coupled together and hauled by a horse to the bottom of the engine-shaft. A *trolly* is a small two-wheeled truck used in a rolling-mill to wheel the balls of puddled iron to the squeezer.

Rol'ley-way. (*Mining.*) A tramway in a mine.

Roll-grind'ing Ma-chine'. A machine for accurately grinding rolls for the finer kinds of sheet-metal rolling, and more especially for calender rolls. Poole's machine, patented July 8, 1868, has one or more pairs of cutting or grinding tools upon a frame which is free to move laterally or transversely to the object which is being turned or ground, the tools constituting a pair being capable of adjustment thereon, in relation to one another, and dependent for their movements to and from the surface of the object placed between them to be turned or ground by their contact with the surface or surfaces of the object at opposite points thereof.

Fig. 4405.



Poole's Roll-Grinding Machine.

The view is a transverse section through the roll *D*, bed *A*, and ways *a*, showing the grinders *F*, rests *G*, and slide-bed *H* in end elevation.

See also his patents, January 18, 1870; June 21, 1870; August 20, 1872. In the June 21, 1870, patent, the surface is reduced by devices moving parallel to a vertical plane passing through the axis of the roll, but inclined to a plane passing horizontally through the said axis. This obliquity is obtained by the depression of one of the bearings. The effect is to give a diminished waist to the roller, the grinding line being a curve and the roll spindle-shaped. See also description under ROLLER, 10 (previous page).

Elliott, December 15, 1874, has an arrangement of three grinding wheels presented at an angular relation of 120° to the roll to be ground, the grinders being journaled in a frame, which is free to move in all directions in a plane transverse to the cylinder placed between them, their movement depending on the surface to be ground. To prevent undue pressure of the upper wheel upon the surface, the weight of the frame is counterbalanced by a lever and counterpoise.

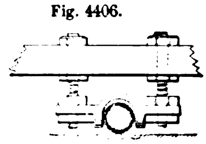
Roll'ing. 1. (*Metal-working.*) The process of drawing out or flattening metal by passing between rollers. See ROLLING-MILL.

2. (*Bookbinding.*) The process of flattening the pack of gathered signatures by hammering or passing through the rolling-press.

Roll'ing-bar'rel. (*Gunpowder.*) A barrel in which the ingredients for making gunpowder are pulverized. It has an axis at each end, on which it rotates, and a door for the introduction and removal of materials. That used for charcoal is of cast-iron, having a series of interior ledges, and that for niter and sulphur of leather stretched on a wooden frame. The material, together with twice its weight of bronze balls, is placed in the barrel, which is rotated from one to eight hours, according to circumstances.

Roll'ing-bridge. *a.* A railway *drawbridge* made to move laterally upon a carriage until it has passed the junction of the line of rails, and thence to pass inward, so as to leave the water-way clear.

Fig. 4406.



Rolling-Bridge.

b. Another form of the rolling-bridge, intended for ordinary roadways, is merely withdrawn on the main track, and when restored is supported by struts which rest in set-offs in the wall of the abutment.

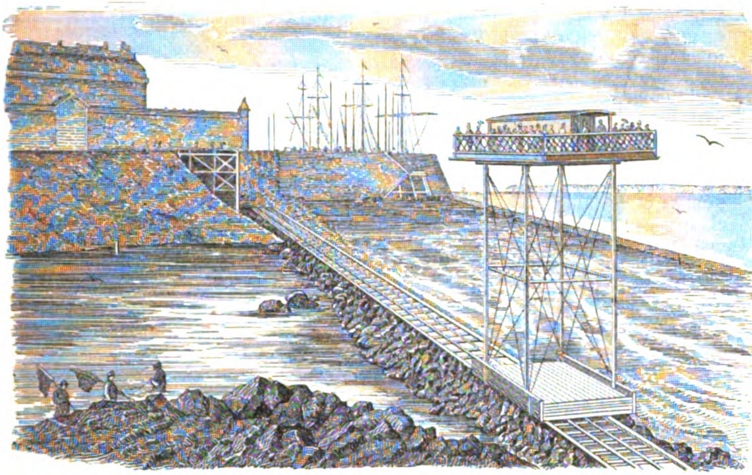
c. Or the rolling-bridge may have a strong frame supported by wheels upon a line of rails and an overhanging portion sufficient to span the water-way; or one half of the water-way, if it be met by a similar half-bridge from the other side. When closed by being rolled forward, the rolling frame leaves a gap between its platform and that of the approach. This gap is filled by another rolling frame that moves sideways. The latter rolling frame is rolled out of the way before opening the bridge.

Another rolling-bridge traverses in an arc on cannon-balls. See SWING-BRIDGE.

d. Figs. 4407 and 4408 illustrate the bridge connecting the towns of St. Malo and St. Servan, in

France, on an estuary into which the river Ronce discharges. The rise of the tide is here very great, so that while at low tide the bed of the estuary might be crossed, at high tide passengers were compelled to make a wide circuit. To obviate this, the arrangement shown, consisting of a platform having accommodation for horses and vehicles, supported on pillars, and having wheels running upon rails laid on the bed of the estuary, was designed by M. Leroyer.

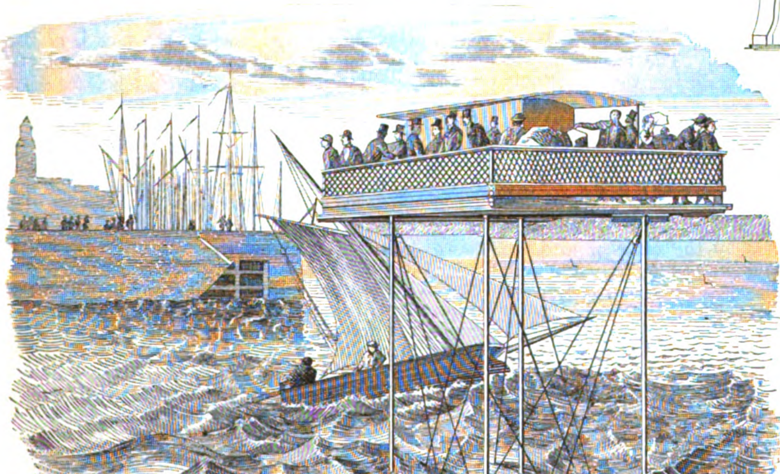
Fig 4407



Rolling-Bridge of St. Malo, France (Tide out).

e. The rolling-bridge for the assault of fortifications is a platform on wheels or rollers, driven up the glacis and intended to span the ditch, to admit the assaulting column into the works.

Fig. 4408.

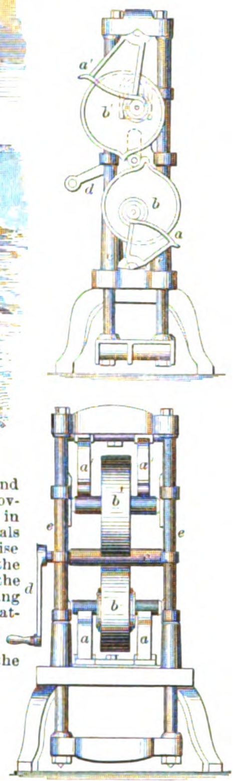


Rolling-Bridge of St. Malo (Tide in).

Roll′ing-cam Press. A press operated by a roller revolving between cam-wheels. This movement was invented by Dick, about 1848.

In the figure, *a a′* are the sectors, the lower one of which has a bearing in a groove in the lower fixed bed, and the upper in a groove in the movable bed above; their faces are in contact with the eccentric journals of the cam-wheels *b b′*, which rise and fall between guides on the standards *e*, and between which the roller *c* is interposed; on depressing the lever *d* to which this roller is attached, the sectors are caused to rotate into the position shown, bringing the longer axes of the cams into perpendicular position, thereby raising the upper bed.

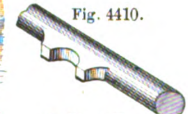
Fig. 4409.



Dick's Anti-Friction Press.

Roll′ing-chocks. (*Nautical.*) Jaws on a yard to steady it against the mast when a ship rolls.

Fig. 4410.

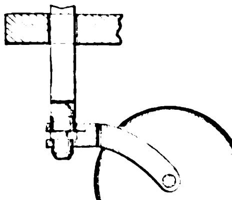


Rolling-Chock.

Roll′ing-col′ter. A sharp-edged wheel which is attached to the beam of a plow, and cuts downwardly through the grass and soil to divide the furrow-slice from the land.

Roll′ing-frame. (*Dyeing.*) The frame with

Fig 4411.



Rolling-Colter.

rollers by which cloth is drawn through the dye-beck. *Gallopers.*

Roll'ing-hitch. (*Nautical.*) Passing a rope round a spar, log, or cask, so that a pull upon the rope will roll the same.

Not to be confounded with the PARBUCKLE, which see.

Roll'ing Met'als. (*Metal-working.*) The process of forming metal into rods, bars, or plates by drawing it between cylindrical rollers, which are either plane or grooved to suit the shape to be imparted.

The grooved rolls are the invention of Henry Cort, in 1783. Iron, steel, and copper are rolled while red-hot, but most other metals and alloys are rolled cold; in most instances requiring frequent annealing during the process of their gradual reduction to the required dimensions. With the exception of iron and steel, the metal is cast into slabs preparatory to being drawn into sheets.

In some instances, as in the case of plating silver with gold, one metal is united with another by rolling. See ROLLING-MILL.

Roll'ing-mill. In the rolling-mill, the iron, which is heated and balled in the puddling-furnace, is made into bars or sheets. The rolls are journaled in pairs in metallic boxes in the iron standards or cheeks, and are capable of being set toward or from each other by means of set-screws. The grooves in the rolls are so made as to be coactive in giving the required form to the heated iron passing between them. Sometimes, as in the larger description of rolls, the grooves are counterparts, each forming one half of the bar of iron; and sometimes a ridge or rib on one roll projects into a groove in the roll beneath and forms one side only of the bar. The face of each roll has a series of grooves gradually decreasing in size toward one end. The iron is passed through each in succession, being thus gradually reduced in size and increased in length. Each time through is known as a *pass*, — a term which is also applied to the groove in a roll or the opposite groove, forming the space through which the bar passes.

The ball of iron from the squeezer is dragged along a track of iron plates on the floor of the mill and jerked on to a platform in front of the train of rollers. It is here directed by the operator into the larger of the grooves, is nipped by the rolls and drawn through. If the mass be large it is received on the other side of the rolls by two men, one of whom raises it by a bar which is suspended by a chain, the other man seizing the end of the bar with his tongs, and directing it so as to rest upon the upper surface of the upper roll which carries it over and allows it to drop again on to the platform. The head operator then again seizes it with his tongs, and directs its end into the next of the series of grooves, when the operation is repeated again and again till the required size is reached, and the bar is dragged off and laid on a floor to cool.

The operation of rolling has the effect of compressing the iron, knitting its fibers together, and drawing them out so as to assume a direction longitudinal of the bar, some extraneous matters being also removed in the operation.

In the year 1783, Henry Cort, of Gosport, England, received an English patent for the rolling of iron, as a substitute for hammering. During the following year he patented the puddling process.

Cort is the greatest name on record in the "History of Iron."

Plain rolls for reducing metal were in use before Cort's invention, and are mentioned in Dr. Johnson's Tour, 1774: —

"We then saw a brass works, where the *lapis calaminaris* is gathered, broken, washed from the earth, and the lead (though how the lead was separated I did not see) then calcined, afterward ground fine and then mixed by fire with copper. We saw several strong fires with melting-pots, but the construction of the fireplaces I did not learn. At a copper works, which receives its pigs of copper, I think, from Warrington, we saw a plate of copper put hot between steel rollers and spread thin. I know not whether the upper roller was set to a certain distance, as I suppose, or acted only by its weight. At an iron works I saw round bars formed by a notched hammer and anvil. There I saw a bar of about half an inch or more square, cut with shears worked by water, and then beaten hot into a thinner bar. The hammers, all worked as they were by water, acting upon small bodies, moved very quick, as quick as by the hand. I then saw wire drawn, and gave a shilling. I have enlarged my notions, though not being able to see the movements, and having not time to peep closely, I know less than I might."

Cort was the first to use *grooved* rolls, for which, in combination with other improvements, a patent was granted him. The first mention that we have of the use of rolls for reducing iron is to be found in "Coxe's Tour in Monmouthshire," where they are said to have been invented by John Hanbury, and used for rolling plates. This is mentioned in a note to chapter second, by Scrivenor, "On the Iron Trade."

Rolling-mills are of several kinds, according to the condition or the destination of the iron.

The first set is called the *forge-train, muck-train, blooming-mill*, or *puddle-bar train*.

The second is called the *merchant-bar train, plate-mill, rail-mill*, or *wire-mill*.

The first pair of each set is the *roughing down*, and the second pair is the *finishing*.

When the iron is to be re-rolled, as for nail-plates for instance, the bars are cut into plates of equal length and built in piles, into a re-heating furnace, whence they are taken and rolled in the nail-plate train, assuming a width equal to the length of the plates from which the nails are to be cut. See BAR-SHEARS.

For special and important work, such as *breaking down* (rolling to a gage) ingots of gold or silver for coin, a register has been contrived by Franklin Peale, late chief coiner of the United States Mint, Philadelphia. It has a hand and index, and the crank on the hand arbor is the means of giving the *set* to the rolls, while the hand indicates their relative distance. See REGISTER.

In the British and French departments at the French Exposition were exhibited armor-plates for ships originally rolled from 20 to 30 feet in length, from 3 to 6 feet in breadth, and from 8 to 13 inches in thickness.

An armor-plate was rolled at the "Atlas Works," Sheffield, England, in 1862, 20 × 4 feet, and a thickness of 15 inches. The operation was thus described by a spectator: —

The plate, when laid in the furnace, rests upon little stacks of fire-bricks, so that the flame and heat play equally round it, till all is glowing white and the successive layers have settled down into one dense mass. At a signal from the furnace-man, the bands of workmen, to the number of about 60, arranged themselves on each side of the furnace, as near to it as they could bear the heat. Then the doors were opened to their fullest, and in the midst of the great light lay a mass even whiter than the rest. To this some half a dozen men drew near. They were all attired in thin steel leggings, aprons of steel, and a thin curtain of steel wire-work dropping over their faces like a large, long visor. All the rest of their bodies were muffled in thick, wet sacking. Thus protected they managed, with the aid of a gigantic pair of forceps slung from a crane above, to

work, as it were, amid the flames for a few seconds, and to nip the huge plate with the forceps. The signal was then given, and the whole mass of iron, fizzing, sparkling, and shooting out jets of lambent flame, was, by the main force of chains attached to the steam rollers, drawn forth from the furnace on to a long wrought-iron car. The heat and light which it then diffused were almost unbearable in any part of the huge mill, but the men seemed to vie with each other to approach and detach the colossal pinchers which had drawn the iron forth. More than a dozen attempts were made on this occasion before this was effected, and more than a dozen of the best and most skillful workmen were driven back one after another by the tremendous heat and glare. At last all was made clear. The forceps, then red-hot from their grip of the plate, were drawn away, the chains cleared from the rollers, and, with a great hurrah, the other workmen seized the chains attached to the iron truck and drew it to the incline by main force, where it was left by its own weight to run into the jaws of the rolling-mill. It was then *sauve qui peut* among the workmen, who rushed for shelter in all directions as the mass was nipped between the rollers and wound rapidly in amid quick reports like those of dull musketry, as the melted iron was squeezed by the tremendous pressure out of the mass, and flew out in jets of liquid fire on all sides. The turning of the rollers crushes the plate through to the other side, where it rests for a minute on a wrought-iron truck similar to that on which it was brought from the furnace. The action of the rollers is then reversed after they have been, by the action of screw levers, brought closer together by about an inch. These again nip the plate and drag it back in an opposite direction, and again and again does the mass go forward and backward, each time passing between a smaller space between the rollers, till the whole of the huge thickness is reduced to a compact mass 15 inches thick in less than a quarter of an hour. During every stage of the process, quantities of fine sand are thrown upon the plate, and this literally takes fire as it touches the flaming surface, and covers it as it melts with a coat of silica, or with a glaze like that of earthenware. After every discharge of sand, and these go on almost incessantly, buckets of water are thrown upon the plate and explode in clouds of scalding steam; and when these are partly dissipated, men rush forward and with wet besoms with handles 20 feet long sweep off whatever little scraps of oxidation may have taken place. Thus, every time the plate passes through the mill the sand is scattered, the water thrown, and the surface swept, and at every roll the chief roller of the establishment runs forward, and, under the shelter of wet cloths, measures with a gage its thickness from end to end. The required dimensions were obtained by less than a quarter of an hour's rolling, and a plate 15 inches thick, the product of the labor of nearly 200 men and of the consumption of nearly 250 tons of coal, was shot out by the rolling-mills and left to cool. When this had been effected, two large rollers of iron, each weighing 15 tons, were placed upon it by the cranes, and moved slowly backward and forward; and eventually, as the plate cooled, were left upon its ends to keep the whole perfectly level. Nothing farther now remained in order to complete it as the finest specimen of armor-plate manufacture ever attempted but to plane off its rough ends and edges. The flat surfaces on either side, which form what is called the skin of the plate, are never interfered with, for the action of the steel rollers leaves them literally almost as smooth as plate-glass.

Several devices for making the rolling of bars more continuous in point of time have been suggested, and one of them used, the *three-high train*, in which the iron is passed between the upper and middle roll, then back between the middle and lower one, and so on. A series of six rolls in the same vertical series has been proposed, so that the bar might have five passages without much loss of time.

The other proposition was to set the rolls in parallel rows, so that the iron would pass from one set to another, preserving the same line of motion through as many as might be necessary to produce the grade of bar required.

The *three-high* train has three rolls in vertical order, affording two sets of *passes*, one between the upper and middle roller, the other set between the middle and the lower roller, as seen at Figs. 4412, 4416. It is designed to enable the metal to be passed in each direction, rolling at each passage. Fig. 4412 shows the three-high feature, and also the mode of bringing a bar gradually to form by sending it through passes of a shape gradually approximating that required. The triple flange is gradually educed, as may be seen by tracing the shape from the square bar in Fig. 1, through that series, and then through the series in Fig. 2.

Reversing-mills are generally employed in Great Britain in preference to three-high rolls. In France, three-high trains have been in use for rolling girders since the year 1849, and everywhere upon the Continent of Europe the principle seems to be perfectly well understood; but the reversing-mill is generally preferred.

Fig. 4413 is an arrangement of rolls for rolling taper tubes or rods. Each of a pair of rolls has a spiral groove of variable depth, and of half-round section, turned on it. The groove in one roll is a right-handed, and that in the other a left-handed spiral, as shown in the engraving; and when the rolls are placed together and geared, so as to revolve in union, the grooves form a series of eyes, which, as the rolls revolve, appear to move laterally and gradually decrease in size. Thus, if a bar or tapered strip of iron, bent so as to approximately form a tube, be introduced between the rolls at that end where the grooves are largest and deepest, it will be gradually shifted toward the other end of the rolls as it passes between the latter, and will thus be rolled taper.

Fig. 4412.

Fig. 1.

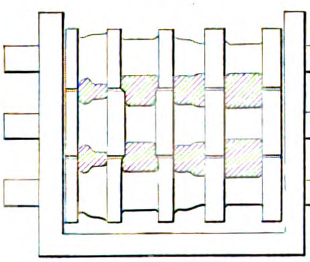
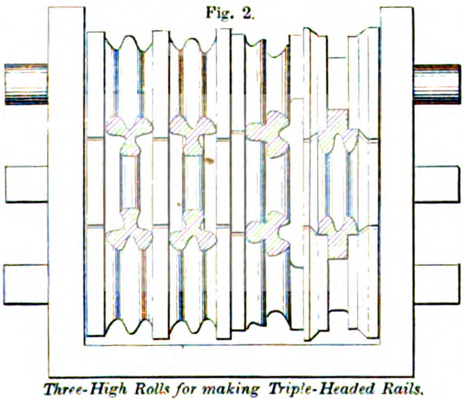
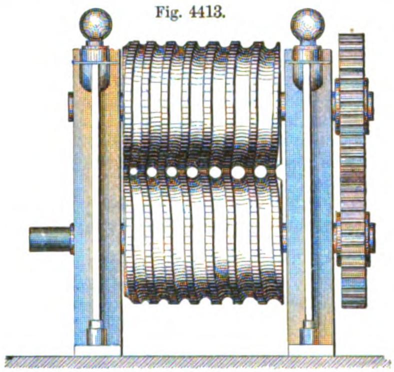


Fig. 2.



Three-High Rolls for making Triple-Headed Rails.

Fig. 4413.



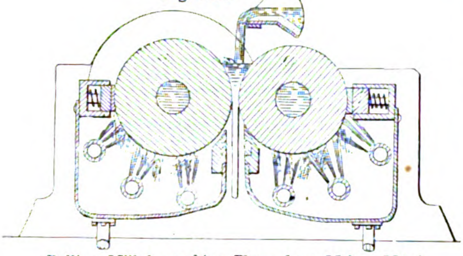
Spiral-Groove Rolls.

A mill adapted to sheet-iron or sheet-lead has a platform like that of a wood-planing machine, except that it has rollers to enable the sheet-lead to travel with less friction, and thus prevent buckling.

Fig. 4414 shows Bessemer's plan, intended to make the plates or sheets of metal directly from fluid iron or steel as it comes from the furnace. The metal is allowed to flow from the ladle or furnace into the space between two rollers, the said rollers being provided with openings in their centers for the circulation of water. The external surfaces of the rollers are cooled by jets of water.

The same plan was attempted many years ago by Chance of Birmingham, England, for making plate-glass. It was abandoned.

Fig. 4414.



Rolling-Mill for making Plates from Molten Metal.

Owens's (Rotherham, England) method of making tires, etc., consists in bending a rod or rods of iron around a block, so as to form a coil having about ½ the diameter and 2½ or 3 times the depth of the finished tire.

This is brought in a furnace to a full welding heat, and transferred to a die on the anvil of a steam-hammer, whose piston carries a similar die. By these it is compacted into a homogeneous mass, which is expanded to the proper diameter between two rollers, the upper one of which may be lifted to any required distance from the lower by means of a small hydraulic press. A larger hydraulic press is employed to force the two rolls together in proportion as the diameter of the tire is enlarged. Other rolls, adjustable by hand or automatically, serve as guides to impart a true circular form to the blank.

Different plans have been adopted by others for preparing tire-blanks for the rolling-machine. Krupp's method consists in forging a bar of steel into the form of a compressed hoop, which is then cut down the middle, opened out, and afterward finished in the rollers.

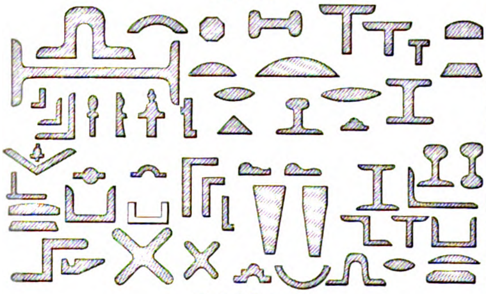
Bessemer forms an ingot of steel and cuts out the central part, so that the annulus left may be enlarged by the rolls.

Naylor and Vickers, of Sheffield, prepare the circular steel blanks by casting.

An exemplification of the nicety to which the rolling of mètal can be carried is shown in the process known as *nature-printing*. A piece of delicate lace is placed on a small sheet of metallic tin, which is then passed once between a pair of steel rolls, the surfaces of the latter being brought in close approximation by means of actuating screws. The pattern of the lace is reproduced with the utmost fidelity on the tin. See NATURE-PRINTING.

Fig. 4415 exhibits some of the many forms which may be imparted to malleable iron by suitable grooves

Fig. 4415



Rolled Irons.

in the rolls composing the train. Each is made by one continuous operation. See also Figs. 2698 and 2699.

Pig-iron is the crude metal from the smelting-furnace, cast into bars or pigs.

The term bar-iron is restricted to refined or wrought iron. The bars are *flat*, *square*, *round*, *oval*, *half oval*, or *half round*; *horseshoe* is a fine quality of flat bar-iron; *nail-rod* iron, small square iron of fine quality. *Heavy bands*, *light bands*, and *hoop iron* are thin and comparatively wide bars. *Railroad iron* includes flat and T rails, axles, fish-plates, bolts, chairs, and spikes. Building-iron embraces *beams*, *deck-beams*, *channel-bars*, *T-iron*, and fittings. *Angle-iron* is known as *equal-sided*, *unequal-sided*, *obtuse*, *star*, *sash*, etc. Sheet-iron is divided into *common*, *charcoal*, *galvanized*, and *planished*. *Russia sheet* is a fine quality of planished charcoal iron. See RUSSIA IRON.

Roofing-iron is corrugated or crimped, and is either *galvanized* or *black*; it is numbered according to thickness. *Tank* and *fire-bed iron* are similarly classified. Boiler-plate iron is thicker than the above, that common in the trade varying from $^3/_{16}$ to $^5/_8$ inch.

Weights of Wrought-Iron, Steel, Copper, and Brass Plates soft rolled. (HASWELL.)

Thickness determined by American Gage.

No. of Gage.	Thickness of each Number.	Plates, per Square Foot.			
		Wrought-Iron.	Steel.	Copper.	Brass.
	Inch.	Lbs.	Lbs.	Lbs.	Lbs.
0000	.46	18.4575	18 7036	20.838	19 688
000	.40964	16.4368	16.6559	18.5567	17.5326
00	.3648	14.6376	14.8328	16 5254	15.6134
0	.32486	13.0351	13.2088	14.7162	13 904
1	.2893	11 6082	11.7629	13.1053	12.382
2	.25763	10.3374	10.4752	11.6706	11 0266
3	.22942	9.2055	9.3283	10.3927	9 8192
4	.20431	8.1979	8.3073	9.2552	8.7445
5	.18194	7.3004	7.3977	8 2419	7.787
6	16202	6.5011	6.5878	7.3395	6.9345
7	.14428	5.7892	5.8664	6.5359	6.1752
8	.12849	5.1557	5.2244	5.8206	5.4994
9	.11443	4.5915	4.6527	5.1837	4.8976
10	.10189	4.0884	4.1428	4.6156	4.3609
11	.090742	3 641	3.6896	4.1106	3.8838
12	.080808	3.2424	3.2856	3.6606	3.4586
13	.071961	2.8874	2.9259	3.2598	3.0799
14	.064084	2.5714	2 6057	2.903	2.7428
15	.057068	2 2899	2.3204	2.5852	2.4425
16	.05082	2.0392	2.0664	2.3021	2.1751
17	045257	1.8159	1.8402	2.0501	1 937
18	.040303	1.6172	1.6387	1.8257	1.725
19	.03589	1.44	1.4593	1 6258	1.5361
20	.031961	1.2824	1.2995	1.4478	1.3679
21	.028462	1.142	1.1573	1.2893	1.2182
22	.025347	1.017	1.0306	1.1482	1.0849
23	.022571	.9057	.9177	1.0225	.96604
24	.0201	.8065	.8173	.91053	.86028
25	.0179	.7182	.7278	.81087	.76612
26	.01594	.6396	.6481	.72208	.68223
27	.014195	.5696	. 772	.64303	.60755
28	.012641	.5072	.514	.57264	.54103
29	.011257	.4517	.4577	.50994	.4818
30	.010025	.4023	.4076	.45413	.42907
31	.008928	.3582	.363	.40444	.38212
32	.00795	.319	.3232	.36014	.34026
33	.00708	.2841	.2879	.32072	.30302
34	.006304	.2529	.2563	.28557	.26981
35	.005614	.2253	.2283	.25431	.24028
36	.005	.2006	.2033	.2265	.214
37	.004453	.1787	.181	.20172	.19059
38	.003965	.1591	.1612	.17961	.1697
39	.003531	.1417	.1436	.15995	.15113
40	003144	.1261	.1278	.14242	.13456
Specific gravities		7.704	7.806	8.698	8.218
Weights of a cubic foot (lbs.).		481.25	487.75	543.6	513.6
Weights of a cubic inch (lbs.).		.2787	.2823	.3146	.2972

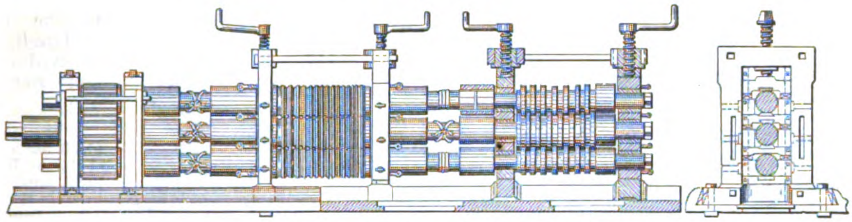
Roll'ing-mill Train. The system of grooved rollers by which iron bars are gradually drawn down from balls or blooms.

The rolls in Fig. 4416 are arranged in series of three each, each having grooves corresponding to those in the roller above or below it. The rough bar is drawn through the largest first and then through the next smaller, and so on in succession to the smallest, by which the finished bar is completed.

The grooves are of such sections as to form square, round, T, or other angle iron, and are known as *passes*.

Fig. 4417, *a a'* and *b b'* are two-high grooved rolls made of chilled cast-iron. The former are designed for rolling flat and the latter square bars. Nuts *c c'* regulate the distance of the rolls from each other, and the tubes *d d'* serve to convey water for cooling

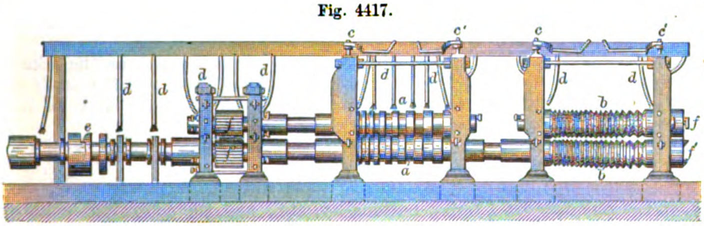
Fig. 4416



Three-High Rolling-Mill Train for Merchant Bar.

the machinery. By means of the coupling *e*, the rolls are put in or out of gear with the motor which, through the medium of the gears *f f'*, causes the upper and lower rolls to rotate in opposite directions.

Fig. 4417.



Rolling-Mill Train.

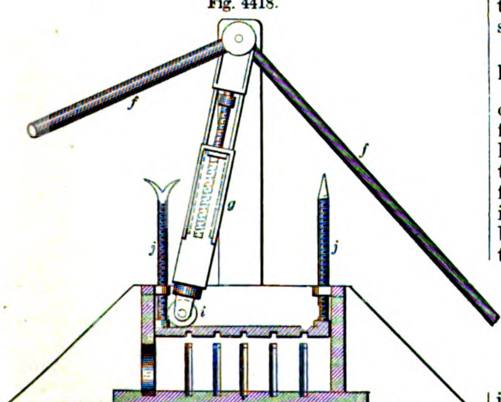
Roll'ing-pen'du-lum. A cylinder caused to oscillate in small excursions on a horizontal plane. It was designed as a time-measurer, but appears to have answered no practical purpose.

Roll'ing-pin. (*Domestic.*) A wooden cylinder having a projecting handle at each end, by which dough is rolled into sheets suitable for pie-crust, etc.

Roll'ing-press. 1. (*Printing.*) The copperplate printing-press in which the plate and bed pass beneath a roller by means of rotation applied to the latter. A certain degree of elasticity is afforded by a sheet or two of paper between the plate and the bed and a number of blankets on the roller. See COPPERPLATE PRINTING-PRESS.

2. (*Bookbinding.*) A machine for smoothing and condensing the leaves of books as a substitute for hammering. It usually consists of a pair of iron rollers turned by a crank, and having a table at each side for the feeding and delivery of the packets between plates.

Fig. 4418.



Rolling-Pressure Baling-Press.

Roll'ing-press'ure Press. A baling-press in which the follower is depressed by the pressure of the roller *i* at the end of the extension-bar *g*, which traverses to and fro, as rocked by the levers *f f*. The downward position of the follower is sustained by screws *j j*.

Roll'ing-stock. (*Railway.*) The cars of all descriptions which traverse the rails of a railway. See LOCOMOTIVE; RAILWAY-CAR. See also list and general index under RAILWAY ENGINEERING and PLANT.

The return of railway rolling-stock, as given in "Poor's Manual" for 1874, 1875, on the roads of the United States and Canada, is as follows: —

Passenger-cars of all classes	2,990
Baggage, mail, and express cars	4,157
Box, merchandise, and house cars	87,009
Platform, gondola, and flat cars	52,198
Stock-cars	14,222
Coal-cars (number of wheels not stated)	66,887
Four-wheel cars (mostly coal)	37,892
Caboose-cars	1,549
Oil-cars	3,154
Ore-cars	2,102
Lumber-cars	193
Freight-cars not classified	94,694
Total	373,959
Locomotive engines	14,939

Deducting from these aggregates 774 engines and 13,980 cars of all classes, as returned by the Canada roads, leaves for the roads in the United States a total of 14,165 engines and 359,979 cars, exclusive of what are denominated service-cars, and exclusive of narrow-gage cars.

Roll'ing-tack'le. (*Nautical.*) A tackle which keeps a yard over to leeward when the ship rolls to windward. It is hooked to the weather quarter of the yard, and to a lashing on the mast near the slings.

Roll-joint. A sheet-metal joint in which the parts are rolled upon one another and pressed tight.

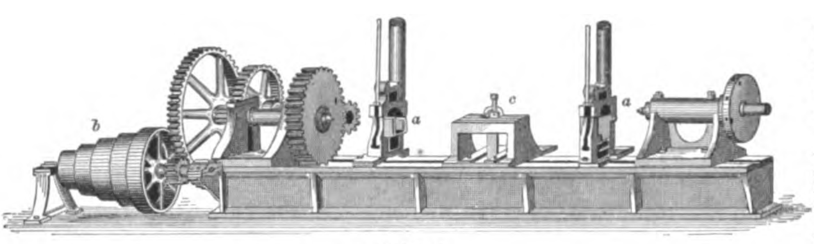
Roll-lathe. (*Machinery.*) A lathe for turning off rolls for rolling-mills, calendering-machines, and for other purposes. In Fig. 4419, it is shown as having a pair of rests *a a*, in which the journals of the heavy iron roll rest, so as to take the weight from off the centers. The mandrel of the head-stock is driven by the usual slow-speed gearing from the band-pulley *b*. *c* is the slide-rest which carries the tool.

Roll-mold'ing. (*Architecture.*) A molding used in Gothic architecture, the upper half of which extends over the lower half, as if it were formed of a thick substance rolled up.

Rom'al. (*Fabric.*) An Indian silk.

Ro'man Bal'ance. An instrument for weighing, consisting of a lever having arms of unequal weight on the respective sides of its point of suspen-

Fig 4419.



Roll-Lathe.

sion, and a *bob* which traverses the longer, graduated limb. See STEELYARD.

Ro'man-can'dle. (*Pyrotechny.*) *a.* A tube (an old gun-barrel sawn off short is best) is partially filled with alternating perforated stars and small charges of gunpowder. Fire communicated to the upper end ignites the charges successively, which throw out the stars until all are discharged.

b. A similar firework in paper tube.

Ro'man-cem'ent. A kind of cement originated about 1812, by Parker, of London. The term "Roman" is a misnomer. Septaria — nodules of indurated clay with lime and iron — are burned, ground, and mixed into a mortar with lime and sand. It hardens very quickly, and is very durable. See POZZUOLANA; HYDRAULIC CEMENT; CEMENT.

Ron'dle. (*Metal-working.*) A round plate or disk. The term is applied to the crust or scale which forms upon the surface of molten metal in cooling, and which is removed from the crucible or cistern from time to time as it congeals, in order to obtain the metal in a form suitable for farther treatment instead of in a solid mass. Spelled also *rondelle.* Copper thus treated is known as *rose copper*, from its red color, and the disks are known as *rosettes;* they are again refined to restore or acquire malleability by the reduction of the suboxide of copper.

Ron-geant' Style. A mode of calico-printing. See DISCHARGE-STYLE.

Rood-loft. (*Architecture.*) A gallery over the entrance to the choir in medieval churches, at the front of which a large *rood* or crucifix was usually placed.

Roof. 1. (*Architecture.*) The uppermost member of a building. It consists of the *framework* and the *covering.*

The following table shows the structure, flattest ordinary slope, and weight in pounds per square foot of several kinds of roofs: —

Material.	Flattest ordinary Slope.	Weight in lbs. per sq. foot.
Sheet-copper, .022 inch thick..	4°	1.00
Sheet-lead	4°	7.00
Sheet-zinc (average)	4°	1.50
Sheet-iron, $\frac{1}{16}$ inch, plain......	4°	3.00
Sheet-iron, $\frac{1}{16}$ inch, corrugated	4°	3.40
Cast-iron plates, $\frac{3}{8}$ inch........	4°	15.00
Slates	30° to 22½°	5.00 to 11.20
Tiles	30° to 22½°	6.50 to 17.80
Boarding, $\frac{3}{4}$ inch thick.........	22½°	2.50
Thatch	45°	6.50
For the extra timbering of slated and tiled roofs, add........		6.00
For the pressure of the wind, add		40.00

The *span* is the width between supports.

The *rise* is the hight in the center above the level of the supports.

The *pitch* is the slope of the rafters. It is expressed in many ways: —

1. The *angle* which it forms with the horizontal; expressed in degrees.

2. By a name which indicates to the expert conformity with received models and standards, as, —

a. Grecian pitch, which has an angle of 12° to 16°, or a hight equal to $\frac{1}{9}$ to $\frac{1}{7}$ of the span.

b. Roman pitch, which has an angle of 23° or 24°; or a hight equal to $\frac{1}{5}$ to $\frac{2}{9}$ of the span.

c. Gothic pitch, which is equilateral, the rafters being equal to the span.

d. Elizabethan pitch, the rafters longer than the span.

3. By the hight in parts of the span, as *quarter*, *fifth*, *whole*, etc.

4. By the length of the rafters in parts of the span, as *two thirds*, *three quarters*, etc.

Pitch varies between the *knife-edge*, as the Elizabethan is sometimes called, and the flat *leads* in which the slope is only sufficient to carry off the water.

Common pitch, so called, has a rafter $\frac{3}{4}$ of the span. See PITCH.

The names of roofs indicate form, structure, material, nationality, etc., and the following includes the principal varieties. Some of the names are synonyms: —

Compass-roof.	Imperial roof.
Composed roof.	Killessed roof.
Crib-roof.	King-post roof.
Crown-plate roof.	Lean-to roof.
Curb-roof.	Mansard-roof.
False roof.	Pavilion-roof.
Flat roof.	Pent-roof.
French roof.	Platform-roof.
Gabled roof.	Pointed roof.
Gothic roof.	Queen-post roof.
Gravel roof.	Ridged roof.
Grecian roof.	Saddle-roof.
Ground-roof.	Shed-roof.
Half-hip roof.	Span-roof.
High roof.	Tin roof.
Hip-roof.	Truncated roof.

The early Gothic architects endeavored, as far as possible, to dispense with wood by the employment of stone vaulting, and it is not until the reign of Edward III., 1327, that timber-framed roofs became common in large constructions. They began to be common in churches about the year 1400, and from that time to the present, wood, though now to some extent supplanted by iron, has maintained a preëminence as a roofing material.

The simplest form of roof (1) consists merely of inclined rafters *a b*, butting at their upper ends; to keep their lower ends in place, however, a fixed bearing of some kind is necessary. For this purpose the tie-beam *c* (2) is introduced, into which the lower ends of the rafters are mortised.

To stiffen the truss thus formed, and to support the middle of the tie-beam so as to prevent its sagging at the center, the king-post *d* (3) is added; this is formed from a large piece of timber, partially cut away for the greater portion of its length, so as to leave a projection on either side at top forming the *joggles*, against whose under surfaces the rafters rest, and two shoulders toward the bottom against which struts *e* (4) supporting the rafters bear.

The lower end of the king-post may be mortised into the tie-beam, but is preferably connected with it by an iron strap passing round the tie-beam and secured to the post. The ends of the tie-beam are immediately supported by the walls of the building. Thus it will be seen that the tie-beam supports the rafters, and keeps their feet from spreading apart; that the rafters support the king-post and through it the center of the tie-beam; and that the king-post, in its turn, through the medium of the struts, helps to sustain the rafters.

5, 6 are two forms of flat-topped roof. In the first, the tie-beam is supported at two points by the side posts *f f*; these depend from the truss-beam *g*, against which the upper ends of the rafters rest. This construction is not so stable as the following, in which the lower ends of the side posts are united by straps which also serve to connect them with the tie-beam.

7 is a queen-post roof. The rafters are sustained at dif-

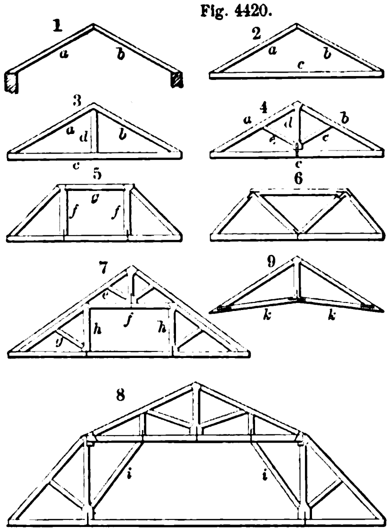
ferent points by the struts *e*, straining-beam *f*, and braces *g*; the straining-beam depends from the central post against which the ends of the rafters abut, and the queen-posts *h h* support the tie-beam on either side of the center, as in the first form of flat-topped roof. See also QUEEN-POST ROOF.

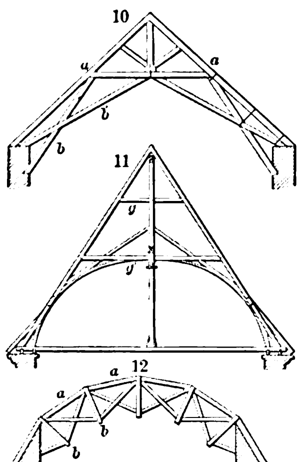
It is not usual, except in the smallest and cheapest constructions, to fasten the boarding to which the roof covering, whether shingles, tiles, or slates, is nailed, directly on the main rafters.

These are coupled at intervals of 8 or 10 feet, and have transverse pieces, called purlins, let into them to support the common rafters, placed at closer intervals, to which the boarding is fastened. See Fig. 2754, *C*.

The mansard-roof (8) has two sets of rafters, the upper set

Fig. 4420.





Roofs.

having a less inclination than the lower. The latter brace the upper ends of the queen or side posts, which, by means of the struts *i i*, assist in supporting the straining-beam; this depends from the upper pair of rafters by a center post and side posts; the upper rafters are braced by struts from the center post.

In the arched roof (9) two stretchers or hammer-beams *k k* are substituted for the tie-beam. These are held partly by their pressure against each other and partly by the king or center post, and are tied to the feet of the rafters.

10 illustrates the roof-framing of the circus at Edinburgh. It will be seen that the downward pressure is distributed upon the rafters *a a* and stretchers *b b′*, which are so tied together by straps as to bring the stress of the outward thrust ultimately upon *b*.

11 covers the principal apartment of the Episcopal Palace at Auxerre, France. Two sets of stays *g g′* are inserted above the tie-beam, between the king-post and principal rafters; a series of curved ribs receives the ceiling plank

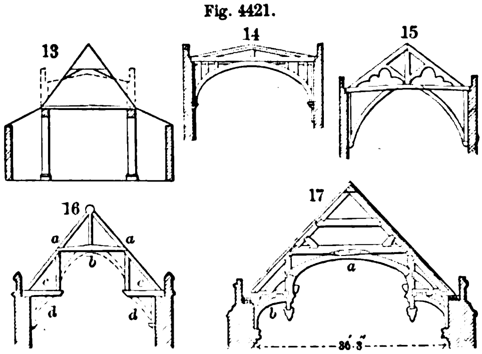
12 is a Norman roof; so called because it was introduced by that people into Southern Europe. The rafters *a a* butt against joggles on the king-posts *b b*, between which braces are disposed.

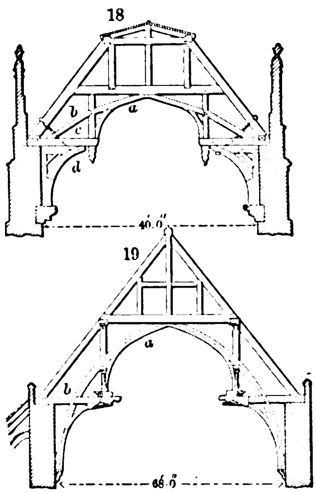
13 shows in dotted lines a way by which a pointed Gothic roof was converted into a flat roof by carrying the nave walls up so as to obtain a clere-story.

In 14, the tie-beam is supported at the center by struts from the main beam. A post resting on the tie-beam supports the rafters at the ridge.

15 resembles in appearance a king-post roof, but is in fact supported by the girders, which perform the office of a tie-beam, and are themselves sustained by wall-posts, so as to distribute

Fig. 4421.





Roofs.

the pressure over a considerable surface at the upper part of the wall.

16 is a form of roof common in Gothic constructions. The principals *a a* are connected by a *collar-beam* or *wind-beam b*, and are supported by *hammer-beams c c* resting on the walls and on curved struts *d d* attached to posts supported by corbeling. Auxiliary struts are introduced between the collar-beam and queen-posts, the whole being so disposed as to produce the effect of a vaulted ceiling. In the roof of the hall at Eltham Palace, Kent (17), the whole weight is thrown on the top of the wall; the bottom pieces *b* are merely ornamental, the tension-pieces *a* forming a complete tie.

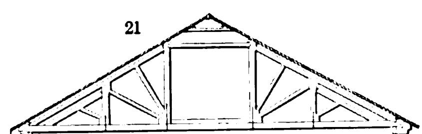
The roof of the great hall at Hampton Court (18) is so arranged that the beams *a b c* serve as ties; the curved struts *d* distribute the pressure over the wall and its sustaining buttress.

In (19) the roof of Westminster Hall, the weight rests entirely on the upper part of the wall; the arched rib *a* distributes the thrust and assists in preventing the hammer-beams *b* from sliding on the walls

Westminster Hall was erected under the orders of William Rufus at the latter end of the eleventh century. It is 274 × 74 feet, without a pillar. The room and the roof are equally admired. William said it was only antechamber to the one he would build; but that arrow of Sir Walter Tyrrel upset this calculation.

21 illustrates a queen-post roof of 80 feet span, covering the theater at Birmingham, England.

Fig. 4422.



Queen-Post Roof, Birmingham Theater, England.

Iron roofs were first used in England, and were the subject of a patent by Robert Ransome, 1783.

They are composed of essentially the same members as those of timber, malleable rods or flat bars

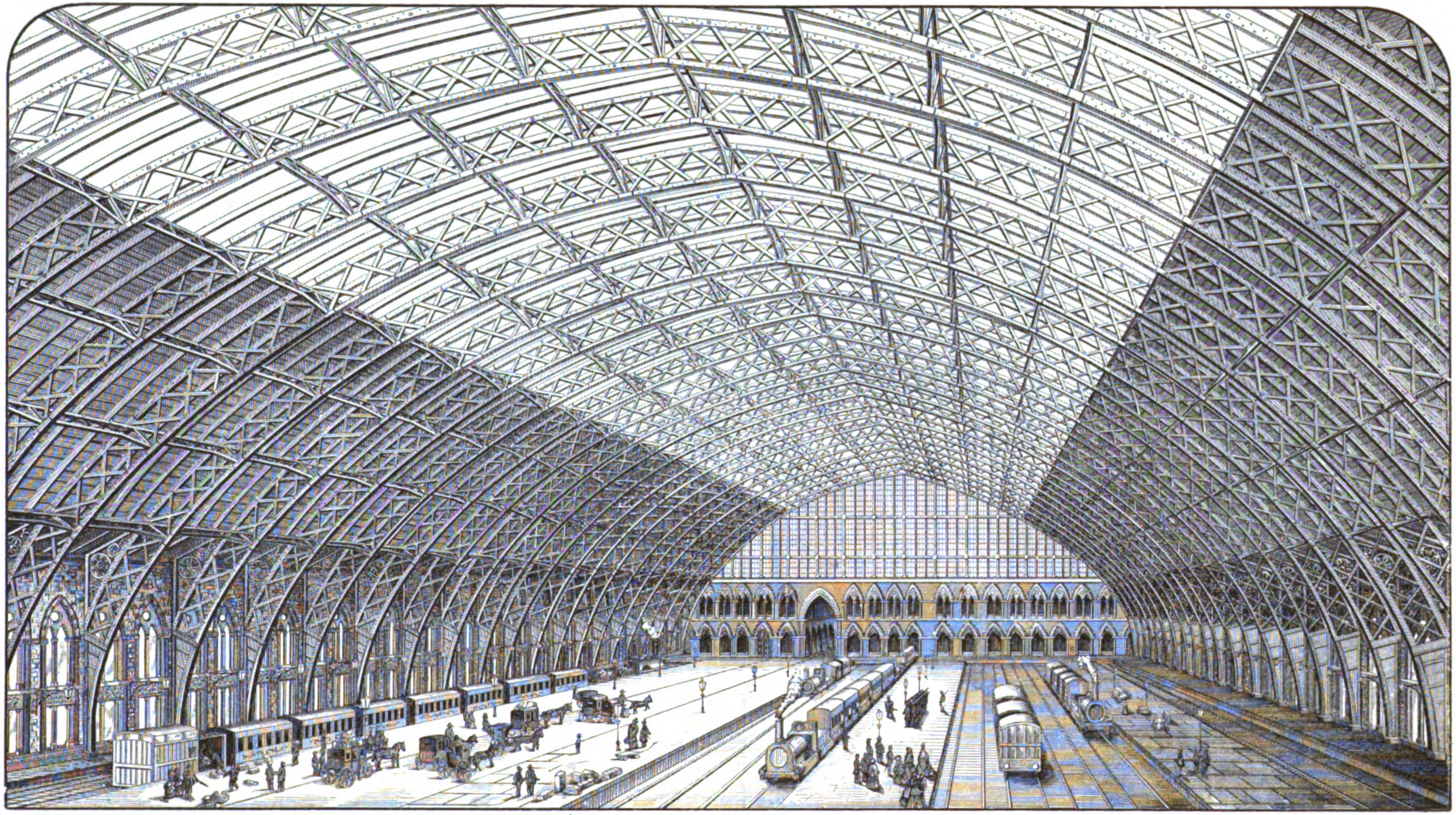


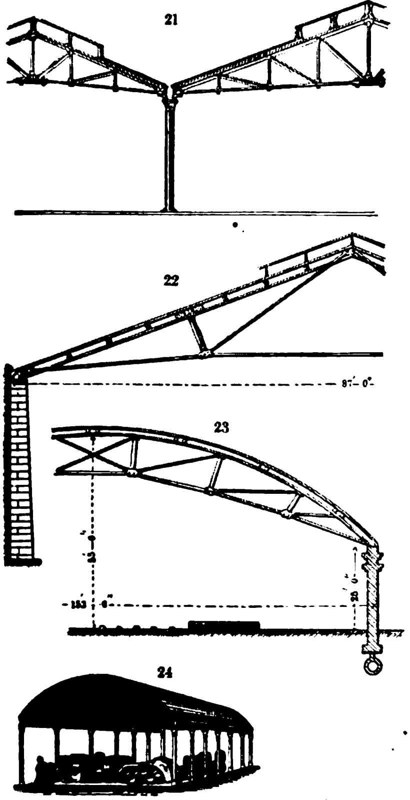
PLATE LII. ROOF OF THE PANCRAS STATION, MIDLAND COUNTIES RAILWAY, LONDON, ENGLAND. *See page 1973.*

being substituted for the tie-beams and king-posts, and the rafters and posts made of sufficient stiffness with bars of malleable L or T iron, or with cast-iron of suitable form and section.

The meeting points of the several parts of each truss are provided with cast-iron shoes, sockets, and connecting plates, into which the ends of the rafters, struts, and rods are secured with screw-bolts and nuts or gibs and keys.

The roof of Smithfield Market, Manchester, is one of the simplest forms (21, Fig. 4423); its total width is 244 feet, covered by two outer spans of 50 and two central spans of 72 feet each, supported on cast-iron pillars.

Fig. 4423.



Iron Roofs.

22 is the roof of the Providence Magazine at Paris. It has 87 feet span. The roof of the railway station in Lime Street, Liverpool (23), has a span of 153 feet 6 inches. 24 is an ordinary freight-depot with iron roof and columns.

The roof of the Pancras Station, Midland Railway, London, has the widest span of any roof, unbroken by ties or braces. It covers ten acres. It is illustrated on the opposite page, Plate LII.

The length of the roof is 690 feet, with a clear span of 240 feet, covering five platforms, ten lines of rails, and a cab-stand 25 feet wide, thus making a total area of 165,600 square feet. Its hight at the ridge is 125 feet above the level of the road. There are twenty-five principal ribs in the roof, each weighing about 50 tons. Between each of these, which are about 29 feet 4 inches apart from center to center, are three intermediate ribs, carried by trussed purlins, constructed so as to stiffen the bottom flanges of the main ribs laterally. The station walls rise behind the spring of the principal, the space at the top being filled in with open iron-work

The roof is glazed about 70 feet on each side of the center, and the remainder is covered with slates on boarding one inch and three eighths thick, grooved and tongued and chambered, the under side being varnished.

The transverse girders which support the floor of the station take the thrust of the roof. They are connected so as to form continuous girders across the station. Besides being tied to them, the feet of the ribs are each secured by four 3-inch bolts to an anchor-plate built into the wall and strongly fastened.

The rail level of the station is about 17½ feet above that of the adjoining streets, thus affording very extensive cellarage. See also Plate III.

Among other kinds of roof-coverings may be cited: —

Metal in sheets, seamed and painted.

Fabric or paper saturated in tar and covered with sand and gravel.

Fabric or paper treated with a material which will resist sun, rain, and frost. Among the compositions for this purpose are the following: —

West, 1855. Gutta-percha; oil.

Billings, 1856. Shellac, 50 pounds; rosin, 120 pounds; linseed-oil, 10 quarts; steatite, 150 pounds.

Smith, 1857. Coal-tar, 21; linseed-oil, 1.

Milks, 1857. Naphtha, 20 gallons; turpentine saturated with asphaltum, 2 gallons; alcohol saturated with shellac, 2 gallons; turpentine saturated with caoutchouc, 2 gallons; linseed-oil, 1½ gallons; steatite, 10 pounds; gypsum, 1 peck.

Lighter and Morrell, 1857. Coal-tar, 1; pine-tar, 50; rosin, 12; caoutchouc, 6; gutta-percha, 6; asphaltum, 12; shellac, 6; linseed-oil, 12; litharge, 6; fire-proof material to be scattered on surface of the above, 12; yellow ocher, 12; beeswax, 3.

Oaks, 1859. Coal-tar, 25 gallons; linseed-oil, 2 gallons; caoutchouc, dissolved, 2 gallons; shellac, dissolved, 2 gallons; asphaltum, 5 pounds; steatite, pulverized, 5 pounds; litharge, 5 pounds; sulp. baryta, 5 pounds; gypsum, 5 pounds.

Grant, 1862. Coal-tar, 25 gallons; linseed-oil, 3 gallons; caoutchouc, dissolved, 3 gallons; shellac, dissolved, 1.5 gallons; asphaltum, dissolved, 2.5 gallons; Japan varnish, 2 gallons; white-lead, 25 pounds; mineral paint, 60 pounds; yellow ocher, 6 pounds; acetate lead, 5 pounds.

Wauzer, 1862. Pitch, 1; quicklime, 2; Ven. red ocher, 2; linseed-oil, 0.5.

Fuller, 1863. Saturated sheets of paper.

Wheeler, 1866. Coal-tar, 20 gallons; linseed-oil, 2 gallons; shellac, 10 pounds; rosin, 4 pounds.

Stead, 1866. Paint-skins, broken up; potash, 2 pounds; water, 1 gallon; linseed-oil, 2 gallons. Boil to evaporate water, and add mineral paint, 10 pounds.

Fields, 1867. Coal-tar, 1 barrel; fire-clay; silicate of iron; silicate of magnesia; linseed-oil, 1 gallon; litharge, 3 pounds.

Hutchings, 1868. Rosin, 1 pound; leached ashes, 1 pound; whiting, 0.5 pound; salt, 0.5 pound; red-lead, 0.12 pound; linseed-oil, 0.12 pound.

Irish, 1868. Gypsum, 10 pounds; water, 1 gallon; linseed-oil, 0.5 pint; white-lead, 0.08 pound; turpentine, 1 ounce.

Hinman, 1868. Coal-tar, 1 barrel; glycerine, 2 gallons; oil, 2 quarts; caoutchouc, dissolved, 3 pints.

Capron, 1868. Coal-tar, 40 gallons; acetate lead, 5 pounds; Japan varnish, 2 gallons; caoutchouc, 4 pounds; shellac, 4 pounds; linseed oil, 2 gallons; turpentine, 2 gallons; alcohol, 2 gallons.

Hutchings, 1869. Rosin, 1 pound; linseed-oil, 0.3 pound; covered by sifted sand, 4 pounds.

Joy, 1869. Coal-tar, 1 barrel; linseed-oil, 3 gallons; compounded with pulverized clay and sand, equal parts.

Dumpleman and Dotch, 1869. Coal-tar, 1 barrel; pine-pitch, 1 barrel; sulphur, 15 gallons; litharge, 2 pounds; pulverized slate, 2 pounds; linseed-oil, 2 gallons.

Fisk, 1869. Linseed-oil, 1; rosin, 5; petroleum, 1; pitch, 5; tar, 5. Mix with gravel, broken stones, or cinders.

Ruttkay, 1870. Linseed-oil; pulverized stone; litharge; chalk.

Ruttkay, 1870. Sifted gravel, 3; pulverized brick, 0.5; litharge, 0.12; linseed-oil, 0.25; Japan varnish, 0.08.

Barnes. Coal-tar, 40 gallons; pulverized slate, 30 gallons; pulverized clay, 10 gallons; boiled rice, 5 pounds; glue, 1 pound; terra de sienna, 1 pound; linseed-oil, 1 gallon. Mix the coal-tar, slate, and clay together. Boil the rice and strain it through a fine sieve, and liquefy the glue by heat. Add the rice, glue, and terra de sienna to the linseed-oil, and incorporate. Apply with a brush or trowel.

See L. W. Sinsabaugh's "Digest of Paving and Roofing Compositions," Washington, 1875.

2. The ceiling of a mine.

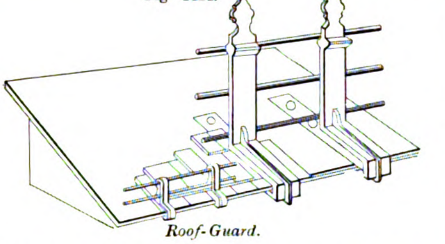
3. The top of a standing-top carriage, coach, or car. The central, raised portion of a car-roof is the *dome*.

4. The arched top of a reverberatory furnace.

Roof-guard. (*Building.*) A device for preventing snow from sliding from a roof. It consists usually of a continuous series of horizontal slats, slightly raised above the roof-cover and supported by uprights. In the example, the frame is attached to the sheathing beneath the shingles and carries horizontal longitudinal bars.

Roof'ing-ma-chine'. One for preparing mate-

Fig. 4424.



Roof-Guard.

rial for roofing purposes; saturating or paying fabric or paper with a water-resisting compound, or preparing metallic plates for roof covering.

Haven, 1857. The sheet is drawn down through a hopper containing tar, and passes out between pressure-rollers.

Davis, 1858. The canvas is drawn through a vat containing coal-tar.

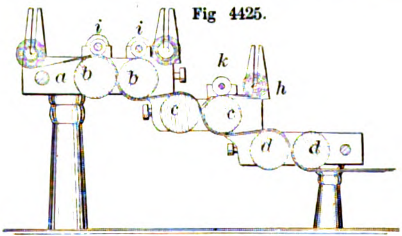
Pomeroy and Allen, 1859.

Anderson, 1861. Steam-pipe to heat composition.

Robinson, 1865. Coat sheets of felt, etc., with asphalt on one side, the other being supported by a roller. Sheets cemented together between pressure-rollers.

Fig. 4425 is a machine for preparing roofing fabric by passing sheets of felt or other material between rollers, the asphalt in a

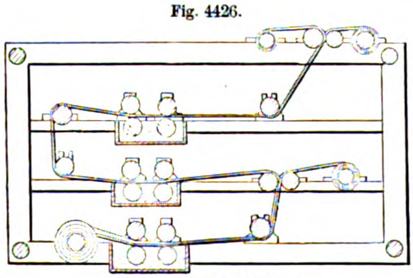
Fig 4425.



Robinson's Roofing-Machine.

plastic state being applied between the sheets as they pass between the rollers. The upper rolls of paper are shown in the holders from which the sheets pass beneath rollers *i i*, and are compacted together with an included thickness of asphalt by the pressure of rollers *b b*. A third sheet of paper comes from roll *h*, passes beneath roller *k*, and is compacted with the former sheets by rollers *c c*. The three-ply roofing-paper receives its final pressure between rollers *d d*. The material used upon the paper is coal-tar, or Trinidad pitch, with 60 per cent of earthy matter, chiefly clay, though lime and sand may be used. Fig.

Fig. 4426.



Roofing-Fabric Machine.

4426 is a modified form in which the strips of paper are tarred, cemented, and pressed together by passage between rollers. The tarring-rollers rotate in fountain-troughs, and raise the contents into contact with the paper.

Pulte, 1866. Hopper and movable gate. Felt drawn over a roller in the bottom of the hopper.

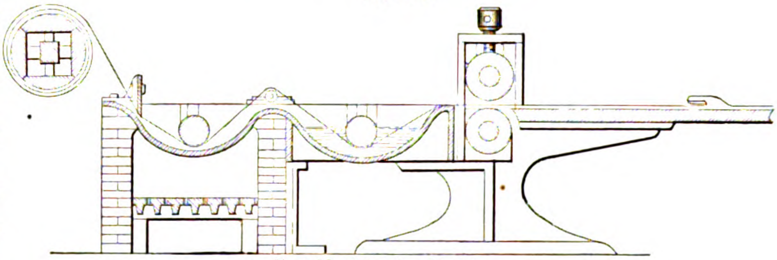
Brown, 1869. Mixing vessel with steam-jacket and beaters. Sand-box and movable apron for carrying along the materials.

Cobb, 1869. Tank, sand and gravel box, and pressure-roller, so as to make the operation on the paper continuous.

Benton, 1869. Felt or paper placed on a bed, and the tar-hopper moved over it, spreading the tar. Sand operation similar.

Fig 4427 is a machine for forming sheet-metal plates into continuous strips for roofing, the strips being afterward joined together on the roof. The ends of sheets or strips of metal are interlocked, and the metal then passed between rollers to close the seams, and then through a bath of molten tin or other soft metal, which coats the surface and closes and covers the

Fig. 4427.



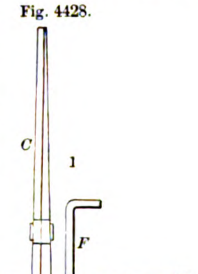
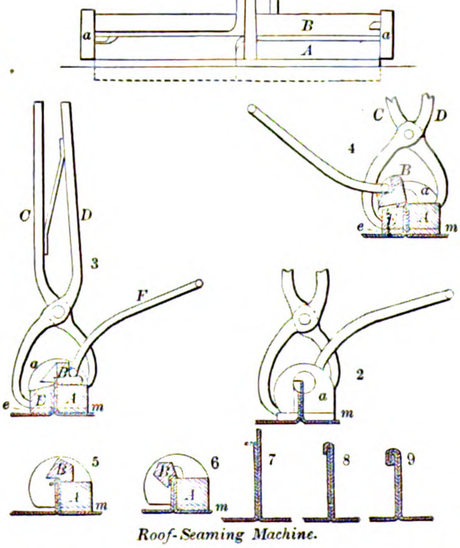
Sheet-Metal Roofing-Machine.

seams, so as to form continuous pieces, of indefinite length, without appreciable or pervious joints.

See also roofing-machines and machines for making roofing. Numbers of patents: —

57,091	113,604
63,873	114,139
75,197	114,174
77,257	116,470
78,014	119,601
83,575	120,153
84,074	121,118
84,205	121,166
91,577	124,794
99,701	123,517
101,478	128,367
104,380	136,022
104,887	

Fig. 4428.

Roof-Seaming Machine.

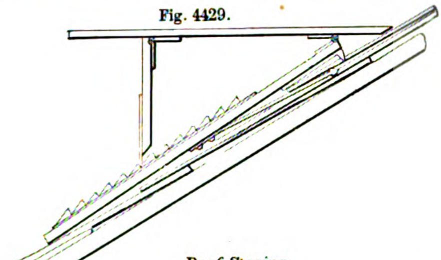
Roof-seam'ing Ma-chine'. A device for unit-

ing the joining edges of sheet-metals in covering roofs.

The double-seaming tool for roof consists of blocks *A E*, which pinch together the upturned edges of the adjacent sheets when the handles *C D* are grasped, as shown in sections 2 and 3 of the figure. By then turning the lever *F*, the block *B*, which is journaled in the ends *a a*, is laid over against the block *E*, carrying with it the taller of the two strips, as shown at 4 and 7. The bending apparatus is then shifted along half its length, and the other part of the block *B* acts upon the bent-over edge of the strip, as shown at 5 and at 8. The sole-pieces *e m* are now taken out, which lowers the blocks *A E*, and the process is repeated, as shown at 6 and 9. See also DOUBLE-SEAMING MACHINES.

Roof-stag'ing. A scaffold for resting upon a slanting roof while shingling, slating, repairing, or painting. The barbed rod is thrust up beneath a course of shingles, and the barbs hold in the course

Fig. 4429.



Roof-Staging.

both above and below. The claw-plate holds to the top of the roof, and serves, with the barbed rod, to hold the plank to which the bracket is hinged and braced.

Roof-truss. The framework of a roof, consisting of thrust and tie pieces. See ROOF.

Rook'er. (*Bakery.*) A tool like the letter L, used for withdrawing ashes from the oven.

Room. (*Mining.*) The worked space in a mine, especially of a coal-mine, where the roof is supported by regular pillars. The whole winning is thus said to be worked with *pillar* and *room*, or *post* and *stall*, — the same thing. *Thirlings* are worked spaces connecting *rooms*, and the cutting of the *thirlings* changes a *wall* to a row of *pillars*.

Room and Space Staff. (*Shipbuilding.*) A long measuring-rod used in spacing and regulating the distances apart of a ship's frames.

Room and space is the distance between the stations of the timber frames which constitute the ribs. It varies from 2 feet 6 inches to 3 feet 9 inches. *Room* is the rib; *space* the distance apart.

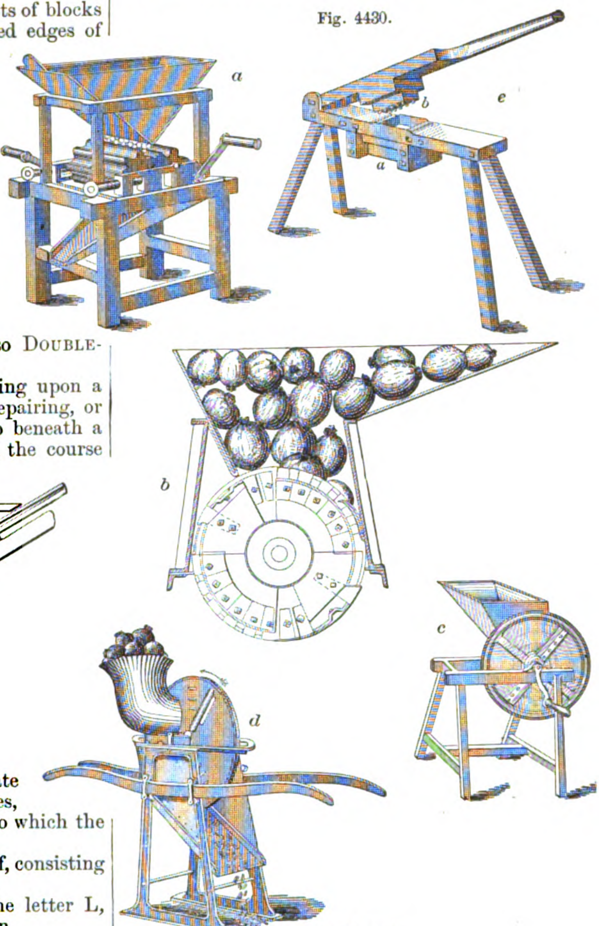
Room-pa'per. Wall-paper. Paper-hangings.

Root. (*Hydraulic Engineering.*) The end of a weir or dam where it unites with the natural bank.

Root-bruis'er. (*Agriculture.*) A machine for mashing or bruising potatoes, turnips, carrots, or other raw roots for feeding stock. The machine *a*, used in Britain, has two widely fluted rollers placed under a hopper and turned by two hand-cranks. The pomace falls into a chute, which delivers it into a tub. The object is to obtain the root in such a shape as to be more digestible and less likely to choke the animals.

The feeding of turnips, mangel-wurtzel, and other roots has become a regular part of the system of British husbandry. To bring the roots to a convenient size for the stock and to remove

Fig. 4430.



Root-Machines.

the danger of choking, root-cutters were introduced. These at first consisted of wheels or reciprocating blades, which cut the root into broad and thin slices; but, by an additional set of knives, these broad slices are cut into pieces about the size of one's finger.

There are three different forms of turnip-cutters in use in Britain. One has knives placed on a disk; another, knives placed on a cylinder; and lastly, knives working through a grating by a crank motion.

In the first form, a series of knives are placed in the face of an iron disk by screws. The turnips are placed in a hopper set at an angle, so that they may press by their own weight against the disk.

The knives are of two kinds; one flat and extending from nearly the axle to the outer edge of the disk, and at a distance from it equal to the thickness the slice of the turnip is required to be.

If only slices are required of the full breadth of the turnip at the part it is cut, then this knife is used by itself; but if it is necessary that the turnip should be cut into sections the cross-way of the cut, as for sheep, then a series of small knives, projecting from the face of the disk at right angles, are placed at distances apart equal to the width required The pieces, after being cut, fall into the receptacle beneath.

Gardner's root-cutter (English), *b*, has curved peripheral knives which remove the slices from the roots in the hopper, and radial knives which give preliminary gashes in the roots before the curved knives reach them, so that the slices removed by the latter fall into pieces and drop into the basket below. The illustration shows two of the peripheral knives, each preceded by a set of slitters, which are arranged in a V-form, on the face of the cylinder, so as to come in action in turn.

The knives of the root-slicer *c* are attached to the arms of a

fly-wheel and act upon roots presented at a side opening at the lower part of the hopper. By having two sets of knives, one to *cut into* the root to a certain depth, and the next to *cut off* a slice, the roots are reduced to strips, as in Baird's machine (*d*). The cutter-wheel of this machine is thickened toward the edge, to give it the effect of a fly-wheel. The knives are set to a distance from the face of the disk according to the thickness of the slices required. Each knife is preceded by three or more lancet-pointed studs, which slit the roots in passing and prepare the slices for falling into pieces as soon as they are detached from the root by the radial knives, which are parallel with the disk-wheel.

Where roots are fed upon the ground, a chopper is used to divide the root, to bring it to a more convenient size and a shape less likely to choke cattle.

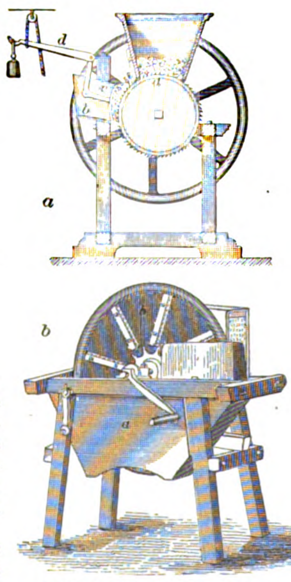
A simple device (*e*) for cutting roots consists of a box *a* with a row of sharp knives in the bottom, their edges presented upwardly. This is secured to a bench, and above it is a pivoted lever having on its lower side a block *b* fitting the box and provided with studs agreeing in position with the openings through which the slices are to be thrust. The roots are fed into the box, and by the descent of the lever are driven out below, being divided by the sharp-grated bottom. See VEGETABLE-CHOPPER; VEGETABLE-SLICER.

Root-dig′ger. (*Agriculture.*) An implement for pulling up fusiform roots, as beets, carrots, etc. The example (Fig. 4431) has jaws, each of which forms part of the semi-frustum of a hollow cone, affording a firm hold on the upper part of the root. See also POTATO-DIGGER.

Fig. 4431

Root-Digger.

Fig. 4432.



Root-Grinder and Root-Pulper.

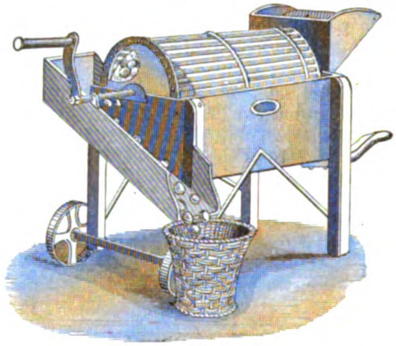
Root-grind′-er. A machine (*a*) for comminuting roots for the purpose of obtaining starch, sugar, or color from them.

Instances of its employment are found in grinding potatoes for starch, beets for sugar, madder for dye. One form of the mill is shown in the cut. The cylinder of sheet-metal (*a*) is punched from the inner surface so as to leave sharp projecting burrs which form teeth. The roots are placed in the hopper above, and are partially grated by the toothed cylinder as they pass from thence through the throat into a box *b*, where they are again subjected to the action of the grating cylinder, against which they are pressed by a follower *c*, which is pushed against them by a bell-crank lever and weighted arm *d*. From this box they are discharged into a trough beneath, for elutriation or pressure, as the case may be.

Root-pulp′er. (*Agriculture.*) A machine (*b*, Fig. 4432) for finely comminuting roots to serve as food for stock. In the example, the roots placed in a hopper *a* are acted on by a series of toothed knives radially arranged on the surface of an iron disk *b*, having a heavy rim which acts as a fly-wheel and is turned by a winch. The angle of the knives may be varied to cut more or less finely.

Root-wash′er. A machine which usually consists of a slatted cylinder revolving in a tank of water. The roots are subjected to mutual attrition and contact with the bars of the cage, so as to loosen the dirt, which settles to the bottom of the tank.

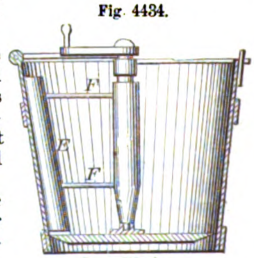
Fig. 4433.



Root-Washer.

A modification of the foregoing is made by an interior spiral chute, which acts on the principle of the conveyor, so that the roots which pass into the cylinder from the hopper at one end are carried along and discharged at the other, the operation being continuous.

Fig. 4434.



Root-Washer.

In another form, the potatoes, etc., are placed in a tube having arms *F F* and a sweep *E* attached to a vertical shaft whose rotation stirs and cleanses the roots.

Rope. A general name applied to cordage over one inch in circumference.

Ropes are of hemp, flax, cotton, coir, or wire, and are known by their construction; as,—

Cable-laid; three strands of *hawser-laid* rope, twisted right hand.

Hawser-laid; three strands of yarn twisted left hand, the yarns being laid up right hand.

Shroud-laid or *four-strand;* having a central strand slightly twisted and three strands twisted around it.

Hemp is laid up *right*-handed into *yarns*.

Yarns are laid up *left*-handed into *strands*.

Three *strands* are laid up *right*-handed into a *hawser*.

Three *hawsers* are laid up *left*-handed into a *cable*.

Coir ropes are made of the fiber of the cocoa-nut, and will float in water.

Wire ropes usually consist of six strands laid or spun around a hempen core; each strand consisting of six wires laid the contrary way around a smaller hempen core.

Sash-line; a rope of plaited yarns.

Ropes are known also by their purpose; as,—

Awning	**Brail.**	**Clew.**	**Entering.**
Bell.	**Breast.**	**Crown.**	**Fall.**
Boat.	**Bucket.**	**Crowfoot.**	**Foot.**
Bolt.	**Buoy.**	**Davit.**	**Gaub.**
Brace.	**Cat.**	**Downhaul.**	**Grab.**

Grapnel.	Keel.	Ring.	Stirrup.
Guest.	Man.	Rudder.	Swab.
Guy.	Mast.	Safety.	Tiller.
Halyard.	Messenger.	Sash.	Top.
Head.	Outhaul.	Sheet.	Tye.
Heel.	Painter.	Signal.	Well.
Inhaul.	Parrel.	Slip.	Yard.
Jaw.	Passing.	Spilling.	Yoke.
Jeer.	Pendant.	Stay.	

See also RIGGING.

A rope is —

Whipped, by winding twine around the end to prevent untwisting.

Payed, by painting or tarring to resist wet.

Served, by coiling yarn around it closely and tightly.

Parceled, by wrapping with canvas.

Puddened, by making a bulky cushion around a part to prevent chafing.

Stopped, when lashed; as the *end* to the *standing part* in a *hitch*.

Stoppered, when a rope is made fast to it to prevent veering.

Bent, when it is secured to an object by a hitch or otherwise. *Hitch*, *clinch*, and *knot* are forms of fastening. See KNOT.

Wormed, by laying a smaller rope or yarn in the lays of a cable. It is preliminary to *serving*. *Link-worming* is worming with chains.

Laid, by placing and twisting the twisted strands together in the operation of rope-making.

Grafting and *splicing* are modes of uniting one rope to another by interweaving the strands. See SPLICE.

Seizing and *lashing* are sailors' terms to express respectively the binding of one rope to another by a smaller rope or yarn, and the fastening of one object to another by similar means.

Pointing is a mode of finishing the end of a rope by tapering and braiding the strands.

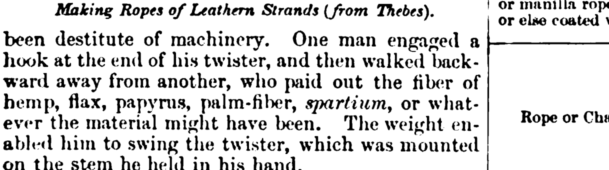
To *marle* a rope is to bind it with spun-yarn or twine, with a knot at each turn, so as to secure the wrapping if cut in one or more places.

Galvanizing is applied to iron-wire rope. It consists in coating the wire or rope with zinc.

Ropes were made of various materials in ancient Egypt, but especially of the papyrus and of leathern strands. The use of the papyrus in this connection has been described by Pliny, and is cited elsewhere in this work, as is also that of the *spartium*, which was employed extensively, though the particular variety was confined to moderate geographical limits. The *spartium* made a coarse article of cordage, as did the *leef* or fibers of the date-tree, which were used for ropes in ancient and in modern Egypt. For a finer article, flax was used. Pieces of ropes of these materials still remain as mementos of the ancient dwellers by the Nile.

The rope-makers of ancient Egypt seem to have

Fig. 4435.



Making Ropes of Leathern Strands (from Thebes).

been destitute of machinery. One man engaged a hook at the end of his twister, and then walked backward away from another, who paid out the fiber of hemp, flax, papyrus, palm-fiber, *spartium*, or whatever the material might have been. The weight enabled him to swing the twister, which was mounted on the stem he held in his hand.

In a tomb at Thebes, of the time of Thothmes III., the Pharaoh of the Exodus, is a group representing the process of twisting thongs of leather, which were fastened to the end of a tube, which revolved on a cord slung around the loins of a man who receded backwardly from the person who arranged and payed out the strands. The tube had, in all probability, a collar or sleeve which was grasped by the man, and had a bar and weight which caused it to rotate as it was swung around by the operator. The strands of the rope passed between the legs of the stool and between the feet of the man who arranged the strands and kept them from becoming entangled. The character of the material is indicated in the manner which is so peculiarly Egyptian, by the skin hanging up in the shop, and a man is shown cutting a continuous thong with a knife like our modern leather-knife, and by the same means which we adopt, by turning the piece of leather round as he cuts. Two of the coils are represented hanging up in the shop.

The process of preparing the hemp is shown in the tombs of Beni-Hassan and Thebes. Ropes of the palm are found in the tombs, and it was probably almost as common as *coir* or cocoa-nut fiber in India.

The ropes which supported the planks of the Hellespont bridge constructed for Xerxes were of papyrus and flax. These were the ordinary materials for the purpose in Egypt, from which country the king had a large contingent. See MILITARY-BRIDGE.

Ropes of goat's hair are mentioned by Aristotle and Virgil.

The famous vessel, the "Syracusia," built for Hiero, was furnished with hempen ropes from Rhodes, according to Moschion.

"The ropes of the Tartars are made of camel's hair or horse-hair." — Huc.

Coir rope is manufactured from the husk or pericarp of the cocoa-nut.

The nuts are picked a little before the fruit is ripe, and the rind separated by thrusting it upon an iron stake fixed in the ground. The rind is then water-soaked for several months, to separate the fibers from the interstitial matter, is beaten with a heavy mallet upon a stone, and then rubbed by the hands to rid it of the cellular substance. 40 cocoa-nuts yield 6 pounds of coir, which is twisted into yarns and made into mats or cordage.

Coir rope is more buoyant than hempen, and is an excellent material for hawsers.

Its strength, relatively to hemp, is, for large ropes, 87 to 108; for small ones, 60 to 65. It is not injured by sea-water, and is much used for running rigging, though from its contractibility it is not so suitable for standing rigging.

Wire rope appears to have been first used in the silver-mines of the Hartz Mountains, about 1831. They have since come into very general use for ships' rigging, as well as for transmitting power in other situations. Some ropes of this kind employed in the underground levels of the English coal-mines probably have a length of more than 3,000 feet. One constructed at the works of John A. Roebling, a few years ago, was said to be the longest, largest, and weightiest wire-rope ever made in one piece. It is 3,700 feet in length; its diameter is over 2¼ inches, and its weight some 20 tons. The machinery employed is said to be capable of making a rope twice as long and large as this one. The rope is used upon an inclined plane, for the purpose of raising coal out of the Wyoming Valley. See WIRE ROPE.

Various processes have been patented for making wire rope. For some purposes, untwisted wires bound together by hempen cord or inserted within canvas have been employed. More generally, however, a slight twist is imparted, and they are formed into strands, which are afterward laid up in a manner analogous to that used in making hempen or manilla ropes. The wires are galvanized, or rather zincked, or else coated with a preservative composition.

Rope or Chain.	Dimensions.	Multiplier for proof of strength.	Multiplier for weight of 100 fathoms.	Proof-strength in fathoms of rope or chain.
Hempen Rope.	Inches	Tons.	Tons.	
Hawser-laid	Girth squared	0.1875	0.0103	1,820
Shroud-laid	Girth squared	0.15	0.01	1,500
Cable-laid.........	Girth squared	0.12	0.0096	1,250
Wire Rope (36 *wires*).				
Iron..............	Girth squared	0.75	0.039	1,923
Steel.............	Girth squared	1.125	0.04	2,812
Rigging Chain....	Diameter of rod	12.00	2.9	414

The preceding are the ordinary rules for calculating the *proof* strength and weights of ropes and chains, in English tons (2,240 pounds); the dimensions being in inches.

The *breaking* load is from two to three times the above.

The old rope-makers' rule for hempen rope was to square the girth of the rope in inches, which, multiplied by 4, gave the ultimate or breaking strength of the rope in hundred weights; and it was a good rule for small cordage up to 7 inches in circumference.

The square of half the circumference was considered to represent the weight of a fathom in pounds.

What is believed to be the longest rope in the world is a grapnel rope, 10,000 fathoms long without a splice, and has been made for the Siemens Telegraph Company. It is made of three strands, the diameter of the completed rope being 2 inches.

The table below shows the comparative strength of various kinds of rope and chain, the sizes on each horizontal line being of equal strength.

Capacity of the Ropes and Chains.		Round Iron Wire Rope.		Round Steel Wire Rope.		Round Hemp Rope.		Flat Iron Wire Rope.		Flat Steel Wire-Rope.		Iron Chain.	
Working Load.	Breaking Strength.	Circumference.	Weight 100 feet.	Circumference.	Weight 100 feet.	Circumference.	Weight 100 feet.	Size.	Weight 100 feet.	Size.	Weight 100 feet.	Diameter of Link.	Weight 100 feet.
Lbs.	Tons	Inch.	Lbs.	Inch.	Lbs.	Inch.	Lbs.	Inches.	Lbs.	Inches.	Lbs.	Inches.	Lbs.
300	1	1	17	...	...	2¾	33	......	...	......	...	¼	66
550	1½	1¼	23	...	...	3	50	......	...	......	...	5/16	92
800	2½	1½	28	1	17	3¼	55	......	...	......	...	⅜	133
1,500	4¼	1¾	43	1¼	28	4¼	78	......	...	......	...	7/16	183
2,000	6	2	65	1⅜	36	5	100	......	...	......	...	½	260
2,500	7½	2¼	86	1½	45	6	160	......	...	......	...	9/16	300
3,300	10	2½	108	2	65	6½	166	......	...	......	...	......	...
4,200	12½	2¾	124	2⅛	75	7	200	2 × ⅜	132	......	...	⅝	400
5,000	15	3	140	2¼	86	7½	234	2¼ × ⅜	154	......	...	11/16	460
6,000	18	3¼	158	2⅜	97	7¾	250	2½ × ⅜	168	......	...	......	...
7,000	21	3½	180	2½	110	8¼	284	3 × ⅜	220	2 × ⅜	132	¾	533
8,000	24	3¾	200	3	140	9	333	3 × ½	270	2¼ × ⅜	168	13/16	650
9,000	27	4	250	3¼	158	10	433	4 × ⅜	315	2½ × ½	190	⅞	720
10,000	30	4¼	284	3½	180	10½	466	4 × ½	366	3 × ⅜	220	15/16	833
11,000	33	4½	320	3⅝	195	11	500	4½ × ½	390	......	235	1	933
12,000	36	4¾	350	3¾	200	12	567	5 × ½	400	3½ × ⅜	240	......	...
13,500	40	5	380	3⅞	225	13	784	5½ × ½	450	3 × ½	270	1 1/16	1,000
18,000	55	5½	440	4	250	14	900	6 × ½	500	4 × ⅜	300	......	.....
22,000	65	6	540	4¼	280	16	1100	6½ × ½	560	5 × ⅜ 4 × ½	336	......	.....

The winding drums or pulleys for wire ropes should be one hundred times the size of the rope, and round ropes should lead fair on to and fit the groove of the pulleys.

All the ropes of a vessel composing the standing rigging, running rigging, ground tackle, etc., are distinguished by names corresponding to their uses, without reference to the make or size of the rope; thus, the cable of a vessel may be *hawser-laid*, or the hawser *cable-laid*. The following is a list of those technically termed *ropes*: —

Bell-rope; attached to the bell, on which the half-hours are struck.

Bolt-rope; that to which the head-leaches and foot of a sail are sewed.

Breast-rope; a band of canvas, secured at each end to the rigging for supporting the body of the leadsman while heaving the hand-lead.

Bucket-rope; a laniard attached to a bucket for dipping water from alongside.

Buoy-rope: a rope attached to the crown of the anchor, and to a buoy floating on the surface to show the position of the anchor when in the ground.

Clew-rope; a rope attached to the clew of a sail, and leading up forward; used in clewing up the sails for furling, and rousing the clew forward of the bunt.

Crown-rope: used at the corners of the cable tiers to keep the fakes in their places.

Entering or *man rope*: a rope secured at the upper end and hanging down the ship's side by the ladder for persons going up or down to hold on by. Also by the ladders at the hatches. The former may be termed *entering*, the latter *man* ropes.

Foot-rope. *a*. The bolt-rope at the foot of a sail.

b. The rope beneath a yard, or the bowsprit on which the men stand when furling or reefing sail; the former are also called *horses*.

Gaub-rope; a rope extending inboard from each leg of the martingale to secure it.

Grab-rope: used to confine the bunt of a sail in furling.

Guest or *guess rope*: a rope used for towing a boat or vessel.

Guy-rope; used for steadying a purchase, spar, or other similar object. See GUY.

Head-rope; the upper bolt-rope of a square sail

Heel-rope: a rope secured to the heel of a mast or boom to rouse it down, out, or in by, or to lash it.

Jaw-rope; a rope or parral secured to the jaws of a gaff and passed around a mast; it is often provided with rollers to enable it to slide up and down easily.

Man-rope. See *Entering-Rope*.

Mast-rope; a rope used for hoisting and lowering masts.

Parral-rope; a single rope secured at the slings or centers of yards, and passed around the mast. Used only on light yards.

Ring-rope; a rope rove through the ring of the anchor and secured to the end of the cable

Slip-rope: used to suspend the bight of a hawser or cable.

Tiller-rope; a rope connected to the end of the tiller and wound around the barrel of the steering-wheel.

Top-rope: a rope used in swaying up a topmast. It is rove through the top block, hooked in the cap, and through the heel of the topmast.

Yoke-rope: a small rope attached to each end of the yoke by which a boat is steered.

Round-in; to haul upon a rope; generally used with reference to the weather-braces.

Round-up; to haul up; generally applied to the act of hauling up the slack of a rope through its leading block or a tackle, which hangs loose by its fall.

Rouse; to haul or pull together on a rope.

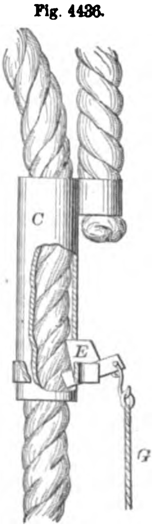
Rope Bridge. Bridges of rope were probably first constructed in China. They are of frequent occurrence among the Andes of South America, where the ropes are made of ox-hide thongs twisted together; two are usually employed, their ends being attached on each side of the chasm; transverse pieces are lashed to them, over which the flooring is laid; in other cases but a single rope is employed; from this a hammock or basket is suspended, and drawn from bank to bank by a rope at each side.

A rope bridge may be made by placing a trestle at the midlength of a set of suspension ropes and laying two or more beams from each bank to this trestle to support the roadway. When a stream is too wide to be spanned by a single length, a mast may be erected in the middle, and steadied by guys from each shore; the ends of the rope are attached to this, and the beams supported by other ropes depending from it. In some cases masts are erected on both banks, and the ends of the suspension-ropes attached to their tops; ropes hanging perpendicularly from these, and other ropes extending diagonally from the masts, support the timbers carrying the roadway; in this case the construction resembles that of a wire bridge. See SUSPENSION-BRIDGE.

In all cases, especially where the structure is of considerable length, guys extending up and down stream should be attached to the bridge at suitable points, particularly at and near the center, to check its vibrations.

Rope-clamp. A device by which a rope is compressed in order to restrain its motion. In the example, the rope passes through the sleeve *C*, and may be checked

Fig. 4436.



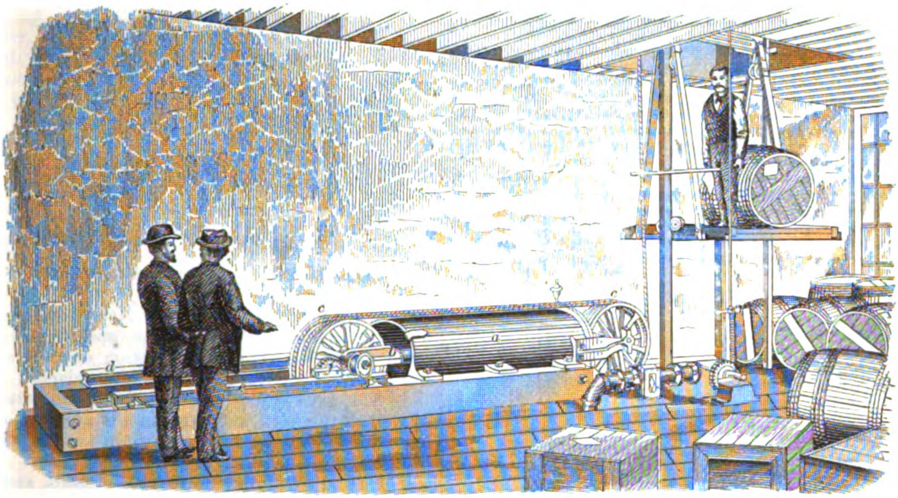
Rope-Clamp.

or held by the pivoted tooth *E*, which is vibrated by the cord *G*. See CABLE-STOPPER.

Rope-clutch. A device for holding fast a rope, consisting usually of two movable jaws, or a movable and fixed jaw, which are caused to nip the rope by pulling a cord, or sometimes by automatic devices. See CABLE-STOPPER.

Rope El'e-va'tor. An elevator in which the platform or cage is raised and lowered by means of a rope and winding mechanism.

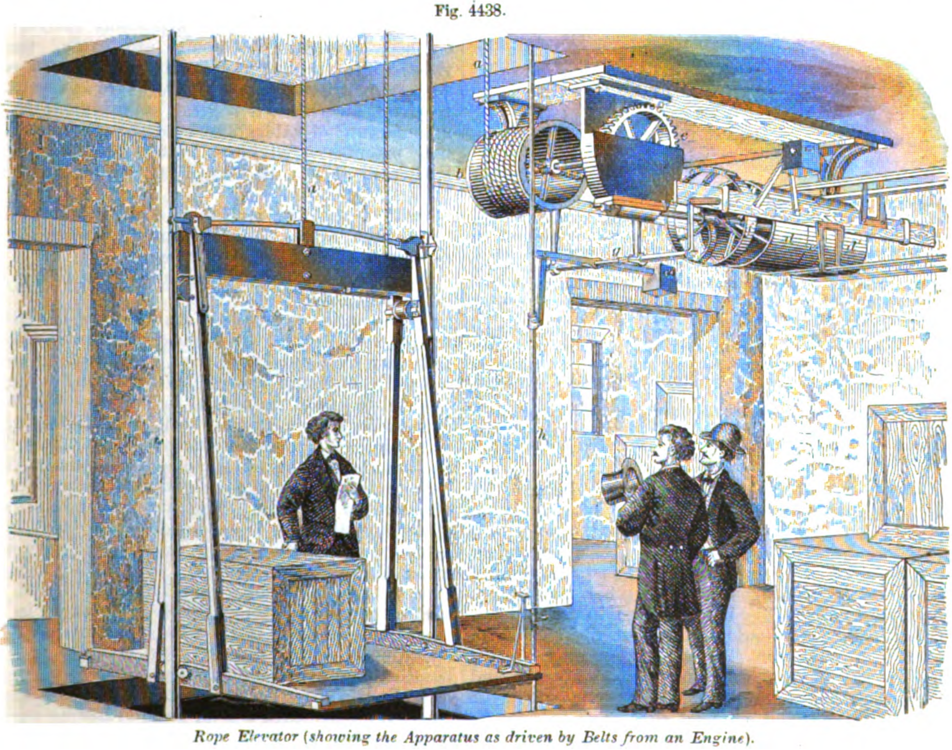
Fig. 4437.



Rope Elevator (showing the Hydraulic Machine in the Cellar).

In Fig. 4437, steam admitted to the closed end of the cylinder *a* operates a piston carrying a cross-head *b* having a jaw at each side, in which the drum *c* is journaled; as this advances along the guides *d e*, it is at the same time rotated by a pinion *f*, which engages with a rack on the bed and a pinion on the drum-shaft. The drum *c'* remains stationary, and the amount of rope taken up, and consequently the

Fig. 4438.



Rope Elevator (showing the Apparatus as driven by Belts from an Engine).

length of hoist, is equal to the length of traverse of the drum *c* multiplied by the number of turns of the rope around it.

Safety-catches are provided to arrest the platform in case the rope should break.

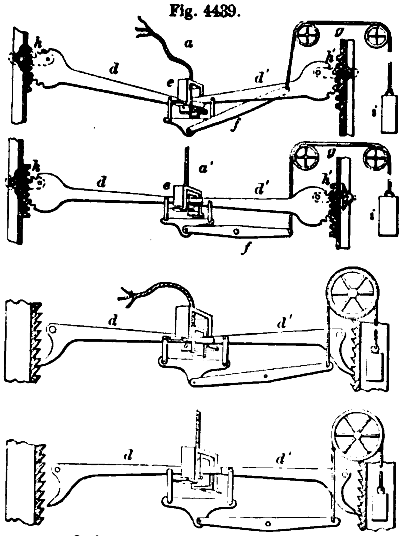
When steam is permitted to escape from the cylinder *a*, the weight of the platform causes it to descend, partly uncoiling the rope from the drums *c c'* and restoring the drum *c* and piston to their first position.

The hoisting-rope *a* of the elevator (Fig. 4438) passes over a grooved wheel in the upper story, and is wound upon the drum *b*, which is turned by the wheel *c* gearing with a worm on the shaft of the fast pulleys *d d'*; one of these is driven by a straight and the other by a crossed belt, by shifting one or the other of which from the loose central pulley *e* to its own proper pulley, the shaft is rotated in contrary directions, and the elevator raised or lowered.

The brake-wheel *f* is acted on by the device *g*, connected with the rod *h*, which extends from the top to the bottom of the building, and may be operated from either floor.

The safety-cage *a a'*, and that shown in the two succeeding figures, are each operated by a weight and a cord passing over one or two pulleys. The safety-catch is shown at *a'* in its normal

Fig. 4439.



Safety-Catcher for Rope Elevators.

position, with the hoisting-rope intact; the two levers *d d'*, whose inner ends, passing each other, are supported on a pin within the box *e*, are connected by links to a cross-head, to which one end of the lever *f* is pivoted, the other end being connected with the check-rope *g*. The toothed-cam ends of the levers *d d'* are connected with the racks *h h'*, with which they mesh, rising and falling with them. They are also connected by straps with shoes behind the upright guides. Should the hoisting-rope break, as shown at *a*, the weight *i* is brought into action, depressing, through the lever *f*, the inner ends of the cam levers *d d'*, bringing the shoes into contact with the back of the guides, and preventing descent of the apparatus.

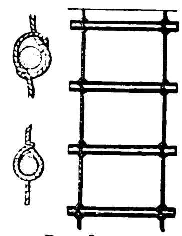
In the two lower figures, the levers *d d'* are, in case of breakage of the rope, actuated in a precisely similar manner, causing detents at their outer ends to enter notches in racks on the guide-frames.

Rope-guard. A device to prevent chafing. In Fig. 4440, a hollow metallic knob is held at the exposed point by a pin passing through the rope.

Rope Lad'der. (*Nautical.*) Rope ladders are employed for enabling persons to ascend and descend from the deck of a ship or from her booms into boats alongside. They are also used in fire-escapes. Other uses will doubtless suggest themselves to readers of romance. The side pieces only of side ladders are of rope, the rungs being of wood, and secured as shown in the cut. Those by which the rigging is ascended are termed *shrouds*. A *Jacob's ladder*.

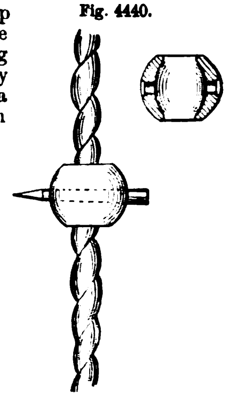
Rope-ma-chine'. Hemp is mentioned by Pliny as the favorite material for making ropes. *Spartium*, a variety of the broom growing on a tract of ground lying upon

Fig. 4441.



Rope Ladder.

Fig. 4440.



Rope-Guard.

the sea line of the province of New Carthage, was used for common rope or cordage, and also for some other purposes. The outer portion of the papyrus was also used by the Egyptians for cordage.

In fact, most vegetable fibers of sufficient strength, as well as the hides and intestines of animals, are, or have been, used at different times and in various countries for this purpose.

The twisting of the fibers into strands, and *laying up* these into rope, was, from the earliest times until a comparatively recent period, almost entirely effected by manual labor; the simple means by which the process was effected hardly deserving to be called machines. A machine for this purpose was patented in England by Richard March in 1784, and another by Edward Cartwright in 1792. In 1805, Captain Huddard invented a series of machines, in which some of the features of the latter were introduced, by which hemp was successively combed, straightened, spun into yarns, tarred, twisted into strands, and finally laid up into rope. These were introduced into the dockyard at Chatham, England, and effected a great improvement in the manufacture of cables and cordage. See also English patents, — Sylvester, 1783; Seymour, 1784; Fothergill, 1793; Balfour, 1793, 1798; Chapman, 1797, 1799, 1807.

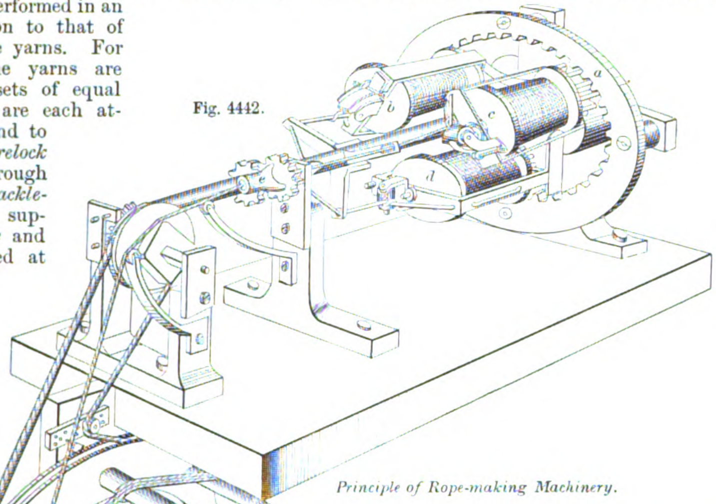
In the year 1820, machinery was introduced into the United States from England, for working the spun yarn into strands and ropes.

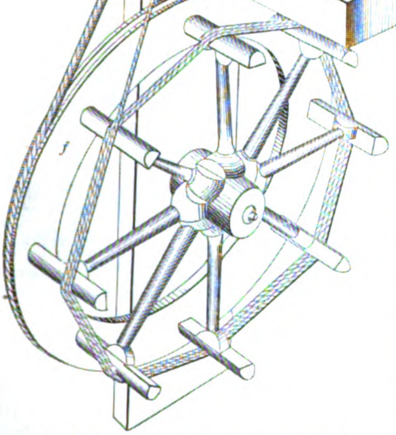
Mr. Treadwell introduced his rope-making machinery in 1834.

In the ordinary process of manufacture, the hemp, having been heckled and formed into skeins, is spun into yarn by a number of men, each of whom wraps a bundle of hemp around his body, and attaches one end to one of a series of hooks rotated by band connection with a crank-wheel, and walking backward along the ropewalk draws out the fibers from the bundle with his left hand and compresses them between two fingers of the right, until he reaches the other end of the walk. The thickness and hardness of twist of the yarn is governed by the quantity of hemp fed out by the spinner, and the rapidity with which the hooks are revolved. The yarn is then detached from the hook, wound on a reel, and the spinner proceeds as before, working this time in the opposite direction. If the rope is to be tarred, this operation is next performed. 300 or 400 yarns are bundled together, forming a *haul*, which is dipped into a kettle of tar heated to about 212°, and drawn through a hole called a *grip*, *gage*, or *sliding-nipper*, which presses the tar into the fiber and squeezes out

the superfluous portion. The yarns, either tarred or untarred, are next twisted or *laid* into strands, the twisting being performed in an opposite direction to that of the fibers in the yarns. For this purpose the yarns are made up into sets of equal number, which are each attached at one end to a winch or *forelock hook*, passing through holes in the *tackle-board*, and are supported on *stakes* and *stake-heads* placed at intervals along the walk; when they have become shortened by twisting, they are detached from the posts to which their other ends were fastened, and these are attached to a *sledge*, which is loaded with weights, so as to keep the strands taut, yet yield as they become farther shortened by twisting. When each strand has become *full hard*, they are detached from the tackle-board, and the three are placed in the three grooves of a conical wooden block termed a *top*, through which is passed a transverse stick forming the handles or *woolders;* one end of each is fastened to the center hook of the tackle-board, and the other to one of three hooks in the breast-board of the sledge; these are turned in one direction, while the tackle-board hook is turned in the other. The top, having been inserted between the strands as closely as possible to the tackle-board, is gradually forced along as the twisting proceeds, until it is brought up close to the sledge, the strands closing in behind it as it advances.

Fig. 4442.



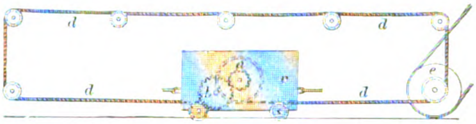


Principle of Rope-making Machinery.

By another arrangement, a carriage *c*, which is caused to traverse from one end to the other of the walk, is substituted for the sledge. This carries a frame and wheel, having spindles on which the strands are wound, forming the equivalent of the breast-board. The wheel is caused to rotate in one direction and the spindles in another, by gearing driven from the ground-wheels of the carriage as it is moved along the walk by means of the ground-rope *d*.

In the illustration, this is shown as passing around a drum on the driving-pulley *e*, and supported by overhead pulleys; it passes around the pulley *a*, on the carriage, whose axis has a pinion that turns the wheel *b*, which by means of suitable interior gearing causes the twisting-wheel and its spindles to revolve as described, and also gears with the ground-wheel of the carriage to give it a forward or backward motion.

Fig. 4443.



Ground-Rope.

The ground-rope may simply be employed to turn the twisting mechanism, the carriage being moved back and forth by ropes at each end; or, as shown at *g d'*, two ground-ropes may be used, by one of which *g* moves, as shown above, and imparts the traversing motion to the carriage, while the other, *d'*, passing around the smaller pulley, is fixed at each end, and causes rapid rotation of the operative machinery.

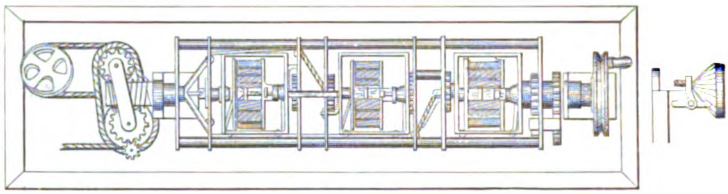
The principle on which the coarse fibers of hemp, coir, manilla, etc., are spun into rope-yarns is essentially the same as that by which yarns or threads for making fabrics are produced. For forming the first into the cords or strands which are twined together to constitute ropes, it is necessary that each of the spools on which the strands are reeled should rotate on its own axis, in order that the strands may freely unwind, and also that they should have a combined revolution around a common axis to twist the strands together.

In the machine (Fig. 4442), this is effected by the fixed sun-wheel *a*; the three spools *b c d* have planet-wheels at their ends, meshing with the teeth of the sun-wheel, and as they revolve on a common axis

concentric with its center, rotate independently on their own journals. The rope is conducted through the hollow rotating shaft *e* and wound upon the reel *f*, whose velocity is such as to take up the rope as fast as twisted and always maintain an equal tension.

The principle is farther illustrated in Fig. 4444, in which the main frame revolves in one direction and the inner frames with their reels revolve in the opposite direction: the threads and cords are respectively and successively associated and entwined to form a complete rope.

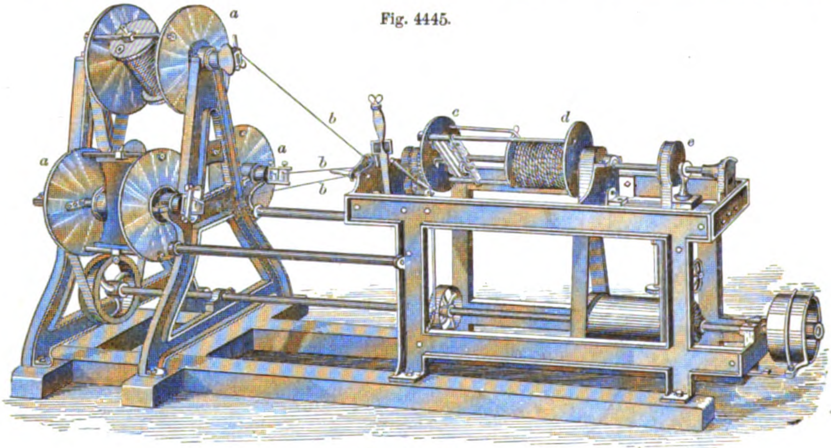
Fig. 4444.



Blackie's Rope-Machine.

The machine (Fig. 4445) is particularly designed for making small rope. The bobbin-holders *a a a* are rotated in a vertical plane by bands, and the bobbins are turned by the unwinding of the strands

Fig. 4445.

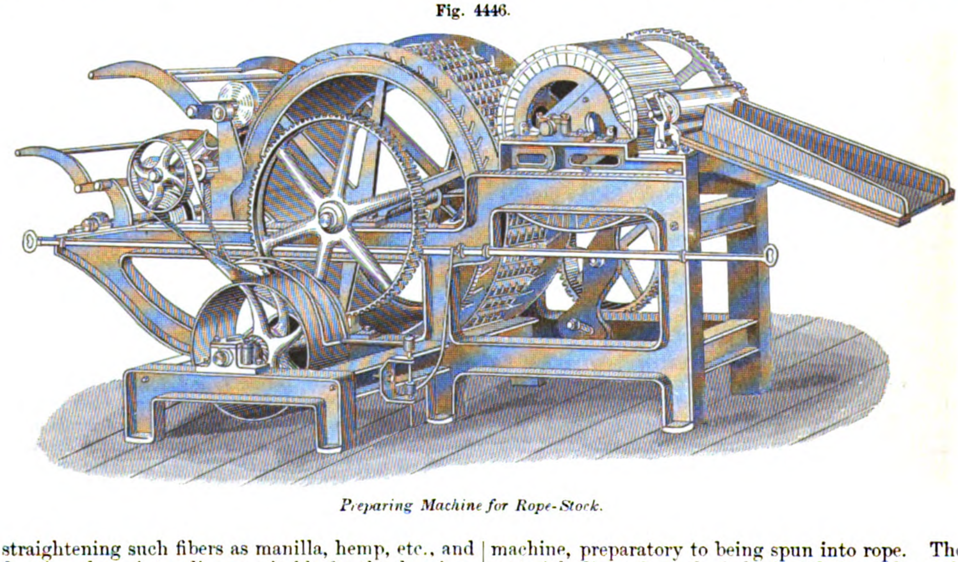


Rope-Machine.

b b b; these are laid together and twisted by the revolution of the reel *c d*, on which the completed rope is wound. This is driven by a pulley *e*, receiving its motion by belting from a drum on the same shaft by which the bobbin-carriers are actuated.

Fig. 4446 is a preparing machine for opening and

Fig. 4446.



Preparing Machine for Rope-Stock.

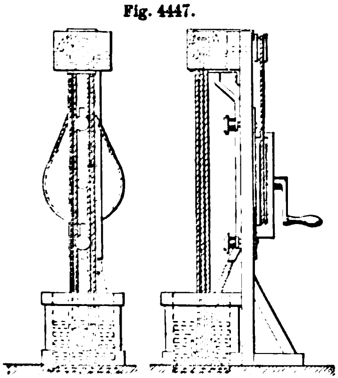
straightening such fibers as manilla, hemp, etc., and forming them into slivers suitable for the drawing-machine, preparatory to being spun into rope. The material, direct from the bale, is fed from the rack

on the left of the machine to the large-toothed cylinder, by which it is combed out, and, being taken off by the smaller slatted cylinder, is transferred to two rollers by which it is compressed into a sliver and delivered into the trough at the right.

Rope-por'ter. A light, two-wheeled carriage employed in the Fowler system of steam-plowing to carry the rope clear of the ground. See STEAM-PLOW.

Rope-pump. A water-elevator, consisting of a rope or ropes or of a fibrous webbing, whose lower end dips in the water which is discharged at the upper end, partly by centrifugal force, and partly by

Fig. 4447.



Rope-Pump.

the compression of the rope on the roller. The water is retained in the rope by capillary action. Such a one was used at Carisbrook Castle, Isle of Wight, England.

Rope-rail'way. A railway on which the cars are drawn by ropes wound upon drums rotated by stationary engines. This is frequently done on inclined planes in mining districts, and is sometimes adopted as a temporary expedient pending the construction of grades of lesser slope. See INCLINED PLANE.

The London and Blackwall Railway, for passengers and freight, was formerly operated in this manner by an engine at each end of the line. Arrangements were provided for detaching each car just previous to arriving at its desired station, so that its momentum would carry it to the proper point. The length of rope required was $6\frac{1}{2}$ miles, double the length of the road. Wire rope was found best; but the system was finally abandoned for locomotive power.

The ropes were connected to the drums by friction-clutches. The drums were of cast-iron, 23 feet in diameter, and their circumference revolved at the rate of about 26 miles an hour.

The rope was $5\frac{1}{4}$ inches in circumference, weighing about 40 tons; and to obviate the power required to drag this heavy weight at high speed, Mr. Elijah Galloway suggested the employment of two sets of wheels of different diameters, around each of which ropes, extending the length of the track, were to be wound: that passing around the larger outer wheel to be kept stationary at each end, while the other traveled as usual; it would thus cause the wheel to move at a much faster rate than itself, the ratio being as the diameter of the larger to the difference between it and the smaller.

One of the stationary engines of the Blackwall Railway was afterward set up in the City Flour Mills, Upper Thames Street, London, where it drove 32 pairs of stones, grinding 20,000 bushels of wheat per week. It is on the marine principle, and has 7 smoke-consuming furnaces. When one fire has just been fired up, the smoke is discharged into the adjoining fire.

Rope-trac'tion Pro-pel'ler. A mode of propulsion adopted with canal-boats to avoid the swell raised by paddles. A rope is laid along the bottom of the canal, and is wound upon a drum driven by the engine on board the boat. The rope passes back into the water over the stern of the boat, and may be picked up again and used by another boat following in the same direction.

The Chinese or differential pulleys have been inverted and used for this purpose, when a light vessel is to be propelled at a high velocity. See TOWING.

Rope'walk. A ground where ropes are made. Its length is estimated in fathoms, and is from 100 to 200 fathoms. At one end is the *spinning-wheel*, which rotates the *whirlers* to which the ends of a bunch of hempen fibers are secured, to be twisted into a *yarn*. Along the length of the walk are horizontal cross-bars with hooks, over which the yarns are swung as the men recede, walking backward from the *whirlers* and paying out the yarn.

A *laying* walk is one in which *yarns* are laid up into *strands* to form a rope. See ROPE-MAKING.

Rope-winch. A set of three whirlers driven by a strap and twisting three yarns which are to be laid up into a rope.

Rope-yarn. A single yarn composed of fibers twisted right-handed; used on shipboard for various purposes. Two or three twisted together form *spun-yarn*.

The size of a strand, and of the rope of which it forms part, is determined by the number of rope-yarns in it.

Rop'ing-nee'dle. (*Nautical.*) A heavy needle for sewing a sail to its bolt-rope.

Ro'sa-ry. A string of large beads representing an equal number of prayers, used by some religious sects. A bead is slipped through the fingers at each repetition of a prayer, until all or the specified number have been recited.

In the rosaries used by Roman Catholics, the beads representing the "Our Fathers" are larger than those for the "Hail Maries."

They are made of various materials, — dried berries, wood, ivory, metal, etc.

The Buddhists have for more than 2,000 years used long rosaries to keep count of their prayers. They also use the beads as counters for other things, and it is probable that the *chaplet*, twice as old as the Italian *rosary*, is the germ of the ABACUS (which see). See also PRAYING-MACHINE.

Rose. 1. (*Lock.*) The annular scutcheon round the spindle of a door-lock.

2. (*Hydraulic Engineering.*) A perforated cup or nozzle acting as a strainer at the induction of water into a pump, or at the nozzle as a means of dividing the water into fine streams for sprinkling.

3. (*Steam.*) The perforated nozzle of the injection-pipe, distributing the injection-water in jets or spray throughout the interior of the condenser.

Rose-cut. (*Gem-cutting.*) A mode of cutting gems in which the back is left flat and the face is cut into a series of inclined triangular facets arranged around a central hexagon. It is adopted for thin stones. See CUTTING GEMS.

Rose-di'a-mond. The *rose-diamond* is flat below, and its upper surface has 24 triangular facets. The center has a hexagonal arrangement, and the base of each triangle is joined to another whose apex touches the margin. The intervening spaces are cut into 12 facets in two zones. The upper or projecting is the *crown;* the lower portion, the *teeth*. See DIAMOND.

Rose-en'gine Lathe. (*Engraving.*) A lathe in which the rotatory motion of the lathe and the radial motion of the tool combine to produce a variety of curved lines. The mechanism consists of plates or cams set on the axis of the lathe, or suitably rotated and formed with wavy edges or grooves which govern the motion of the cutting point toward or from the center.

In another form, the combined radial and rotary motion is inherent in the work, the tool being stationary. In this case, the center of the circle in which the work revolves is not a fixed point, but is made to oscillate with a slight motion while the work revolves upon it.

The mandrel upon whose end the work is chucked does not rotate in stationary standards like those of a common lathe, but the standards form part of a frame which oscillates upon a horizontal axis below the bed and parallel to the mandrel axis.

The work is fixed in a chuck at the extremity of the mandrel, and the tool is held by a slide-rest, and adjusts it to the radius of the rose or figure intended to be cut. The oscillating motion is given to the mandrel by means of metallic rosettes or wheels fixed upon the mandrel, each having its edge or periphery indented and curved with a waving line. The rosettes are acted upon by a small roller at the end of a bar supported from the bed. As the mandrel revolves, the wavy periphery of the rosette is applied to the roller, which moves on a stationary axis and causes a vibratory motion of the mandrel as its frame moves to and fro on its axis.

The mandrel contains a number of rosettes of different patterns, and the governing roller is slipped on its axis so as to act in conjunction with any one of the rosettes, according to the pattern required.

Rose-engines and *geometric lathes* vary somewhat in their details, but agree in the general features that the work is performed by a combined rotary and radial motion. If the center of the rosette and the axis of rotation coincide, and the tool receive an oscillation radial as to the said center, a wavy circle is produced. If the chuck and its mandrel, while rotating, are oscillated back and forth on a parallel axis (as previously stated) while the tool is stationary, the same effect — a wavy circle — is produced; the change merely being to move one part or the other, relatively to its fellow, in the degree and proportion. If the center of the pattern do not coincide with the axis of the mandrel, the effect will be an eccentric figure. If the radial oscillation be given to tool or chuck, in addition to the former conditions, a wavy eccentric figure will be produced. (See CHUCK; ECCENTRIC.) If an oval or elliptical pattern be required, it may be obtained by means of an eccentric guide or ring of brass fastened to the puppet of the lathe close to the collar in which the neck of the mandrel runs. (See CHUCK; OVAL.) If the governing eccentric be wavy, the effect will be a wavy ellipse. By governing squares or other geometric figures, patterns of the required conformation are obtained. By a suitable disposition of the parts involved in the circular and radial motions, the tool is caused to make the peculiar line required within the limits of the said figure. By means of a *straight-line chuck*, the patterns of a rose-engine are made to follow in a straight instead of a circular direction.

Notable instances of the uses of this class of instruments are to be found in the machines of engine-turning watches, and those for making the complicated figures termed *lathe-work*, which abound on the obverse and reverse faces of greenbacks and other bank-notes.

Rose Gas-burn′er. A burner giving a circle of small flames. See STOVE-BURNER.

Rose-lash′ing. (*Nautical.*) A kind of lashing or seizing employed in woolding spars. So termed from its form.

Rose-nail. A nail with a conical head which is hammered into triangular facets. See NAIL.

Rose-steel. A kind of steel of cementation whose interior part exhibits, when fractured, a different texture from that of the exterior.

Ro-sette′. 1. (*Metallurgy.*) A disk of red copper from the refining hearth or crucible. As the impurities are removed in the shape of scoriæ or slag, and the metal exposed, the surface of the metal is congealed by throwing on water. This is called *quenching*. The hardened crust is of a red color, and is called a rosette. The operation being repeated, the metal is obtained in a form for ready handling and farther treatment, instead of being in a solid mass. It is known as *rose-copper*. See COPPER-FURNACE.

2. (*Mill.*) A circular arrangement of sails in a windmill; the vanes attached to radial arms.

3. A leather or metallic ornament placed on a bridle or halter at the point where the front joins the crown-piece.

4. A circular ornament of fabric, plaited with leaves somewhat resembling those of a flower.

5. (*Gas.*) A form of gas-burner in which the gas issues at a circular series of holes resembling a rosette. See STOVE-BURNER.

Ross′ing-ma-chine′. 1. A machine for removing the *ross*, or rough, scaly, exterior portion of bark, from the remainder.

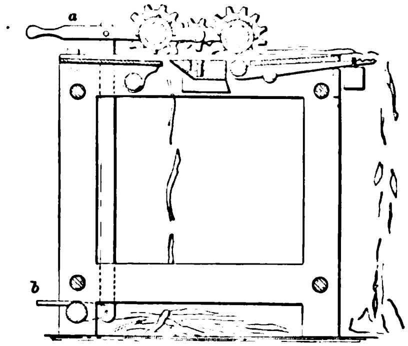
2. A machine for removing bark from logs in advance of the saw. The bark, containing much silex and sometimes grit, soon dulls the saw. See Fig. 4451.

3. A machine for cutting up bark for steeping or boiling. The vegetable extract is used for tanning, medicine, dyeing, etc.

In the most correct sense, the removal of the outer cuticle, there are several processes.

By pressure against a splitting-knife. An example is shown in Fig. 4448, in which the bark is fed along a table and beneath cogged pressure-rollers

Fig. 4448.

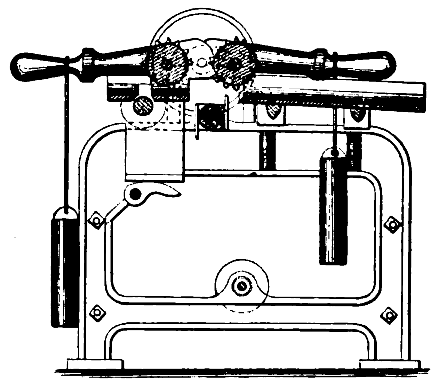


Rossing-Machine.

which carry it against the stationary knife, which is adjustable in hight, so as to take off such a thickness of *liber* as may be desired. The required pressure of the feed-rollers is given by means of levers *a* actuated by treadle *b*.

In a modified form (Fig. 4449), the bark is fed beneath pressure-rollers while its *liber* is planed therefrom by a revolving cutter. The pressure on the rollers is given by the weights suspended from the levers.

Fig. 4449



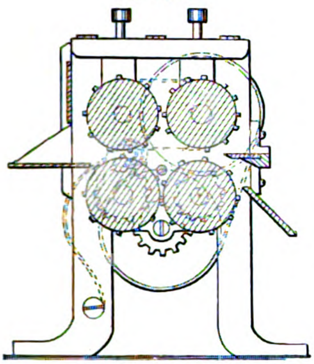
Rossing-Machine.

In Fig. 4450, an idle roller placed between the upper edges of the lower rollers facilitates the passage of the bark. A knife is placed between the rear edges of the upper and lower rollers, and presents a cutting edge to the bark as it comes from the rollers.

A common use of the *rosser* is in saw-mills, where it is used to remove the bark from the log in advance

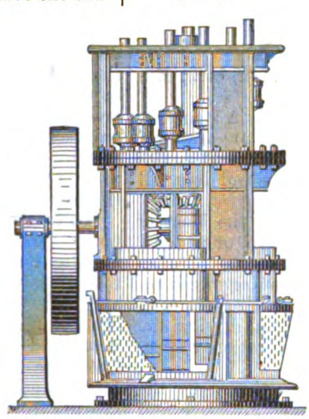
of the path of the saw. This is to save the saw-teeth from being dulled by the bark.

Fig. 4450.



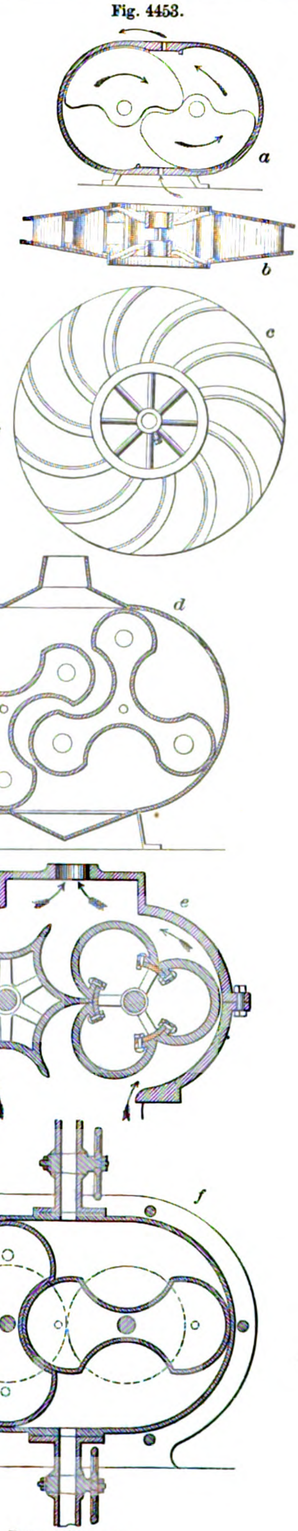
Bark-Planing Machine.

Fig. 4452.



Rotary Stamp-Battery.

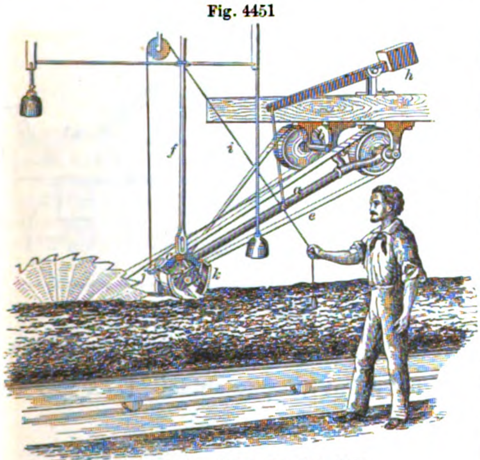
Fig. 4453.



Rotary Blowers.

Stearns's machine (Fig. 4451) consists of an arm *a* fastened to the bearings *b*, so that it swings freely thereon. At the other extremity of the same arm is a disk *c*, carrying a pulley, and a revolving cutter-head *d*. These cutters are driven by a belt *e*, at a high velocity. The disk *c* has an upright rod *f* attached, by which the action of the shields *k* is controlled, they being inclined on one side or the other as the rod *f* is diverged from a

Fig. 4451



Rossing Attachment for Saw-Mill.

straight line. These shields guide the cutters. The arm *a* is counterbalanced by a weight *h*, so that it is easily raised, by drawing on the line *i*, one end of which is attached to a lug *j* on the arm, and the other passes over pulleys to the workman's hand.

The shields *k* raise the cutters while in action, to suit any rough places or knots that may be on the logs by them.

Rost'horn's Gun-met'al. An alloy composed of 55.04 parts copper; 42.36 zinc; 1.77 iron; and 0.83 tin; or, according to another analysis, 57.63 copper; 40.22 tin; 1.86 iron; and 0.15 tin. See table on page 61.

Ros'trum. 1. (*Surgical.*) A crooked pair of forceps with beak-like jaws.

2. The *beak* of a still, connecting the *head* with the *worm*.

3. (*Nautical.*) The prow or beak of a vessel.

4. The elevated platform or stage in the forum of ancient Rome, from which the orators addressed the people. A platform in a hall or assembly.

Ro'ta-ry. Having a motion on its axis, as a wheel (Latin, *rota*), a ball, etc. The words *rotary*

and *revolving* are needed in their peculiar spheres, and should not be confounded.

Rotation, as of a planet on its axis.

Revolution, as of a planet in its orbit.

See ROTARY PUMP; ROTARY ENGINE, etc.; REVOLVING-CYLINDER ENGINE, etc.

Ro′ta-ry Bat′ter-y. (*Metallurgy.*) A stamping battery for crushing ores. The stamps are arranged circularly around a vertical shaft, which carries around an inclined plane that raises and lets fall each stamp in succession.

Ro′ta-ry Blow′er. One in which the blast of air is obtained by the rotation of a piston or pistons, or of a fan.

a (Fig. 4453) is a form in which two segments revolve in a case in different directions, their surfaces in contact; the segments act alternately in driving air.

b c are a sectional view and side elevation respectively of a fan-blower.

d is a three-head piston-blower acting upon the principle of *a*, but having a larger air-space and heads which act in succession and alternation.

e has pistons of varying shape, having concave and convex abutting surfaces respectively.

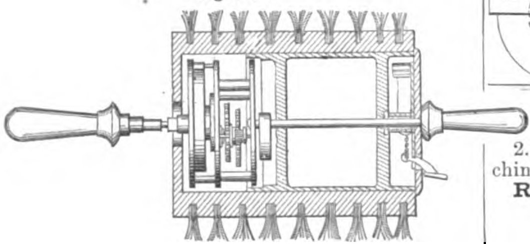
f is a double-headed blower.

It will be seen that in *a d e f* the pistons are of such shape as to pack against the case, and also against their fellows, so that no air may leak around them or between them. See also BLOWER; FAN.

Ro′ta-ry Brush. A cylindrical brush turning on an axis. A kind employed by hair-dressers is turned by an elastic belt suspended from a pulley overhead, and the ends of the axis terminate in handles by which it is manipulated.

Another (Fig. 4454) has an interior helical spring, which is wound up by means of one of the handles, and actuates a train of clock-work, causing the

Fig. 4454.

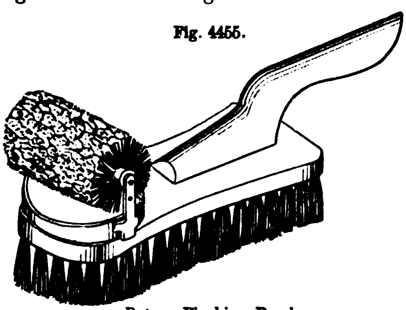


Rotary Brush.

brush to rotate; a brake is provided for checking or stopping its motion.

Fig. 4455 is a blacking-brush in which a rotary

Fig. 4455.

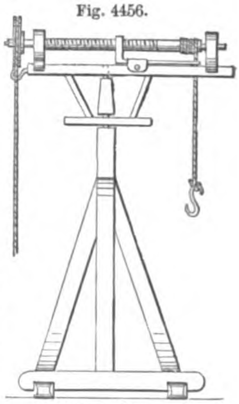


Rotary Blacking-Brush.

cylinder at the back serves the purpose of the ordinary dabber in laying on the blacking.

Ro′ta-ry Crane. One swinging on an axis, so as to present the jib in any direction to lift or deposit the load. In the example (a crane for light purposes), the barrel shaft has a screw thereon, which engages the sliding guide, to coil the cord fairly upon the barrel. See CRANE.

Fig. 4456.

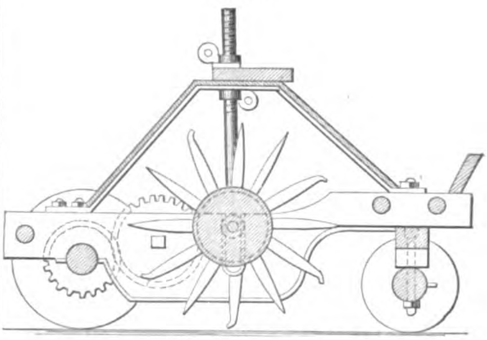


Rotary Crane.

Ro′ta-ry Cul′ti-va′-tor. (*Husbandry.*) A digging implement with rotary spades which pierce and lift the soil. The shaft of the rotary digger is suspended by screw rods from the bridge of the frame, and is rotated by gearing from the ground-wheel. See DIGGING-MACHINE.

Ro′ta-ry Cut-ter. 1. (*Metal.*) A toothed disk on a mandrel, between the centers of a lathe. Used in cutting gears, milling, etc.

Fig. 4457.

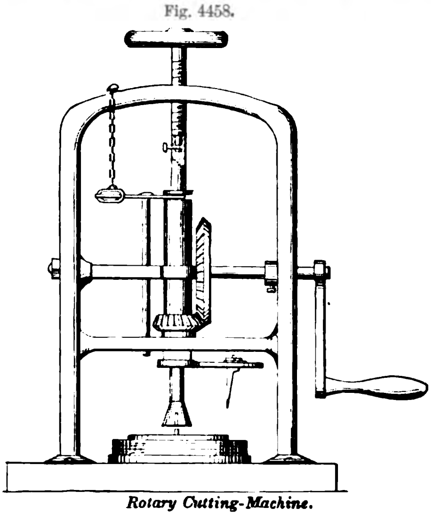


Rotary Cultivator.

2. (*Wood.*) A cutting head in a planing-machine.

Ro′ta-ry Cut′ting-ma-chine′. 1. A tool for

Fig. 4458.



Rotary Cutting-Machine.

cutting an annular hole or kerf. A *crown*, *trephine*, or *cylindrical saw*, or an *annular auger* (which see).

In the example, the middle mandrel acts as a holder when the screw is turned; the sleeve is driven by the gearing, and has a cutter which is adjustable radially to regulate the diameter of the circular pieces of paper cut thereby.

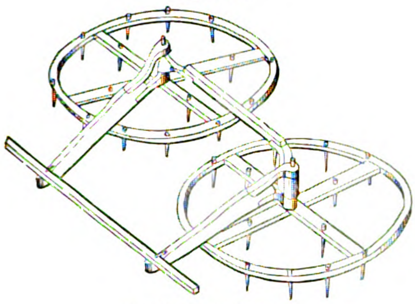
Ro'ta-ry Dig'ger. (*Husbandry.*) A machine with rotary spades. See pages 703, 1068. See also ROTARY PLOW.

Ro'ta-ry En'gine. See ROTARY STEAM-ENGINE.

Ro'ta-ry Fan. (*Pneumatics.*) A blowing-machine with rotary vanes. See ROTARY BLOWER; BLOWER; FAN, etc.

Ro'ta-ry Har'row. (*Husbandry.*) One having the tines set in a frame which rotates on a vertical axis as the harrow is drawn along the surface of the

Fig. 4459.

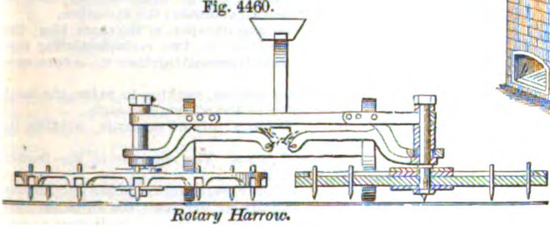


Double Rotary Harrow.

ground. In the example, the bent rim and the spokes have teeth, and their axial pin is journaled in bearing sleeves attached to the draft-bars. The cranks of the rotary harrows are connected by a transverse bar.

The circular tine-frames are so hung to the frame

Fig. 4460.

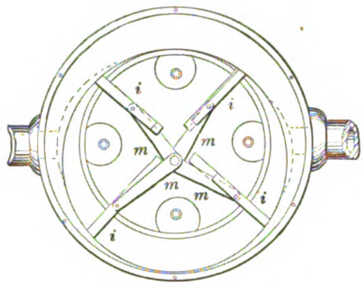


Rotary Harrow.

as to rotate on their axes when dragged upon the ground. This motion is sometimes produced by hanging them eccentrically, so as to have a greater resistance on one side than the other.

Ro'ta-ry Me'ter. One in which the measuring device or piston rotates in a case. It resembles in construction the ROTARY PUMP or ROTARY STEAM-ENGINE (which see), but has a vessel or passage of known capacity, and the revolutions of its piston are registered. In Fig. 4461, the inner cylinder is eccentric, and has radial pistons *i* connected by links *m* to a wrist that forms the center of motion, around which the pistons revolve. A fixed crank is thus dispensed with, and the parts accommodate themselves to conditions incident to expansion and contraction from changes of temperature. The heads of the revolving cylinder work in recesses in the case of the engine, so as to prevent friction and wear upon the pistons. See SPIRIT, GAS, WATER METER.

Fig. 4461.



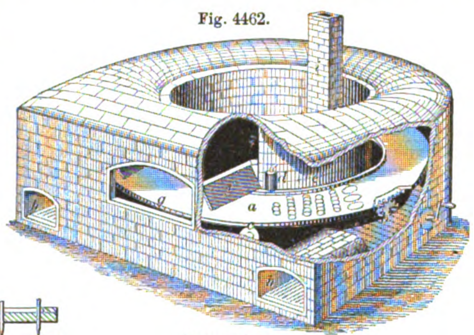
Rotary Meter.

Ro'ta-ry Ov'en. One in which the bread-trays or bread-tables rotate, so as to receive the dough at the oven door, carry it in a circuit around the oven, and present it at the delivery door, the rate of progression being so timed and the heat so regulated as to accomplish the baking during the circuit.

There are two principal varieties of rotating ovens; those in which the circular bread-table rotates on a vertical axis, and those in which the bread-trays are suspended from the arms of a reel which has a horizontal axis: the latter is known as a *reel-oven*. See OVEN.

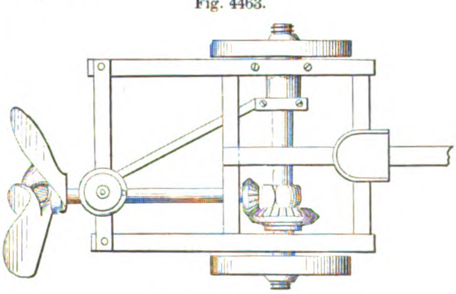
Wedge's rotary oven has an annular plate *a* rotated by a pinion *b* operated by a hand-crank or machinery, and sustained on friction-rollers *c*; other friction-rollers *d* prevent it from bearing against the interior masonry *e*. Swinging damper-doors *f* prevent the escape of heat. These are kept constantly closed when baking crackers. The dough is introduced and removed, when baked, through the door *g*. *h h* are the furnaces, from which the products of combustion pass to the chimney *i* through circulating flues.

Fig. 4462.



Rotary Oven.

Fig. 4463.

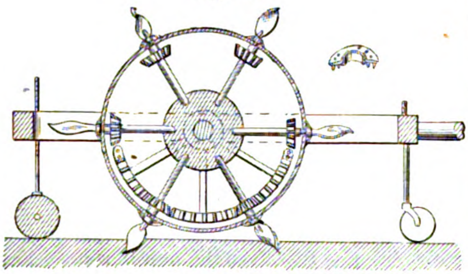


Rotating-Share Plow.

Ro′ta-ry Plow. (*Husbandry.*) A plow with rotary share. In Fig. 4463, it is in the rear of the frame and is driven by gearing from the driving-wheel axle.

In Fig. 4464, the segmental driving cog-wheels connect with supplementary yielding cogs attached with springs. The segmental wheels rotate the earth augers only when in contact with the earth. The yielding cogs insure the meshing of the auger pinions with the rigid cogs of the segmental gears. See also pages 703, 1068.

Fig. 4464.



Rotary Plow.

Ro′ta-ry Pud′dler. (*Metallurgy.*) An apparatus in which iron is puddled by rotary mechanism instead of by hand labor. The idea is believed to have occurred to Henry Cort, but the first practical attempt to execute it appears to have been made by Yates and Tooth, who constructed a furnace having a rotating trough, with fixed rabbles through which a current of water was conducted to prevent them from melting, which, however, it did not effect. The Bromhall puddler was arranged with four rabbles, which were caused to assume different angles, as they were drawn over the bed of the furnace. Subsequently, Mr. Menelaus, manager of the Dowlais Works, contrived a cylindrical rotary furnace, in which the puddling was effected by the rotation of the furnace alone. This was not successful in practice, owing to the great expansion and contraction and the rapid destruction of the lining.

About 1867, Mr. Danks of Cincinnati developed the first practical rotary puddling-furnace. This has since been greatly improved, and has been, to some extent, introduced into Great Britain and the Continent of Europe. See PUDDLING-FURNACE.

Ro′ta-ry Pump. One whose motion is circular. The kinds are various ; in some the cylinder revolves or rotates, as the case may be, moving in a circular path or rotating on its own proper axis. Some of these are considered under CENTRIFUGAL PUMP (see pages 514–516). The more common form of rotary pump is that in which the piston or pistons rotate on an axis, as seen in the illustrations, Fig. 4465.

a is a double-wheel pump from the old collection of Sérviere. The cog-wheels rotate in contact with each other, the teeth of each filling the interdental spaces of the opposite. Sérviere was born at Lyons, 1593. See also Ramelli's book, sixteenth century.

b is Eve's rotary pump, 1825. It has three pistons on a hub, and a rotating abutment, which offers a depression to enable the pistons to pass as they are successively presented.

c has a hub with one piston, and a curved flap which turns on a hinge.

In *d* the pistons are cam-shaped, and the vertical valve which forms the abutment rises on the cam, and then shuts down behind it, to rise again on the next cam.

e has a sliding valve which is operated by exterior devices and recedes to allow the piston to pass.

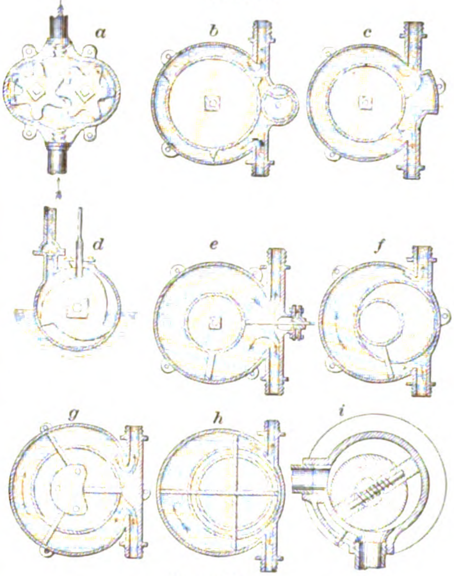
f has two concentric drums, the annular space for the water being traversed by a piston which consists of a rectangular piece of brass driven by a revolving eccentric cylinder, which at the same time forms an abutment.

g has three pistons, which move radially in a circular shell, which rotates in contact with the segment on the case, forming the abutment. A D-cam actuates the pistons.

h has a rotary hub eccentric with the case, and two pairs of pistons acting in diametric slots.

In *i* the hub is similarly placed, but has one pair of spring pistons, in a single diametric slot.

Fig. 4465.



Rotary Pumps.

In *j* (Fig. 4466) the annular piston is moved eccentrically around inside the cylinder. The convex-faced valve is supported on a spring arm and follows the movement of the cylinder, so as to form a continued separation between the induction and eduction passages.

k, Leuchtweiss's pump, has four pistons and an abutment-wheel with four depressions, traversed by the pistons in turn.

l is Andrew's pump, having a pair of segment-cams, each of which is a driver, and forms an abutment for the other.

m, Hardy's pump, is an amplification of the same idea, the double-headed pistons revolving in two communicating segments of cylinders, and being geared together to secure uniformity of rotation.

n is Bazin's three-headed pistons, working in pairs, the head of one filling the depression of the other alternately.

o is Behren's pump. It has a pair of segments, working on the same principle as *l*.

p is Vialon's centripetal pump. The converse of the Barker mill. See Fig. 562, page 231

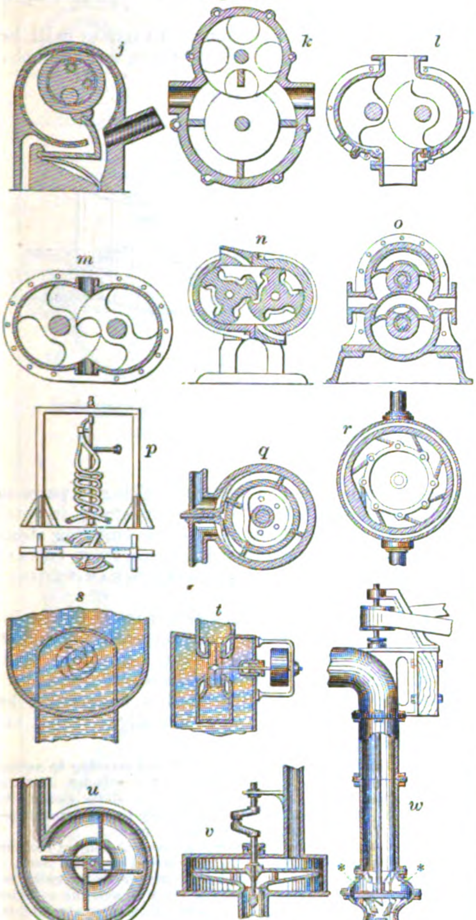
q is a form shown in an old French work. It has four pistons which slip in and out radially, as they pass the abutment between the induction and eduction ports. The stationary eccentric allows them to be pressed in as they come against the incline, and again forces them out after passing the abutment.

r has a number of hinged pistons arranged on the periphery of the hub. As each one approaches the double inclined plane forming the abutment, it is pushed in against the hub, and when it has passed the crest of the rise is opened again by a spring beneath it.

s t are two views of the Appold rotary pump, which has a series of wings on a horizontal shaft revolving in the water. The views are vertical sections taken in planes at right angles to each other. This pump has been largely used in England in wrecking and drainage.

With a hollow cylinder 12 inches in diameter by 3 inches deep, to which a rotation of 800 times a minute is given by a steam-engine, this machine can raise 1,800 gallons of water per minute to a hight of 10 feet. In November, 1851, one of these pumps was set to work to assist in draining Whittlesea Mere. The cylinder was 4½ feet in diameter, and was immersed in one of the channels or cuts by which the Bedford level is intersected. The average velocity is 90 revolutions or 1,250 feet per minute. A double-cylinder steam-engine was erected upon the spot, and its power was applied to drive the pump. The steam pressure was 40 pounds per square inch, and the vacuum 13½ pounds ; the lift, 5 feet. An immense volume of water, no less than 16,000 gallons per minute, was raised by this means, all of which passed through the cylinder of the machine, and was

Fig. 4466.



Rotary Pumps.

carried off by a channel prepared for it. One of Bessemer's pumps, with a cylinder 9 feet in diameter, has raised as much as 200 tons of water per minute by the aid of a 30 horse-power engine. This pump is shown at *v*, Fig. 4466.

The *Massachusetts centrifugal pump* (*u*), shown at the London World's Exposition, has a short horizontal shaft, carrying a square boss with 4 tangential blades, which rotate within a metallic case having axial induction and a tangential eduction. The pump is submerged, and is driven by gearing and shafting.

Gericke's rotary pump is shown at *w*. The vertical shaft carrying the wheel is driven by a band on a pulley above. Above the wheel are a series of curved guides ** to direct the water to the center of the chamber at the foot of the vertical stand-pipe. A fixed plate is placed above the wheel, and forms the floor of the ascension chamber, the water being driven around its margin by the centrifugal power of the wheel.

For early inventions in this line, see,—

Le Demour	1732	Whitelaw	1841 and 1846
Inverted Barker's mill		Gynne	1844
Jorge-West	1816	Bessemer	1846 and 1851
Massachusetts centrifugal	1818 and 1830	Andrew	1846 and 1850
Blake	1831	Van Schmidt	1846
Andrews	1839	Appold	1848

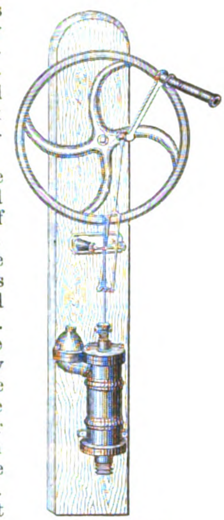
See also CENTRIFUGAL PUMP.

Fig. 4467 is a (so-called) rotary pump. All that is rotary about it is the wheel, on which are the hand-crank and the wrist to which the pitman is attached.

Ro'ta-ry Shap'er. A machine for planing, turning, and slotting.

Van Haagen & Co.'s has a table *a* at front, which is caused to move vertically by means of an upright screw receiving motion by gear connection with a horizontal shaft provided with a crank *b*, so that it may be operated by hand when desired.

Fig. 4467.



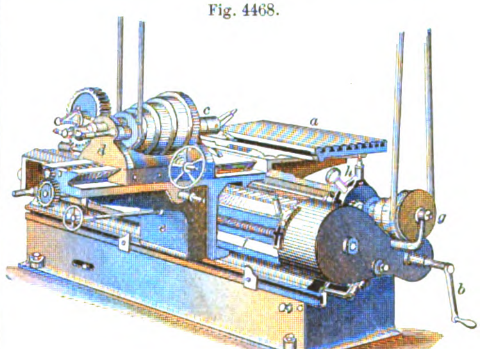
Rotary Pump.

The tool-spindle *c* may be moved both transversely and longitudinally by means of the head-stock *d* and slide *e*. The latter is operated by the feed-screw *f*, which derives its motion, through concealed gearing, from the shaft *g*. By means of a shifter *h*, the motion of the gearing may be changed so as to reverse the direction, both of the slide and table, either or both of which can be thrown out of connection with the shafter and worked by hand. For reversing the movement of the slide *e* in planing, adjustable lugs are attached to the inner part of the shaft, which are struck alternately by the slide *e*, throwing over the shifter *h*; a semi-rotation is automatically imparted to the tool-holder at the same time.

For horizontal drilling, the head-stock alone is advanced toward the work, either automatically or by hand.

In slotting and in cutting the teeth of wheels, a rotary tool is used, the table and head-stock being

Fig. 4468.



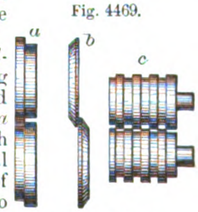
Rotary Shaper.

moved to suit the character of the work by hand or by the self-acting devices.

By the employment of suitable tools, the interior of steam-cylinders, pulleys, and similar work may be turned out, and key-seats cut in pulleys without moving the work after turning.

Ro'ta-ry Shears. (*Metal-working.*) A shears for cutting metal, having rotating instead of reciprocating blades. In *a* (Fig. 4469), the face of each blade has two steps; the metal is sheared between the angles of the prominent faces of the two disks.

Fig. 4469.



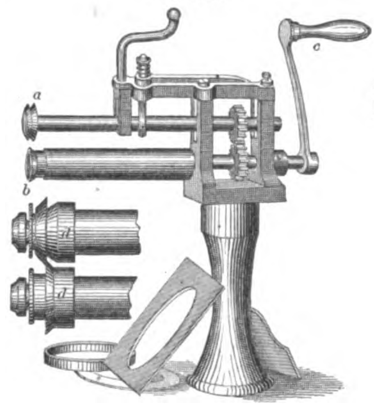
Rotary Shears.

b is better adapted for thin sheets.

c consists of two rollers, each having rectangular annular projections which fit corresponding grooves in the other, enabling a number of strips to be cut from a sheet at once.

In Fig. 4470, the shafts carrying the cutters *a b* are geared together and turned by the handle *c*. The cylindrical portions, shown at *d d* on an enlarged

Fig. 4470.

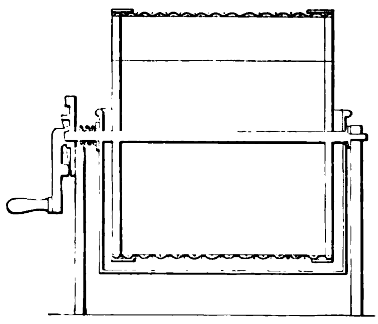


Rotary Shears.

scale, serve to guide and hold the plate to the shears. The distance between the two cutters is regulated by raising or lowering the upper shaft. The machine is designed for cutting plates too thick to be conveniently severed by the ordinary bench-shears.

Ro'ta-ry Sift'er. A cylindrical sieve. It has a segmental opening for the introduction of meal. The hand-crank has a projection which runs on in-

Fig. 4471.



Rotary Sifter.

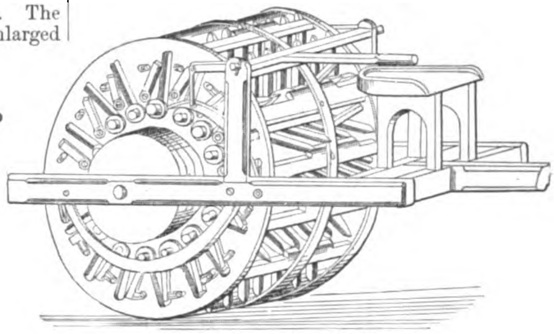
clined abruptly-terminating cams upon a circular disk, which serve, in combination with a spiral spring, to shake the sifter longitudinally. See ASH-SIFTER; SIEVE; SCREEN; RIDDLE, etc.

Ro'ta-ry Spad'er. A digger having on a drum or frame a series of spades brought successively to the ground. In Fig. 4472, when the spades are ready to enter the ground, by the rotation of the cylinders, they are in nearly a vertical position, and are held down by one of the latches, remaining in the same position until the cylinder has passed over them, causing the earth to be broken up and overturned. See also pages 703, 1068.

Ro'ta-ry Steam-en'gine. One in which the piston rotates in the cylinder or the cylinder upon the piston.

The varieties are numerous. Examples will be given of engines with one, two, three, and four pis-

Fig. 4472.



Rotary Spading-Machine.

tons on single axes; of pistons working in pairs on several axes; of wheels driven by steam injected against them, or working by reaction, emitting steam tangentially. For another kind, see DISK STEAM-ENGINE. See also BREAST-WHEEL STEAM-ENGINE; REACTION STEAM-ENGINE.

Rotary engines were suggested or made by the inventors of the last century and the early portion of the present. The names of Watt, Cartwright, Galloway, and others may be mentioned.

The illustrations will be readily understood by reference to Plate LIII., with but slight verbal explanation.

a has a single piston keyed to the hub and rotating in an annular chamber, which has the function of a cylinder. In the middle, on the right, is the abutment which slides radially to allow the piston to pass. Above and below the abutment, respectively, are the induction and eduction ports.

b has a single piston which passes a crescent-shaped rocking abutment situated between the induction and eduction ports.

c. The piston revolves on a hub concentric with the cylinder, and the annular steam space between the hub and the cylinder side is traversed on each side alternately by sliding abutments, connected together and operated by a segmental cam on the piston-shaft, which impinges against anti-friction rollers of the frame.

d. The steam issues from the piston at *, and is educted at ×, passages being provided through the tubular shaft. The abutments swing out of the way for the passage of the piston, being actuated by connecting rods and levers operated by a cam on the main shaft.

e. The piston-wheel is arranged eccentrically within the cylinder, and has two buckets, which are expanded radially by springs, and withdrawn to pass the abutment by contact with the cylinder. Packing segments on the piston-wheel and the edges of the buckets confine the steam.

f has an elliptical piston, the working faces of which are expansible by screws to pack it against the inside of the annular chamber in which it revolves. It has a rocking abutment which oscillates in a chamber.

g has two pistons with vibrating abutments, which retract into recesses to allow the pistons to pass.

h. The pistons are situated upon the extremities of the hollow arms; the steam ports in the hub of the main shaft serve as induction passages for the steam, the eduction ports being located upon the periphery of the inclosing case of the engine. The steam is admitted to a chamber in the shaft through a pipe which revolves therewith.

j has three pistons, which have a certain freedom of motion in seats in the inner cylinder, which rotates in an eccentric drum.

k has three pistons on a wheel keyed to the main shaft. Inclines on the advancing faces of the pistons push back the swinging abutments, which then close the eduction. The induction ports are above and below.

l has three pistons, two valve-abutments, and two induction and eduction ports respectively.

m has three pistons on one shaft, set at angles of 120°. Steam admitted at one side of the casing and departing at the other presses against a flexible band which drives the pistons before it.

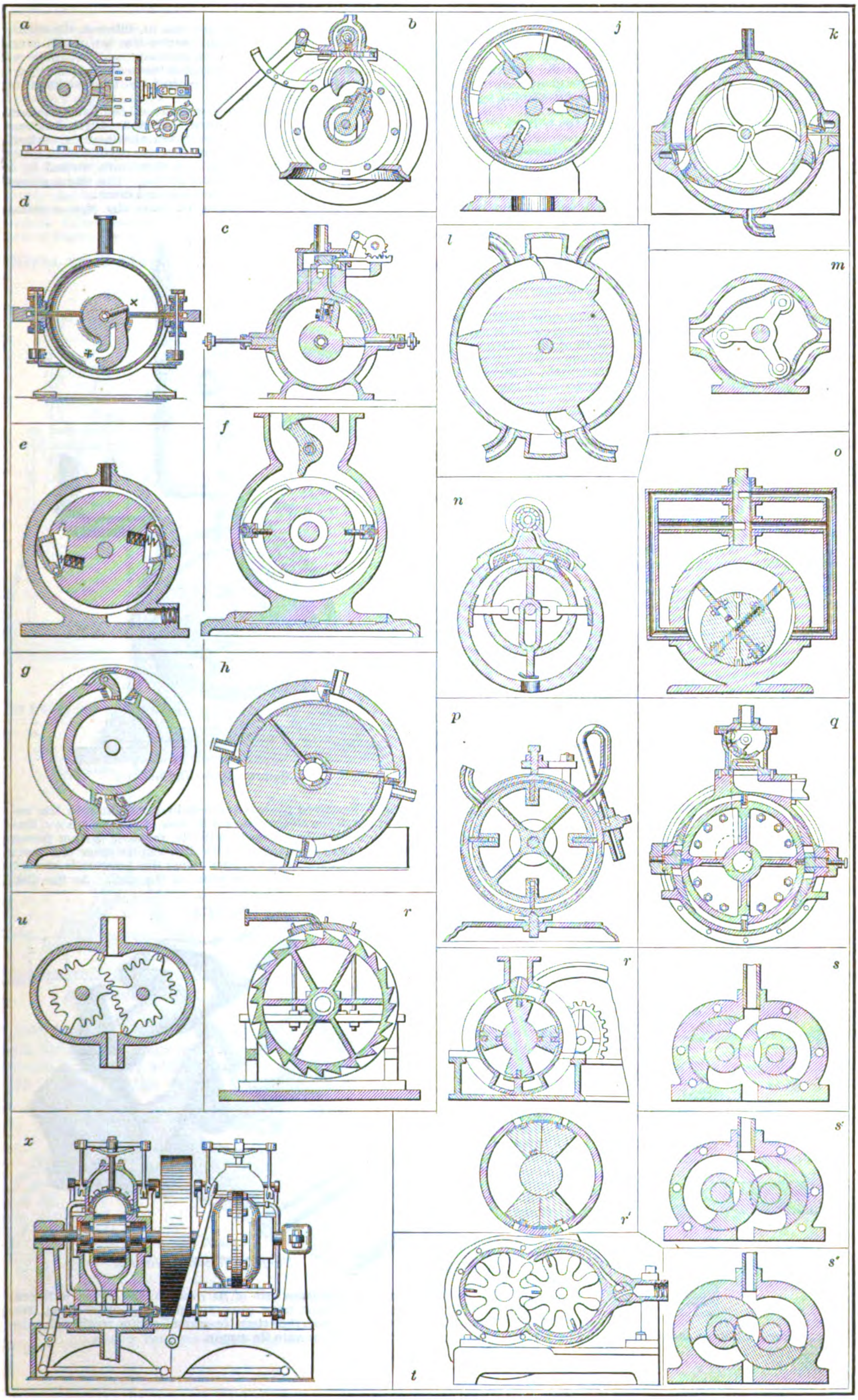


PLATE LIII. ROTARY STEAM-ENGINES. See pages 1990, 1992.

n. The eccentric hub revolves in the annular cylinder, and has pistons arranged on yokes, traversing at right angles to each other, and provided at their ends with spring packing-plates, which accommodate themselves to the interior surface of the cylinder. The induction openings are also covered with flexible plates, which accommodate themselves to the surface of the hub, and permit the passage of the piston. The engine runs in either direction and exhausts at the bottom.

o has also diametric pistons, which are equal to the diameter of the casing, and slip to and fro in slots in the eccentric hub.

p has four distinct pistons, which slip in and out in radial slots in the circumference of the eccentric hub. Steam is admitted and educted by flexible pipes. The abutment, as in the last two mentioned, is formed by the contact of the hub with the inside of the cylinder.

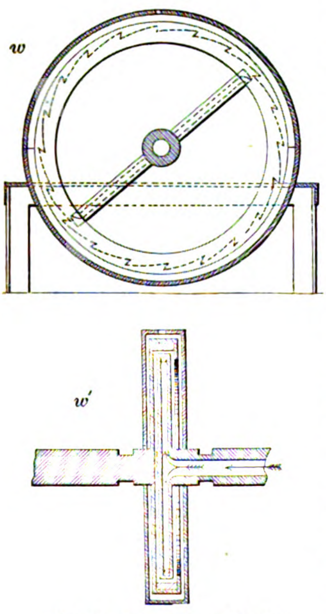
q is the Scheutz engine (Swedish), shown at the French Exposition. Its hub and cylinder are concentric, and the abutments are formed by double inclines, which force in the pistons as they come in contact therewith. Steam is introduced and discharged at ports leading through the inclines on the respective sides of the abutments.

r r′ are two views of another Exposition engine, by Thompson, of Edinburgh. There are two pairs of pistons, each attached to a core which occupies but half the length of the cylinder in the direction of its axis. Each pair of pistons is thus attached to its own core only for half the piston length, while the other half projects over the core belonging to the other pair. Neither pair of pistons can therefore pass the other, though they may come into contact. Each pair of pistons has its independent shaft, and externally to the cylinder each of these shafts carries an elliptical gear-wheel, which works into an equal and similar wheel upon a shaft parallel to the piston-shaft. This second shaft, which is the working shaft, has a fly-wheel regulator. Steam is admitted between the sector-shaped pistons, and the motion is produced by the preponderance of leverage at the time. See Dr. Barnard's Report, pages 87 - 93.

s s′ s″ are three views of Behren's Exposition engine, American. The views show three positions of the pistons which work in apposition. It has two cylinders, whose spaces overlap each other, and in the center of each is a solid cylindrical core. Each piston is firmly attached to an axis, and is part of a solid ring fitting to the core and to the interior of the cylinder. The axes are externally connected to gear-wheels to insure simultaneous and equal action. A portion of each core is removed to enable the opposite piston to pass. Steam enters above and discharges below. The pistons are alternately motors and abutments. In *s* the steam is just commencing to act on the left-hand piston. At *s′* the steam is acting on the right-hand piston. *s″* shows the position of the pistons when changing duty.

t is the Pillner and Hill engine, English, also shown at the French Exposition. It has two cylindrical overlapping chambers, and two systems of rotary pistons, which may be compared to cog-wheels. These wheels, by the close contact of their cogs, prevent the passage of steam between them, and they are adapted steam tight to the interior of their cylinders by metallic packing in the tips of their teeth. Practically, it is found to be sufficient to pack two teeth diametrically opposite to each other in each wheel.

Fig. 4473.



Harris's Rotary Steam-Engine.

u is a somewhat similar form, in which the two packing-teeth are alone prolonged to touch the interior of the cylinder; deep depressions in the opposite wheel allow these prolonged teeth to pass At intermediate points, shorter teeth gear into each other to prevent passage of steam at this point.

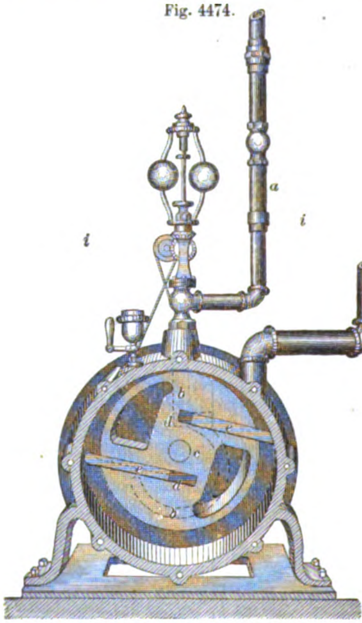
In *v* a jet of steam is forced against the vanes of a wheel as they are presented in turn in a steam-tight case.

Fig. 4473 shows two views of the Harris engine, in which the portions are attached to two hubs and run in different directions. One axis with hollow trunnions carries the two radial arms which emit steam at their ends, tangentially, and so run by reaction; the steam emitted acts against vanes on the other portion and drives it directly. By gearing, the two motions are utilized upon a single shaft.

In *x*, Plate LIII., the common shaft of the two cylinders carries a fly-wheel between them. This fly-wheel has cam grooves on its sides by which the piston abutment is worked. The pistons are so coupled together that one portion shall carry the other over the dead-centers. A slide-valve worked by a hand-lever enables reversion of the engine. The steam passes through the chambered piston-journals and drum.

In Fig. 4474, the steam admitted from the pipe *a* passes

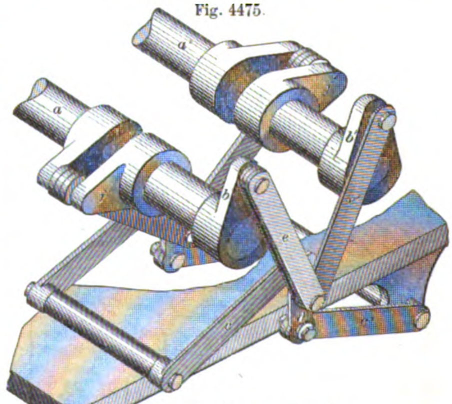
Fig. 4474.



Rotary Steam-Engine.

through the curved passage *b* (shown in dotted lines) in the rotary disk *c* to the steam spaces *d* in rear of the pistons *e e*, forcing each radially outward until its recessed portion passes partly beyond the periphery of the disk and its outer end rests against the surrounding cylinder, when the pressure is exerted circumferentially, causing rotation of the disk. As the disk

Fig. 4475.



Knight's Noiseless Gearing.

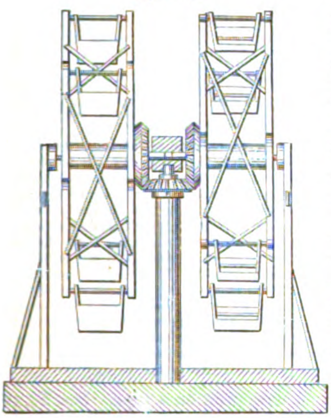
approaches the upper part of its rotation, the piston is forced in and the exhaust takes place, steam being cut off from this piston at the same time that the second piston reaches the induction port to receive its supply.

Knight's noiseless gearing (Fig 4475) is adapted for rotary engines employing paired shafts, for paired rollers, and in other cases where the co-rotation of two objects is desired, avoiding the friction and clattering of the usual modes of gearing.

In the illustration, *a a′* are the piston-shafts of a double-cylinder rotary engine; these have equally eccentric wrists *b b′* at their extremities. *c c′* are two equal arms hinged to brackets or other fixed objects, and having their other ends pivoted to a link *d*, which is pivoted to the two pitmen *e e′* connected to the extremities of the wrists *b b′*. To insure accuracy of movement, a second pair of wrists *f f′* at right angles to the first are formed on the shafts *a a′* and connected to each other by a precisely similar arrangement. The rotation of one shaft thus causes the other to rotate with equal velocity in the opposite direction. Other modifications are shown in George H. Knight's patent of September 10, 1867.

Ro′ta-ry Swing. The horizontal shafts with which the radial arms revolve have bevel pinions engaging the bevel-wheel on a pivot post, by which a horizontal revolution of the whole frame is effected.

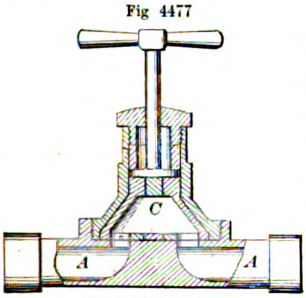
Fig. 4476.



Rotary Swing.

Ro′ta-ry Valve. A valve which acts by a partial rotation, such as the four-way cock or the faucets used in the Worcester, Savary, and early Newcomen steam-engines. The *trunnion-valves* of the oscillating-cylinder steam-engines have a reciprocating partial rotation. The valve has a passage *C*, which, when brought in line with the steam-pipe *A A*, connects the two parts of the same, and is adjustable, so that the passage may be completely or partially interrupted, as desired. When the passage is interrupted, the steam is made to press the valve upon the seat and thus prevent all escape, and makes a steam-tight joint without the use of packing.

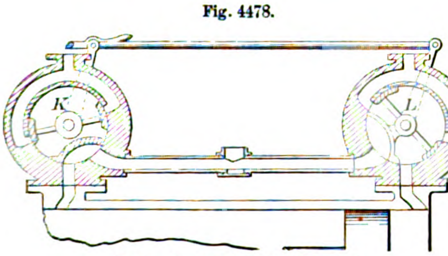
Fig 4477



Rotary Steam-Valve.

In Fig. 4478, the valves *K L* have each three wings; they oscillate in and coincide in form with the frustal chambers, whose ports connect with the steam-cylinder. The pressure on each valve is nearly balanced, and it is kept to its seat by a coil spring acting longitudinally on its stem.

Fig. 4478.



Rotary Valve for Steam-Engines.

Ro′ta-scope. An instrument on the principle of the gyroscope, invented by Professor W. R. Johnston of Philadelphia, about 1832. See GYROSCOPE.

Rot′ten-stone. A soft, brown mineral, found in Derbyshire, England, and used as a polishing material.

It is composed of alumina, 86; carbon, 10; silex, 4. It is sometimes called a variety of tripoli, but the latter is principally silex. Rottenstone is more nearly allied to emery, but has a portion of carbon and no iron. Iron is present in all the emeries.

Rot′ting. The steeping of flax-stalks to soften the gum and loosen the fiber from the woody portions. See RETTING.

Ro-tun′da. (*Architecture.*) A circular building or apartment covered by a dome, as the Pantheon at Rome, the large central apartment in the Capitol at Washington, etc. See also DOME.

Rouge. 1. A peroxide of iron of a light red color, used for polishing gold, silver, and speculum metal.

Sulphate of iron is purified of silex and calcined in a crucible. By restricting the heat to a dull red, the result is light-colored and forms *rouge*. If prolonged, black oxide is formed which gives it a cutting quality, and it becomes *crocus*.

2. The cosmetic is the result of an elaborate treatment of safflower, etc.

Rough-cast. (*Plastering.*) A mode of finishing outside work by dashing over the second coat of plastering while quite wet a layer of washed fine gravel mingled with lime and water.

Rough-coat. (*Plastering.*) The first coat on lath. On brick it is termed *laying* or *pricking up*; on masonry, *rendering* or *roughing*.

Rough-file. A file with heavy, deep cuts. The angle of the chisel in cutting is about 12° from the perpendicular.

The grades are as follows, beginning with the coarsest quality:

Rough.	Second cut.
Middle cut.	Smooth.
Bastard.	Dead smooth.

The number of teeth to the inch of a *rough file* are according to the length of the file in inches.

Inches	4	6	8	12	16	20
Cuts	56	52	44	40	28	21

They are commonly termed *ruffs*, in the trade.

Rough′ing. (*Hat-making.*) The *hardening* of a felted hat-body by pressure, motion, heat, and moisture. See HARDENING.

Rough′ing-down Rolls. See ROUGHING-ROLLS.

Rough′ing-in. (*Plastering.*) The first coat of three-coat plastering when executed on brick. See PLASTERING.

Rough′ing-mill. A lapidary's wheel, used in roughing down the surfaces of gems to make facets. It is of iron, mounted on a vertical axis, and its upper disk is touched with diamond-dust for the harder gems. It is followed by the *grinding* and *polishing* mills.

A grinding-mill used by lapidaries, consisting of a small copper disk, with a face turned true and flat and furnished with spicules of diamond imbedded by hammering into the copper.

A similar disk with fine diamond-dust is used for polishing. See LAPIDARY'S MILL.

Rough'ing-rolls. (*Metal-working.*) The first set of rolls in a rolling-mill, which operate upon the bloom from the tilt or shingling hammer or the squeezer, as the case may be, and reduce it to the bar form. It is then cut up by the *shears*, made into *piles* or *fagots*, reheated in a reverberatory furnace, and passed between the *finishing* rolls.

The roughing-rolls revolve at about 70 revolutions per minute, the finishing one of medium size at 140, and small ones at 220 or over. See ROLLING-MILL.

Rough-string. (*Carpentry.*) One of the slanting pieces supporting the steps of a wooden stairs. A *carriage-piece*. The upper end rests against an *apron-piece* or *pitching-piece*.

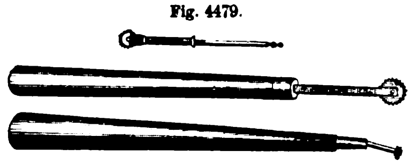
Rough-tree. (*Nautical.*) *a.* A rough or unfinished spar or mast.

b. The portion of a mast above the deck.

Rough-tree Rail. (*Shipbuilding.*) A timber forming the top of the bulwark. It rests upon the *top-timbers*, and caps the external and internal planking.

Rou-lette'. An instrument used in engraving, mechanical drawing, and plotting, for making dotted lines. It has a wheel with points, which, for use on paper, is dipped into india-ink, so that the points

Fig. 4479.



Roulettes.

impress a series of black dots or marks as the instrument passes over the paper. Different patterns of dots are used for national, state, county, and township lines, canals, roads, railways, etc.

Those illustrated are engravers' roulettes, principally used in mezzotinting to raise the burr when the original *ground* produced by the cradle has been too much scraped or burnished away.

Rounce. (*Printing.*) A winch with roller and strap by which the carriage or bed of a press is run in and out under the platen. See PRINTING-PRESS.

Round. 1. (*Joinery.*) *a.* The *rung* or *rime* of a ladder which forms a step, uniting the side pieces. *Round* is the preferable term. It is made out of rived timber, — not sawn, for fear of cross grain, — and dressed by the drawing-knife and spokeshave so as to bulge in the middle, the point of greatest strain. Wedges, driven into their outer ends, secure them to the side pieces. If the *round* does not go through the side pieces the ends are secured by *fox-tail* wedging.

b. The round rail joining the legs of a chair; also known as a *stretcher*.

2. (*Brewing.*) A vessel in which the fermentation of beer is concluded. The *rounds* receive the beer from the fermenting tun, and discharge the yeast at their bungholes into a discharging-trough.

3. (*Ordnance.*) A projectile with its cartridge, prepared for service.

Round Bud'dle. (*Metallurgy.*) A circular frame for working on metalliferous slimes.

Round Chis'el. An engraver's tool having a rounded belly.

Round-edge File. A file with a convex edge; for filing out or dressing the interdental spaces of gear-wheels.

Roun'del. (*Ordnance.*) A disk of iron having a central aperture, through which an assembling-bolt passes. It serves to separate the stock and cheeks. *Rondelle.*

Roun'der. 1. A rock-boring tool having a cylindrical form and indented face.

2. A plane used by wheelwrights for rounding off tenons.

Round File. A file circular in its cross-section.

Small, taper files of this description are known as *rat-tail* files.

Small, round files, without taper, are known as *joint* files, being used for filing out apertures for joint wires and pintles of hinges.

These files are used for *gulleting* saws.

Round-house. 1. (*Shipbuilding.*) A small deck above the level of the quarter-deck or spar-deck, as the case may be, at the after end of the vessel. A *poop*. Sometimes termed the *coach*.

2. (*Railway.*) A circular house with stalls for locomotives around a turn-table.

Round'ing. 1. (*Bookbinding.*) The process of giving a convex shape to the back of a book, hollowing the front edge at the same time.

After the sheets have been folded and sewed together, a strip of paper or thin canvas is glued to the back, and, the book being placed on one of its sides, the back is drawn a little to one side, gently tapping it at the same time with a broad-faced hammer. It is then turned over on the other side and similarly treated, imparting a convex form to the back, which is completed by placing the book in a press between two boards, with the back projecting, and hammering it on each side until the exact degree of curvature desired is obtained. This operation also produces a depression along each edge of the back, into which the side covers of the book lie, so as to present an even surface when attached. This part of the work is also effected by machinery, the book being placed between rollers, which compress it and at the same time draw it up against a former of such a shape as to give the proper convexity to the back.

2. (*Nautical.*) A wrapping on a rope. See SERVING.

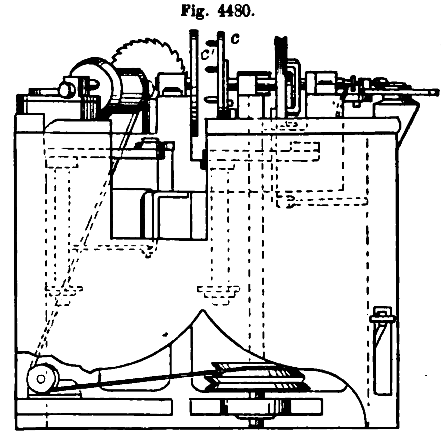
Round'ing-adze. A kind of adze with a curved blade.

Round'ing-gage. (*Hat-making.*) A tool (*d*, Fig. 4481) for cutting hat-brims. The curved portion is kept against the side of the hat, and, as the projecting arm is swept around, a knife held in one of the notches cuts the edge of the brim to an equal width all round. A number of notches are provided, so that the brim may be made of a width to suit the taste or the caprice of fashion.

Round'ing-jack. A stand on which a hat is fixed to have its brim trimmed to shape and size.

Round'ing-ma-chine'. (*Coopering.*) One for giving circular form to the heads of casks. The pieces to form the head are clamped between the

Fig. 4480.

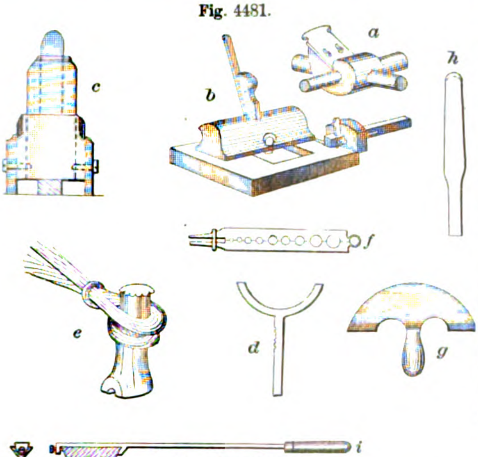


Rounding-Machine for Barrel-Heads.

disks *c c'*, and the protruding portion is trimmed off by the circular saw.

Round'ing-plane. A tool which is a connecting link between the tools of the carpenter and those of the turner. It has a plane-bit which is presented tangentially to the circumference of the circular hole, so that the wood enters in a rough octagonal form and leaves it rounded, being rotated as it passes therethrough. By this, or similar means, the handles of umbrellas, hoes, rakes, pitchforks, and brooms are made; as well as round office-rulers, chair and

Fig. 4481.



Rounding-Tools.

a, Rounding-Plane. b, Router-Plane. c, Reglet-Plane.

ladder rounds, and many articles of similar shape. It is substantially the same as the hollow auger (see AUGER), and is sometimes termed a *witchet.*

Round'ing-tool. 1. (*Forging.*) A top or bottom tool (*e*, Fig. 4481) with a semi-cylindrical groove forming a swage for rounding a rod, the stem of a bolt, etc.

2. (*Saddlery.*) A tool (*f*, Fig. 4481) consisting of a pair of jaws with corresponding, semi-cylindrical notches, which form, when closed, a series of circular openings of varying sizes, through which leathern straps are passed to be *rounded.*

Round-joint File. A kind of clockmaker's file.

Round-knife. 1. (*Leather.*) A currier's circular knife. An annular disk with the edge a little turned over. It is used in scraping skins. (Fr. *Lunette.*) See CURRIER'S TOOLS.

2. (*Saddlery.*) The ordinary cutting-tool (*g*, Fig. 4481) of the saddler, sharp on its convex edge.

Round-nose Chis'el. A tool used by marble-workers for sinking the surface of marble and leveling the cavities. It has at the end a bent portion with serrations, and is a kind of file. See RIFFLER.

Round-nose Plane. (*Joinery.*) A coarse-work bench-plane, the sole of which is rounding.

Round-off File. A small, parallel, half-round file, whose convex side is *safe*, and having a pivot at the end opposite the tang.

It is used for rounding or pointing the teeth of wheels made originally with square notches. The pivot enables it to be readily twisted in the fingers, to allow it to sweep round the curve of the tooth under treatment.

Round-plane. (*Joinery.*) A plane with a round sole for making rounded work, such as stair-rails, beads, etc. A *round-sole* plane; a *rounding* plane.

Round-seam. (*Nautical.*) When the edges of canvas are sewed together without lapping.

Round-shot. (*Ordnance.*) Spherical balls of iron or steel, usually cast. They are solid, while *case* and *shell* are hollow. The term is now little used.

Round-splice. (*Nautical.*) When the splicing is so carefully done that the shape of the rope is scarcely altered. A *long-splice.*

Round-tool. (*Wood-turning.*) A round-nose chisel (*h*, Fig. 4481) for making concave moldings.

Round-turn. (*Nautical.*) One turn of a rope around a timber; or of one cable around another, caused by the swinging of the ship when at anchor.

Round-up. (*Shipbuilding.*) The convexity or arch of a deck.

Rouse-a-bout' Block. (*Nautical.*) A *snatch-block* of large size. See SNATCH-BLOCK.

Rous'er. A stirrer in the hop-copper of a brewery.

Rout'er. (*Joinery.*) A sash-plane made like a spokeshave, to work on circular sash. It may be an *ovolo* router or a *lamb's-tongue* router, according to the nature of the molding.

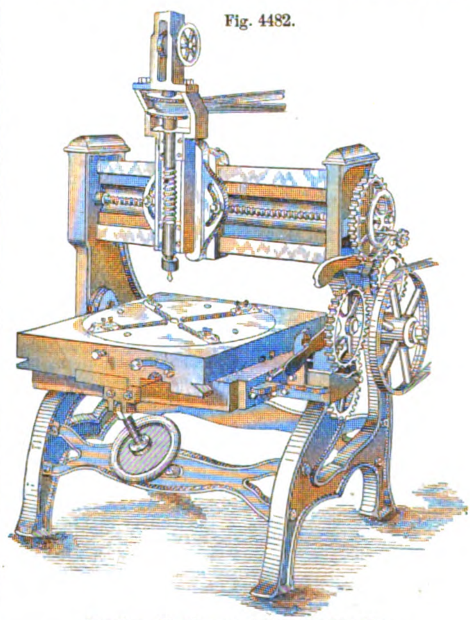
Rout'er-gage. A gage (*i*, Fig. 4481) with a stem and adjustable fence, and provided with a tooth like a narrow chisel, adapted to cut a groove in wood or brass, for the purpose of inlaying.

Rout'er-plane. It has a broad surface, carrying in its center one of the cutters belonging to the plow. It is used for leveling the bottoms of cavities. The stock must be more than twice the width of the recess, and the projection of the iron determines the depth. The sides of the cavity are prepared beforehand by the *chisel* and *mallet*, the *saw*, or the *cutting-gage.* See *b*, Fig. 4481.

Rout'er-saw. A saw having a cutting point on each side of the blade, adapted to cut into the wood, and a less prominent router tooth to remove the chip between the marks or kerfs made by the cutters.

Rout'ing-ma-chine'. A *shaping-machine* which works by means of a router-cutter, adjustable itself,

Fig. 4482.



Routing, Slotting, and Shaping Machine.

and revolving above a bed with universal horizontal adjustment, so as to permit the cutter to follow along a traced line, and thus cut to a shape, or groove to a depth, the work upon the table.

It is adapted for work in metal or stone; in the latter case, black diamonds are used. Paneling in relief or intaglio, raised or sunken lettering, circular slotting, slotting, key-seating, beveling, bordering, may be done upon it.

The cutter-spindle is fixed in a head-block which traverses to the right or left, and may be inclined to any required angle. By means of a hand-wheel and suitable mechanism, the spindle may be raised instantly to clear any obstruction without stopping the machine. The spindle and the feed motions are driven by belting from pulleys not shown in the engraving.

The bed of the machine traverses backward or forward. By means of a screw working in a swiveled nut, the bed may be inclined to any required angle from the horizontal plane. In the center of the bed is a rotating face-plate with automatic feed. By a combination of the backward and forward movements of the bed and the rotating face-plate which carries the piece to be worked, ovals may be cut. The feed-motions are all connected, disconnected, or reversed by simple devices, without interfering with any other motion of the machine. There are four feed-motions: one raises or lowers the spindle, a second traverses the head-block to the right or left, a third traverses the bed-plate backward or forward, a fourth causes the circular face-plate to rotate to the right or left. The inclination of the spindle or the bed does not interfere in the least with the automatic action of these several feed-motions.

Rout'ing-tool. (*Metal-working.*) A revolving tool used for scorping out metal. Such are used in digging out the spaces between and around block-letters and bookbinders' stamps. Also in deepening the "white" spaces in stereotype and zincographic plates, etc. Also for deepening broad spaces in the lettering of door-plates. See ROUTING-MACHINE.

Rove. 1. (*Boat-building.*) A small copper ring or washer, upon which the end of a nail is clinched on the inside of a boat.

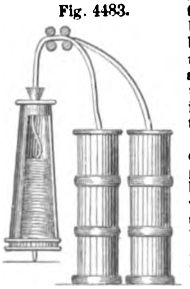
2. (*Spinning.*) A *sliver* of wool or cotton, slightly compacted by twisting, ready for the farther processes, which vary somewhat with the respective materials. See ROVING.

Rov'ing. (*Cotton-manufacture.*) 1. A slightly twisted *sliver* of cotton or other carded fiber.

2. A process intervening between carding and spinning, in which a number of *slivers* from the carding-machine, contained in separate cans, are associated by being conducted between pairs of rollers (see DOUBLING), and then between other successive pairs, by which the combined sliver is reduced and elongated (see DRAWING-FRAME); the sliver, as it issues from the last pair of rollers, being brought to the condition of a *rove*, *roving*, or *slub* by being slightly twisted by mechanical means, which may consist of one of the three following: —

a. Arkwright's plan was to conduct the slivers from the separate cans to a pair of rollers where they were coalesced (*doubling*), then between a pair more rapidly revolving, by which they were attenuated (*drawing*), and from thence the combined and lengthened *sliver* was conducted to a rapidly revolving can, which gave it a twist and brought it to the condition of a *roving* or *slub*.

Fig. 4483.



Roving-Machine.

b. Another plan was the *jack-frame* or *jack-in-a-box*, in which the twist was given by the revolution of the can as before, but instead of being coiled up within the can, the roving was wound upon a bobbin inside the can, the bobbin being rotated by wheel-work with a surface velocity corresponding to that of the delivery drawing-rollers. See JACK-FRAME.

c. A third plan, which is later and preferred to the before-mentioned, belongs to the domain of spinning, its functions being similar and differing only in the degree to which the twist is carried.

The machine is called the BOBBIN AND FLY FRAME (which see). The slivers are wound on bobbins, and the latter are arranged upon a *creel*. The slivers pass from the bobbins through a set of drawing-rollers, and thence to the spindles on which they are wound.

The *sliver* passes through the axial opening of the flyer, and thence down the hollow arm of the flyer, from whose end it is wound upon the bobbin, which has an up-and-down motion by means of the *copping rail*, so as to wind the yarn into a regular form, called a *cop*. See COP.

The *spindle* and flyer revolve together, and give the twist to the *sliver*, but the degree of twist depends upon the ratio of the surface speed of the delivery-roller and the rate of the spindle.

The spindle and the bobbin are revolved by different means and at different rates, in order to wind the thread upon the bobbin; the difference between the motions of the bobbin surface and the delivery arm of the flyer being equal to the surface motion of the delivery-roller, the thread is wound as fast as it is paid out, receiving a twist *in transitu*. See EQUATIONAL BOX.

Bobbin and fly frames are of two kinds, *coarse* and *fine*, or *first* and *second*. The former is fed with *slivers* from *cans*, and the latter with *slivers* wound on *cops* made in the *coarse roving-frame*. See BOBBIN AND FLY FRAME.

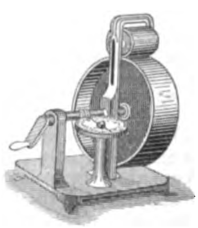
Rov'ing-frame. The roving-frame for worsted is similar to that for cotton. It takes in two slivers from the cans of the *drawing-frame* and elongates them four times, giving them a slight twist to impart coherence. See previous article.

Rov'ing-head. A roving-frame used in the worsted manufacture.

Rov'ing-plate. A piece of iron or steel plate similar to a joiner's scraper, which is held to the top of a grindstone with its edge inclined at a small angle, for the purpose of smoothing its surface.

Rov'ing-reel. A device for measuring the length of a roving, sliver, or hank of yarn. It has a drum and a small presser-roller, between which the roving is drawn by turning a crank on the axis of the drum; the axis has a worm cut on its periphery, which turns a dial-wheel indicating, by means of a pointer, the number of yards which have passed between the rollers; when the crank-handle is down, the dial stands at zero.

Fig. 4484.



Roving-Reel.

Row'el. A spiked wheel, as, —

1. (*Saddlery.*) *a.* The stellar wheel of a spur.

b. The flat ring in a horse's bit.

2. (*Agricultural.*) The spiked wheel of the Norwegian harrow and other soil pulverizers. See HARROW.

Row'el-ing-nee'dle. (*Farriery.*) An instrument used in farriery to insert a rowel through the skin of a horse. A rowel consists of hair or silk, or is even a roll of leather, and corresponds to a *seton* in surgery.

It is sometimes inserted in a gash, in the manner of a *tent*.

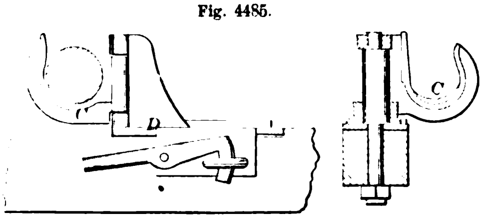
Row'el-ing-scis'sors. An instrument used in inserting *rowels* in the flesh of horses.

Rowl. (*Nautical.*) The sheave of a whip-tackle.

Rowle. (*Nautical.*) A light crane, formerly used in discharging cargo.

Row'lock. (*Nautical.*) A crotch or notch on

Fig. 4485.



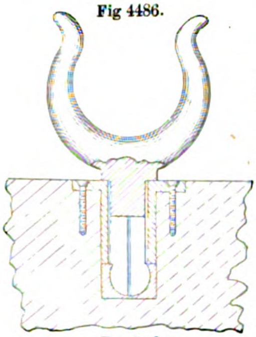
Norcross's Oar-Lock.

the gunwale of a boat, against which the oar works in rowing.

Various devices are used: —

1. Two short pegs or posts rising from the gunwale.

Fig 4486.



Rowlock.

2. An iron stirrup pivoted in the gunwale.

3. An iron pin in the gunwale, and the oar fastened to it by a thong.

4. A pin in the gunwale passing through a hole in the oar.

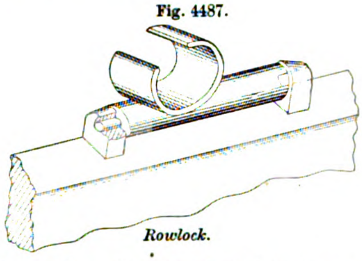
5. A notch in the gunwale.

Fig. 4485 is a hook *C* swiveled on a post *D* which is fastened to the gunwale by a flanged plate, staple, and latch, so as to be unshipped when required.

Fig. 4486 is a fork swiveled in a socket inserted into the gunwale.

In Fig. 4487, the pin of the rowlock enters and

Fig. 4487.



Rowlock.

works in a roller, which is pivoted to two ears attached to the gunwale. See also OAR-LOCK.

Row dry. An order given to the oarsmen to row in such a manner as not to splash the water.

Rowed of all. An order to cease pulling and lay in the oars.

Row-port. (*Nautical.*) Small ports near the water's edge for the *sweeps* or large oars, whereby a vessel is rowed during a calm.

Roy'al. 1. (*Nautical.*) A mast and sail next above the *top-gallant*.

2. (*Paper.*) A size of drawing and writing paper, measuring $23\frac{1}{2} \times 19$ inches and weighing according to quality.

3. (*Ordnance.*) A small mortar.

Rub'ber. A polisher.

1. A grinding agent, as emery or glass paper.

2. *a.* Caoutchouc. See INDIA-RUBBER; CAOUTCHOUC.

b. A block of caoutchouc for erasing pencil-marks.

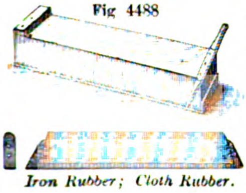
3. A coarse file.

4. A whetstone.

5. (*Fabric.*) *a.* A coarse, unbleached flax toweling for rubbing the body after bathing.

b. A coarse towel used for drying horses.

Fig 4488.



Iron Rubber; Cloth Rubber.

6. (*Masonry.*) A board or block used in grinding or polishing. In the moldings of stone, an iron *rubber* mounted on a wooden stock is employed for fillets, beads, and astragals. These rubbers have convex or concave faces, according to the required contour of the work. A stone or wooden block covered with thick felt is used for polishing stone and marble.

7. (*Electricity.*) *a.* That part of an electrical machine which rubs against the cylinder or disk.

b. The moving pad or piston of an electrophorus.

8. (*Nautical.*) A tool for flattening down the seams in sail-making.

9. A roll of cloth charged with emery, rottenstone, or other abradant or polishing material, for surfacing plates.

10. (*Vehicle.*) The part of the wagon-lock which presses against the wheels.

Rub'ber Cem'ent. 1. Caoutchouc cleaned, triturated with a small quantity (say 3 per cent) of sulphur, and then dissolved in benzine or other hydrocarbon.

In this condition it is ready for spreading on cloth to be cut into shapes to form various articles, such as boots, shoes, coats, buckets, belting, and many other things.

2. For fastening rubber plates or rings to metal or wood. A solution of shellac in ten times its weight of strong ammonia. Left to soften for weeks without heat.

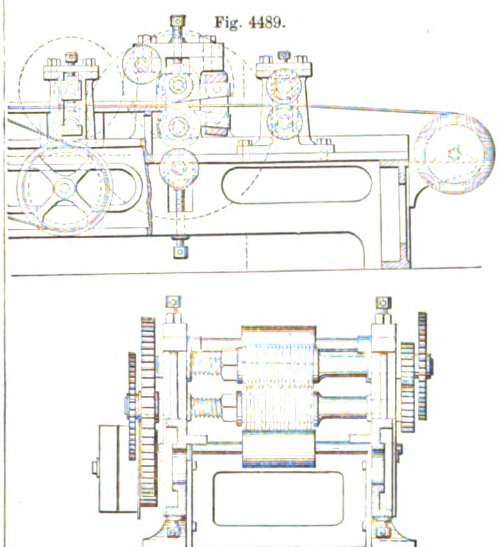
Rub'ber-cloth. 1. Fabric covered with caoutchouc.

2. Caoutchouc in sheets. See CAOUTCHOUC; INDIA-RUBBER.

Rub'ber-cut'ting Ma-chine'. A machine for making threads of caoutchouc for *shirrs*.

Jacques' machine is shown in Fig. 4489 by longitudinal and transverse vertical sections. It has a

Fig. 4489.



Jacques' Rubber-Cutting Machine.

series of disks with square cutting-edges and mounted upon spindles, arranged in such proximity to each other as to allow the disks of one spindle to mesh with the disks of the other. The disks on each spindle are prevented from revolving thereon by means of a spline or feather, and are separated by gage-plates of a thickness equal to the thickness of the cutters, and of a diameter sufficient to support the sides of the disks during the cutting operation, so that they shall not deviate laterally.

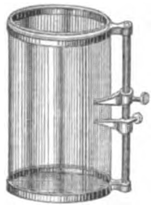
Rub'ber-file. A heavy, fish-bellied file, designated by weight, which varies from four to fifteen

pounds. They are of square or triangular section, and used for coarse work.

When they have three flat faces and one rounded, they are known as *half-thick* files.

Rub'ber-gage. A device for ascertaining the quantity of india-rubber required to make a given article. The vessel (Fig. 4490) is partially filled with water, and the lower index set at the hight of its level. The model of the object is then immersed in the water and the upper index set at the point to which the water rises. The model being removed, the vessel is again filled to the hight of the lower index; rubber is added until it rises to the upper index. The amount required to make it do this is that which the article requires for its manufacture, to which an addition may be made for loss or wastage.

Fig. 4490.



Rubber-Gage.

Rub'ber-knife. A circular blade rotated at high speed and kept constantly wet by a jet or spray of water. It is technically known as a *rubber-saw.*

Rub'ber-mold. 1. A flask or former for shaping plastic rubber.

2. A vulcanite mold for shaping plates for artificial dentures, etc.

Rub'ber-mount'ing. (*Saddlery.*) Harness mounting in which the metal is covered with vulcanized india-rubber in imitation of leather-covered work.

Rub'ber-saw. A tool used in cutting india-rubber, — caoutchouc. It is not properly a saw, but is so termed in the trade. It is a circular knife, driven at high speed, and kept constantly wet by a jet or spray of water.

Rub'bing. The process of straightening the wires for needles. The wire is furnished in coils, from which the blanks are cut in double lengths. The bend is taken out of them by a process called *rubbing.* Several thousands of the pieces of wire are collected within two broad and heavy rings placed on a shelf in the furnace, and heated to redness. A slotted bar, called a smooth file, is then pressed upon the needles in the pack, the rings projecting into slots in the bar, which is reciprocated endways, so as to rub the wires against each other as the pack rolls back and forth until, by mutual attrition, the bend is all taken out.

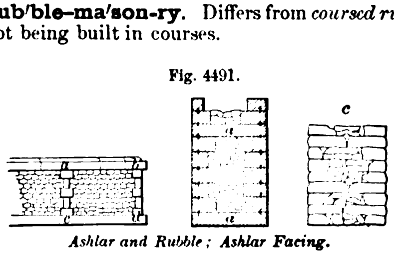
Rub'bing-paunch. (*Nautical.*) A piece of wood nailed on the foreside of a mast to prevent injury to the latter by yards or spars in raising or lowering.

Rub'bing-stone. (*Bricklaying.*) A grit-stone, which is placed upon the *banker* or bricklayer's bench, and upon which stones are rubbed smooth after being dressed by an axe to a shape suitable for gaged arches, domes, niches, or similar work.

Rub'ble. (*Masonry.*) Broken stone, brickbats, small stones used in filling behind the face courses of walls.

Rub'ble-ma'son-ry. Differs from *coursed rubble* in not being built in courses.

Fig. 4491.



Ashlar and Rubble; Ashlar Facing.

Coursed and *rubble* masonry are sometimes combined, and produce a rusticated effect, as in the illustration, where the coping *a b*, the piers *a c*, the plinth *c d*, and the quoins *b d* are of *coursed* masonry, giving solidity to the wall and adding to its appearance. With thick walls, the facing may be of *ashlar*, filled in with rubble. Occasional *bond* or *heading* stones *a* keep the facings from settling apart.

Rub'ble-work. (*Masonry.*) Masonry in which stones are used in the rough without being dressed to size, unless on their exposed faces (*c*, Fig. 4491).

It is *regular coursed* when the courses are of the same hight; *irregular coursed* when the courses are of different hights; *random* or *uncoursed* when stones of different hights are used in the same course.

Ru-belle'. 1. (*Enameling.*) Probably from the red tourmaline. (Ger. *Rubellan.*) A red color in enameling.

2. (*Metallurgy.*) (Ger. *Rubelle*, from *reiben*, to rub.) An iron plate on which ores are ground to test them or prepare for test by assay.

Rub-ir'on. A plate on a carriage or wagon-bed against which the fore-wheel rubs when turning short.

Called *wheel-guard plate* in a field-artillery carriage; one is placed on each side of the stock.

Rub-stone. The flat stone on which the currier's knife is ground to an edge. The *clearing-stone* is one of finer grain, on which the knife receives a more perfect edge, which is then turned over by a *steel.*

Ru'by. 1. (*Printing.*) The name given in England to a type corresponding to that called *Agate* in the United States. See AGATE.

Pearl.
Agate or Ruby.
Nonpareil.

2. (*Horology.*) The jewel of a watch. The *end-stone* is usually a ruby in first-class work.

Rud'der. 1. (*Nautical.*) A flat frame hung to the stern-post of a vessel and affording a means of steering.

The *pintles* of the rudder are hooked upon the *eye-bolts* of the stern-post, which afford an axis of oscillation as the rudder is moved to and fro by the tiller.

Rudders are not as old as boats by any means. The first rudder was a paddle or oar held over the stern. One is shown in the sculptures of Nimroud.

The Nile boats of ancient Egypt had rudders, one, two, or three in number; sometimes the oar traversed on a beam at the stern, or it was slung from a post on which it was pivoted.

The rudder is shown in two forms in the ancient paintings of Edfou; projecting at the stern like an oar, and pivoted vertically. The latter form has the *tiller.*

Hesiod recommends to hang up the rudder in the smoke of the chimney when out of service.

The rudders of the ancients were paddles which protruded through ports in the stern, or rested in rowlocks on the taffrail of the ship or boat. In the tempestuous voyage of Paul, when they had "discovered a certain creek with a shore, into which they were minded, if it were possible, to thrust the ship," they took "up the anchors," "committed themselves unto the sea," loosened the fastenings of the rudders, "hoisted the mainsail to the wind, and made towards shore." Paul wrote well on every subject he undertook, and the account of his voyage gives us a better idea of the mode of navigation 2,000 years ago than any other work which has come down to our time. The rudders, where more than one was used, were on each quarter, protruding through holes in the counter.

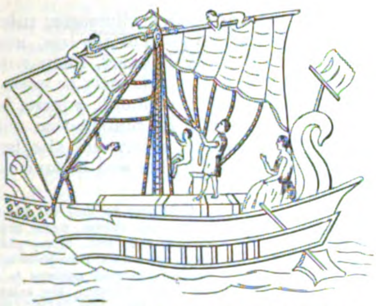
The foremost part of the frame of a rudder is the *rudder-stock.* Its slope is termed the *rake* of the rudder; this depends on the rake of the stern-post. Its upper cylindrical end is the *rudder-head.* It rises through the *rudder-port* in the stern. Its lower end is the *heel*, and rests on the *step.* It turns on *pintles*, fitting into eyes called *braces*, on the *stern-post* or *rudder-post.*

The front edge of the rudder is *bearded* or beveled, to allow it to be *put over* either way to a greater angle.

Rudders are *sheathed* with copper or mixed-metal sheets.

The rudder, when hung, is guarded against being *unshipped* by a movable piece called a *wood-lock*, which is screwed upon

Fig. 4492.



Ancient Ship (from a Painting at Pompeii).

the stern-post or rudder, and fits into a score a little above the uppermost pintle.

Lumley's two-leaved rudder (English) has a *body* hinged to the stern-post in the usual way, and a *tail* hinged to the body. The parts are also connected by a *yoke*, which causes the tail to assume the same angle relatively to the body that the body does relatively to the ship.

Rudder-chains and *pendants* are chains securing the rudder to the stern. See RUDDER-CHAIN.

The *rudder* is moved by the *helm*. This may be a mere lever, called a *tiller*, moving in a horizontal plane. Such was the original device, still used in boats and by Chinese navigators.

Another form is the *yoke;* a horizontal bar on the rudder-head, athwartship, and having ropes from its respective ends, which are used by the coxswain or steersman in moving the rudder. This is common in boats.

The usual form in ships consists of a wheel (see STEERING-WHEEL) with ropes or chains winding on the axis of the wheel and passing through sheaves to the tiller or yoke on the rudder-head.

On the steamboats of our Western and Southern rivers, a tiller is dispensed with, the rudder being operated by wire cords or chains which proceed from the steering apparatus in the pilot-house or "Texas," on the hurricane deck. The chains are made fast to the outer extremity of the rudder. Hempen cords were formerly used, but several accidents having been made much more fatal from the cords burning off, rendering the vessel unmanageable, wires and chains have been generally substituted.

2. (*Agriculture.*) A sieve for separating the chaff from the grain. Probably a corruption of RIDDLE.

Rud′der-band. (*Nautical.*) That member of a rudder-hinge which has bands to brace the rudder and an eye for the pintle on the part attached to the stern-post.

Rud′der-breech′ing. (*Nautical.*) A rope for lifting the rudder to ease the motion of the pintles in their gudgeons.

Rud′der-case. (*Nautical.*) The well in the stern occupied by the rudder-stock. The *rudder-trunk.*

Rud′der-chain. (*Nautical.*) One of the chains whereby the rudder is fastened to the stern quarters.

They are shackled to the rudder by bolts just above the water-line, and hang slack enough to permit the free motion of the rudder. Their use is to prevent the rudder being lost in the event of its becoming unshipped. They also sometimes led in-board, to be used in steering should the rudder-head or tiller give way.

Rud′der-coat. (*Nautical.*) A canvas clothing to the rudder-stock, which keeps the sea from passing through the trunk in the counter.

Rud′der-pen′dant. (*Nautical.*) A continuation of the rudder-chain, secured by a staple around the quarter, under the molding. In the end of the pendant a thimble is spliced, to which may be hooked a tackle, in case the tiller or head of the rudder is carried away.

Rud′der-port. (*Shipbuilding.*) The hole in a ship's counter for the passage of the rudder-head.

Rud′der-tack′le. A tackle employed for operating the rudder in case its head is carried away or for working a make-shift rudder.

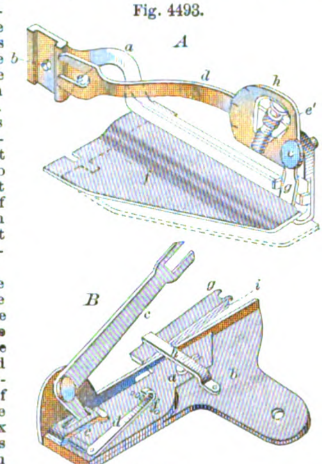
Ru-den′ture. (*Architecture.*) The figure of a rope or staff, sometimes plain, sometimes carved, with which the third part of the flutings of columns is frequently filled up.

Ru′der-a′tion. A term used by Vitruvius for laying of pavement with pebbles.

Ruf′fle. A strip gathered and sewn on one edge and the full edge hemmed. A *double ruffle* is full on both edges and gathered in the middle. A *puff* is gathered on both edges and full in the middle.

Ruf′fler. 1. A sewing-machine attachment for forming ruffles in goods. That illustrated at *A*, Fig. 4493, is Toof's, particularly designed for the Singer machine, but its mode of attachment may be varied to suit other machines.

Fig. 4493.



Rufflers.

The arm *a* is connected by a screw at *b* to the presser-foot bar of the sewing-machine, and to it is connected by a rivet *c* the lever *d*, which is forked at *e* to receive the nut securing the needle, from which nut it derives motion.

The lever *d* carries a set-screw *e′* for adjusting the amount of movement given to the feed-plate *f* at each reciprocation of the needle, which passes through a slot at the rear of the feed-plate.

The goods are placed between the feed-plate and the presser-foot of the machine, and as the needle passes upward and downward, carrying the long arm of the lever *d* with it, the arm *g* of the index device *h* reciprocates the feed-plate to an amount previously regulated by the adjustment of the screw *e′*; at each forward movement the feed-plate acts on the presser-arm, carrying forward and folding the cloth, which is penetrated by the needle as the latter descends and causes the backward movement of the feed-plate.

In the Johnston ruffler (*B*, Fig. 4493), a sliding-plate *a* is secured to the bed-plate *b* of the machine by rivets or screws passing through slots in the plate, so as to permit the necessary motion. The plate *a* is reciprocated by the forked lever *c* operated from the needle-bar. The movement of the plate *a* and the depth of the gather or ruffling are regulated by a bent lever *d* pivoted on the sliding-plate. One arm of this lever passes under a slotted piece *e* attached to the sliding-plate, and the other has a projection at its end for holding it in either of a series of notches *f*. The cloth is held between a spring *g* attached to an arm *h* on the bed-plate, and a spring *i* connected by an arm to the sliding-plate, which is reciprocated at each movement of the needle to a distance determined by the previous adjustment of the lever *d*.

2. A sort of heckle for flax.

Ruff-wheel. (*Metallurgy.*) An ore-crushing mill for the pieces which will not feed into the usual crusher.

Rug. (*Fabric.*) A nappy fabric made for a wrapper, cover, or protection.

A *railway-rug* is a coarse shawl for wrapping the legs or for use as a blanket.

A *bed-rug* is a nappy, woolen, colored blanket.

A *hearth-rug* is a tufted fabric on a backing consisting of a hempen, linen, or cotton web. It is made in the manner of a Turkey carpet. The vertical chain of the web is stretched between the *yarn-beam* above and the *cloth-beam* below. A number of

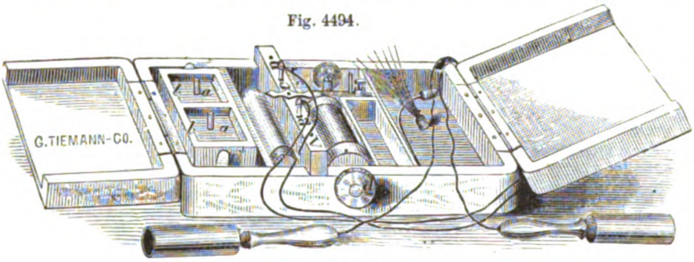
colored worsted yarns are hung over a bar to the right of the weaver, who, taking the end of one yarn, attaches it to the chain, cuts it off to the proper length, then twists in another, which he severs in the same manner, and in this way forms a row of tufts across the warp. He next passes a shoot or two of weft, and drives the weft against the web with considerable force to compact the fabric.

Rug'ging. 1. (*Fabric.*) Coarse woolen wrapping or blanket cloth.

2. (*Saddlery.*) A coarse cloth used for the body of knee and other horse boots.

Ruhm'korff Bat'ter-y. Fig. 4494 shows Tiemann's Ruhmkorff battery for medical purposes. *b b* are the cells, and *a a* elements of the piles. In the middle compartment is shown the induction-coil, and on the partition are holes *A B C D* forming a kind of peg-switch. The two connectors are placed in one or other of the holes, according to the required extent of the length of coil desired to be embraced in the circuit.

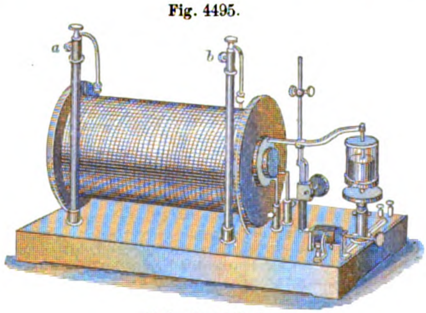
Fig. 4494.



Tiemann's Ruhmkorff Battery.

Ruhm'korff Coil. A form of coil devised by Ruhmkorff, for causing intense electro-magnetic cur-

Fig. 4495.



Ruhmkorff Coil.

rents by induction. It consists of an inner primary coil, made of wires about No. 15, wire gage, in diameter, forming part of the circuit of a battery, and having an axial bundle of straight wires of soft iron, united at each end to a disk of similar metal. The outer, secondary coil is of much smaller wire, about No. 32, wire gage, in diameter, and very much greater length. In a large apparatus, the former might be about 90 yards, and the latter 90 miles long. The convolutions of the secondary coil are carefully insulated from each other and from the primary coil, and its ends are secured by binding-screws *a b* supported by glass pillars. See INDUCTION-COIL; INDUCTORIUM.

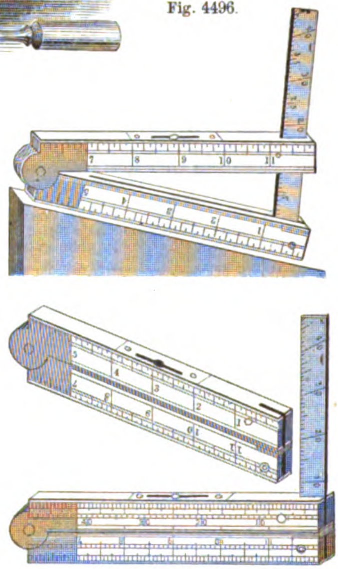
Ru-ille'. (Fr. *ruillée.*) (*Building.*) A pointing of mortar at the junction of a roof with a wall higher than itself. A fillet of mortar to shed the water.

Rule. An instrument for making linear measurements. It is divided into inches and fractions, and is usually jointed, so that it may be folded up and carried in the pocket. Those used by some classes of artificers are, however, made in a single piece.

Fig. 4496 is denominated a clinometer rule. A small spirit-level is set into one of the legs, and being provided with a pivoted branch folding into a cavity in the other leg, the rule may be used as a clinometer or slope level; a plumb, square, bevel, protractor, or T square; in combination with a straight edge, as a parallel ruler, and also for approximately determining hights and distances trigonometrically.

"Abroad to find out one to engrave my tables upon my new sliding rule with silver plates, it being so small, that Browne, that made it, cannot get one to do it. So I got Cocker [the celebrated arithmetician, Ob. 1679], the famous writing master, to do it, and I set an hour by him, to see him design it all." — PEPYS'S *Diary*, 1664.

Fig. 4496.



Rules.

Some rules have a slider in one leg; in Gunter's scale this is graduated and engraved with figures, enabling various simple computations to be made mechanically.

When Dalton (who died in 1844, æt. 78) made known his discovery of the theory of chemical equivalents, Dr. Wollaston invented a sliding rule, on the principle of Gunter's, for facilitating chemical calculations; it was employed for determining the chemical equivalence of compound bodies, and the proportion of one substance necessary to decompose another.

Pattern-makers use a rule whose divisions are made a certain per cent longer than standard measure. Iron castings shrink in cooling about 1 per cent, or $\frac{1}{8}$ of an inch to a foot. The patterns therefore require to be made proportionately larger. By using a rule $\frac{1}{8}$ inch in a foot longer than the standard, every measurement of the pattern is made proportionately larger without the trouble of calculation.

When a woolen pattern is made, from which an iron pattern is to be cast, the latter being intended to serve as the permanent, foundry pattern, as there are two shrinkages to allow for, a *double-contraction rule* is employed, or one in which the measurements are in excess ¼ inch in every foot, for iron.

The shrinkage of brass is about $\frac{3}{16}$ of an inch to the foot. Iron castings weigh about 14 times as much as the pine patterns.

2. (*Printing.*) *a.* A thin plate of metal, used for separating headings, titles, the columns of type in a book, or columns of figures in tabular work.

Rules are of the same hight as the type, and some have a guttered face so as to print a double line.

b. A slip of metal laid above the last line set, to facilitate placing type in the stick.

3. (*Plastering.*) A strip or screed of wood or plaster, placed on the face of a wall as a guide to assist in keeping the plane surface.

Rule-joint. A movable joint in which a tongue on one piece enters a slot in the other, and is secured by a pin or rivet. When the two pieces are in line, their ends abut, so that movement is only possible in one direction. This arrangement is used for carpenter's rules and table-leaves.

Rul'er. An instrument with straight sides, for guiding a pen, pencil, or scriber in drawing straight lines. The fiducial edge, when divided, enables linear measurements to be laid down therefrom.

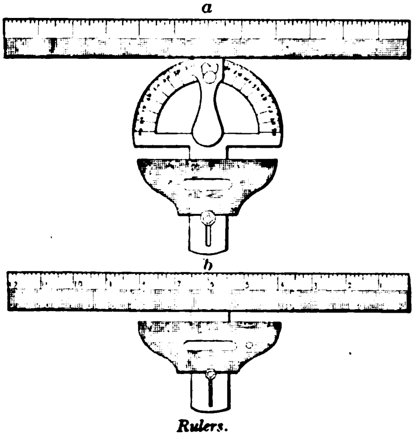
The *regula* (ruler) of the ancient Romans was thus divided, as are the rules of carpenters and other artisans at present.

Desk-rulers are either flat or round; the first have a beveled edge to prevent ink flowing from the sides of the pen on to the paper. The round form is very convenient for ruling parallel lines by one accustomed to its use.

The common parallel ruler is composed of two straight-edged arms, which are kept parallel by means of two pieces pivoted to each. Sometimes an intermediate parallel piece is interposed, or a single straight-edge, having a roller near each end, is employed.

The universal adjustable ruler (*a*, Fig. 4497) comprises a graduated straight-edge and a protractor, enabling angular

Fig. 4497.



Rulers.

measurements to be made or parallel lines to be drawn at any angle with the edge of the table or drawing-board.

The ruler *b* is also adapted for drawing parallel equidistant lines; the protractor being dispensed with.

There are several varieties used for drawing parallel lines.

a. Two-part ruler; the most usual kind.

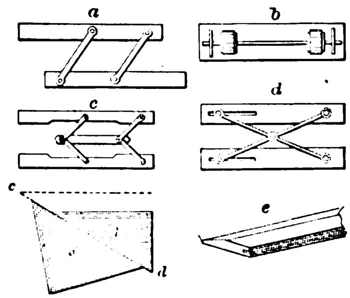
b. Dollond's ruler; has a roller near each end.

c. Three-part ruler.

d. Cross-brace ruler.

The draftsman's table is provided with two triangles; one having the angles of 45° and 90°, and the other, 30°, 60°, and

Fig. 4498.



Parallel Rulers.

90°. By holding the former of these steady with the left hand, at such an adjustment that the edge of the triangle shall be coincident with the given line, a line parallel with the said line may be obtained either above or below it, by slipping the triangle *b* on the triangle *a*.

e has a metallic straight-edge imbedded in the face.

Other rulers have parallel hinged slats, or consist of an elastic straight-edge, which will yield to the bent pages of a record or account-book; a straight-edge considerably elevated from the paper to prevent ink soiling the latter; one provided with clamps to secure it to the edges of a book; containing recess for holding pencil or pen, made of folded sheet metal or both; T-shaped for ruling lines parallel or at right angles to edge of book.

Rule-staff. (*Shipbuilding.*) A lathe about 4 inches in breadth, used for laying off curves.

Rul'ing-ma-chine'. An arrangement for ruling sheets of paper for blanks or for writing.

The simplest ruling-machine, perhaps, is a pen and straight-edge. A cylindrical ruler with a guide for the ruling-pen is a common device.

In ruling paper with *faint* lines for writing, the sheets are passed singly under a series of ruling-pens, arranged at proper distances apart to give the lines.

The pen is a bent strip of thin sheet-metal, forming a trough, down which the ink or dye runs from a bit of cloth or sponge, which is saturated with the fluid. Two or more colors may be ruled in parallel lines by employing a set of pens for each color.

Blank-books and blanks with printed headings are preferably ruled of late years by the ruling-machine, instead of on the letter-press, the rules in the latter case making an impression in the paper which is liable to catch the pen.

Perpendicular rules are sometimes drawn from different points at the top of the page, when heads and sub-heads are printed on the paper. This is accomplished in a ruling-machine by raising some of the pens until the sheet has passed to the point from which the lines are drawn, when the pens are lowered to the paper. This is accomplished by hand, or by a cam movement operating a *striker*.

All the pens are lifted at once at the foot of the sheet, generally by a cam mechanism.

Blanks and blank-books are generally printed before ruling.

The ruling of note and letter paper on three pages is accomplished by a cam movement which raises the pens when halfway across the outside of the sheet. The expense of ruling on three pages is therefore greater than where the paper is ruled entirely across.

Compound lines, as the heavy lines in account-books, when of two colors, are ruled by pens of different length, one pen extending forward on the machine beyond its neighbors. The lines are thus brought close together without crowding the pens, and the dye first run upon the paper has an instant of time to *set* before the second color is reached.

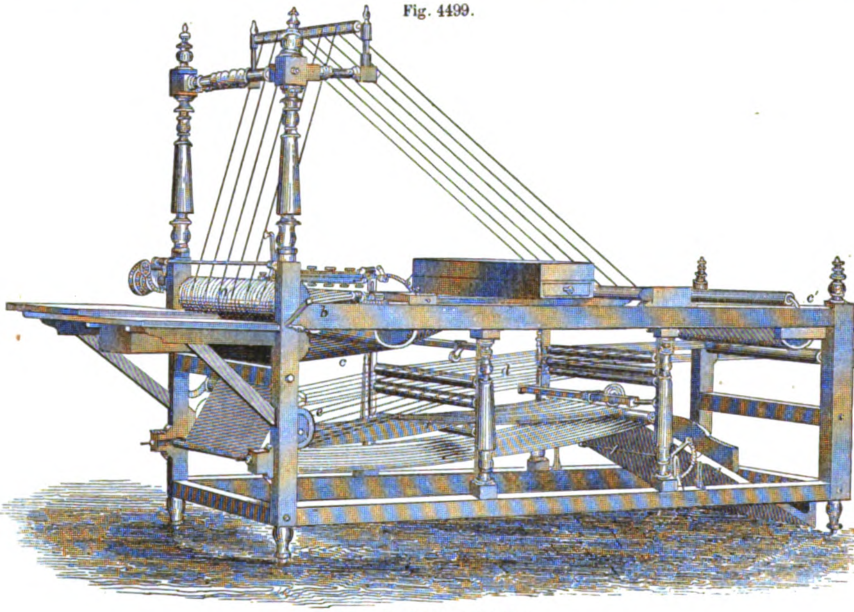
Zigzag, wavy, and cross lines are ruled on bank-notes, checks, etc., by giving the paper a double motion while under the pens. Very neat designs and tints are sometimes secured in this way.

In Hickock's machine, the sheets from the feed-table are received by the roller *a* and carried, by an endless belt and cords, beneath the row of pens *b*, from which they are conveyed by the cords *c* to the other end of the machine, and after passing

around the roller c', travel upon the cords d to e, where they are transferred to the cords f, by which they are conducted to the delivery-board g, having thrice traversed the whole length of the machine. This is done in order to dry the ink.

The pen-holder for ruling-machines (Fig. 4500) consists of an arm a secured to the ruler-bar in such a way that the distance between the holders composing the set may be varied. The other end has a pair of jaws, between which a double pen b is secured

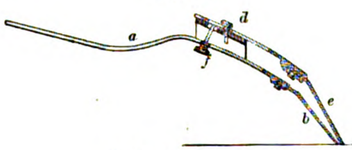
Fig. 4499.



Hickock's Ruling-Machine.

by a set-screw. Above, and hinged to the arm a, is a second sliding-holder c, which may be held fast by the set-screw d. This

Fig. 4500.



Ruling-Machine Pen.

receives a single pen e. The distance between the pens b e is varied by means of a set-screw f.

2. (*Engraving.*) The invention of Wilson Lowry. This consists of a carriage traveling in a groove or on a bar, and carrying a diamond-pointed stylus, which makes a line through the *ground* covering the plate. The line being drawn, a thumb-piece lifts the stylus, and the carriage is retracted. Then, by a lever arrangement, the carriage track is shifted laterally the distance between two lines. This distance is regulated according to requirements for wide or narrow ruling, and when set, the distance is preserved until the job is finished, unless by a gradual increase or decrease in the sweep of the *distance-lever*, the ruling is gradually made more or less open. In line engraving, the sky and still water are usually ruled in by the machine. In the commoner class of line engravings it is also much used for throwing an even tint, either light or dark, over an object. It is considered by the profession to be unworthy of the artist, as cheapening the process and degrading the purity of the art. The effect of ruling in these latter cases gives a smooth mezzotint effect, is easily accomplished, and is pleasing to those who do not care for the conventionalities of the art.

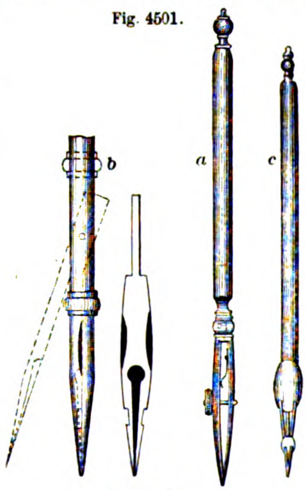
Rul′ing-pen. (*Drawing.*) A pen used for drawing lines of equable thickness. For this purpose, the nibs or the ink-channels, as the case may be, are adjusted for a given width of line, irrespective of pressure; in this respect differing from the writing-pen, which gives a line of varying thickness, according to pressure.

Ruling-pens are for hand or machine. The ordinary ruling-pen a has a pair of steel blades attached to the end of a holder and having even, sharp, elliptical ends, which may be regulated as to relative distance, according to the width of the line required. The pellicle of ink is contained between the blades. A second form of ruling-pen b was introduced from France perhaps forty years since. The instrument has a pair of jaws which shut perfectly together, inclosing an ink reservoir. At the tip of the pen is a small aperture, out of which the ink flows.

Christie's ruling-pen c has a triangular arrangement of converging points, which hold a drop of ink; the small triangular hole between the needle-points forms the ink-duct.

Such pens are commonly made of glass of late years, and are hawked about the streets.

Fig. 4501.



Ruling-Pens.

The ruling-pen for machines, by which letter and account-book paper are ruled, is made by doubling a piece of thin sheet-brass, forming a small trough for the ink. The end of the trough is cut obliquely, so that it rests on the paper, — the width of the line depending on the width of the pen; the depth of color partly on the composition of the ink, and partly on the

speed of the tool over the paper or of the paper under the tool, the latter being usual in ruling-machines.

The ink is furnished by a wetted strip of flannel, which is laid above the gang of pens. (See RULING-MACHINE.) The *music-pen* is similarly constructed. See MUSIC-PEN.

Rum'ble. 1. A rotating cylinder or box in which articles are placed to be ground, cleaned, or polished by mutual attrition. Grinding or polishing material or merely sawdust or bran may be added, according to the need of the subject. Chains are cleaned of rust, castings of sand and scale. Small articles are polished by means of the rumble.

The machine is extensively used in various trades, sometimes being called a *tumbling-box* or a *shaking-machine*. It is used,—

For polishing needles, pins, and steel-pens with sawdust and bran.
For polishing bone buttons with sand.
For polishing lead-shot with graphite.
For scouring small castings to remove the sand coat.
For brightening tacks in water before tinning.
For cleaning the rust off cannon-balls.
For drying coin blanks, etc., in sawdust.
For dissolving gums in spirits of wine for making lacquers and varnishes.

2. (*Vehicle.*) An elevated seat behind the body of a carriage.

Rum'bow-line. (*Nautical.*) Condemned canvas, rope, etc.

Rum'swiz-zle. An Irish fabric made of undyed foreign wool.

Run. 1. (*Mining.*) The *direction* or *lead* of a vein of ore, or a seam or stratum of other mineral, as of coal or marble.

2. (*Founding.*) A mold is said to *run* if the metal makes its way along the parting, or in any other way appears on the outside edges of the flask. It is avoided by *weighting* the flask.

3. A plank laid down to support rollers in moving buildings and other heavy objects. Also as a track for wheelbarrows.

4. (*Nautical.*) *a.* The aftermost part of a ship's bottom, which becomes gradually narrower from the floor-timbers to the stern-post.

b. The course or distance sailed by a vessel.

c. To *run out a warp, hawser,* or *cable* is to carry out its end to any object, for the purpose of mooring, warping, etc.

To *run out the guns.* To force their muzzles out of the port by means of the side tackles.

To *underrun* a cable or hawser. To pass along it in a boat, the cable being lifted from the bottom at the bow of the boat and passed out over the stern as she proceeds, in order to examine it or for the purpose of weighing the anchor.

To *let run a rope.* To unloose it.

Run'dle. 1. The *step* or *round* of a ladder. A *rung.*

2. (*Nautical.*) The drum of a capstan.

3. One of the bars in a LANTERN-WHEEL (which see).

Rung. 1. The *round* stick forming a step of a ladder.

2. The spoke of a wallower or *lantern*-wheel, or one of the radial handles projecting from the rim of a steering-wheel.

3. (*Shipbuilding.*) A floor or ground timber of a ship's frame. The spaces between the *rungs* are *spirkets.*

4. One of the bars of a windmill sail.

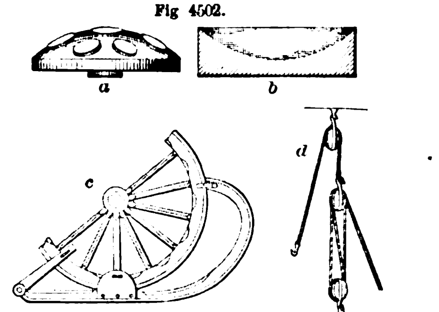
Rung-head. (*Shipwrighting.*) The upper end of a ship's floor-timber.

Run'ner. 1. (*Milling.*) The revolving millstone of a grinding-mill. It is usually the upper stone, but not always. Sometimes both stones (*F*, Plate XXII.) are driven, and thus become the *upper* and *lower* runner, respectively. See GRINDING-MILL.

2. (*Saddlery.*) A loop, usually of metal, used in harness-making to receive a running strap or rein. The gag-rein passes through runners suspended from the throat-latch on each side of the throat.

3. (*Vehicle.*) The curved pieces of a sled or sleigh which *run* or slide upon the ground and support the bed. The best are made from a natural bend or crook, and best of all is to dig up a tree and use the natural bend where the bole of a tree spreads out to form a root. This portion is very tough, and holds the roller well without splitting. (See SLED; SLEIGH.) In factories, where the same amount of care in selection cannot be exercised, runners are made of bent stuff. Farmers prefer a natural crook. The material depends on the part of the country. In Ohio, blue-ash is admired, oak is much used. Red

Fig 4502.



Runners.

beech is lasting, and wears very smooth. *c*, Fig. 4502, shows a runner attached to a wheel to be used, when permitted by the condition of the roads, for sleighing.

4. (*Founding.*) Specifically, the horizontal channel — one or more — cut in the sand from the bottom of the gate to the space left by the removal of the pattern, and through which the metal runs. This term is, however, constantly used as a synonym for *gate* or *git.*

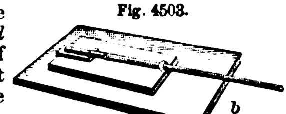
5. (*Nautical.*) A thick rope (*d*, Fig. 4502) rove through a single block, a hook attached to one end and the other passed around one of the tackle-blocks.

It may be applied by attaching the hook of the *runner* and also the hook of the lower tackle-block to the body to be moved; or the lower may constitute a standing block by being hooked to an eye-bolt.

A *whip and runner* has a single block only, attached to the fall of the runner. See TACKLE.

6. (*Optics.*) A convex tool (*a*, Fig. 4503) of cast-iron on which lenses are supported while grinding in the *shell b.* The *shell* is of cast-iron, and is cast upon a *mold* made from a wooden *pattern.* The *pattern* is shaped on the lathe to correspond to a *templet.* The *templet* is a piece of sheet-brass or glass, whose edge is curved to the radius required. This is the backward way of stating it, but is consecutive, starting from the *shell.*

Fig. 4503.



Runner.

7. (*Stone-working.*) The upper, moving slab (Fig. 4503) in the process of grinding and polishing stone. The upper may be a smaller piece of marble or stone, which is ground or polished, as the case may be, while it effects the same upon the lower (*b*). The upper is generally the harder quality.

In some cases, the runner is of iron, with a raised rim around the upper surface to form a tray which holds the sand and water. The bottom of the tray is perforated and allows the abradant to pass through, keeping a constant supply of sand and water to the grinding surfaces.

In each case, sand or other powder is the cutting material.

The *runner* is sometimes termed the *rubber*, for obvious reasons, and is moved by means of a long handle secured to it in the manner indicated.

8. (*Well-boring.*) A loop-shaped piece for taking hold of the *topit* or top-piece of the train of boring-rods.

9. The slider of an umbrella to which the spreaders are pivoted.

Run'ner-ball. (*Gunpowder.*) A wooden disk which crushes the mill-cake through the meshes of the sieves in granulating gunpowder.

Run'ner-stick. (*Founding.*) A cylindrical or slightly conical piece of wood, which acts as a pattern to form the upright part of the gate. Its point is stuck in the sand of the lower molding-box and the sand of the top part rammed around it. It is withdrawn before lifting the latter.

Run'ner-tack'le. (*Nautical.*) A luff-tackle applied to the running end of a rope passed through a movable pillow. See RUNNER.

Run'ning-block. (*Nautical.*) A hooked block which moves as the fall is hauled upon. In contradistinction to that block of a tackle which is hooked to a stationary object, and is called the *standing-block*.

Run'ning-bow'line Knot. (*Nautical.*) The end is taken round the standing part and made into a bowline around its own part.

Run'ning-bud'dle. (*Mining.*) See BUDDLE.

Run'ning-gear. (*Vehicle.*) The entire portion of the vehicle below the bed or body. Specifically, the wheels, axles, perch (if any), hounds, bolsters, and tongue.

Run'ning-hand. (*Printing.*) A font of type in imitation of running-hand.

This is Double Small Pica Running-Hand.

Run'ning-knot. See KNOT.

Run'ning-off. (*Founding.*) Opening the tap-hole of a blast-furnace to allow the metal to flow into the channels and thence to the molds.

Run'ning-part. (*Nautical.*) The hauling part or *fall* of a tackle; as distinguished from the standing part. See TACKLE.

Running-rein. (*Menage.*) A driving-rein which runs over pulleys on the headstall to increase its freedom of motion. It frequently passes over sheaves on the bit and returns up the cheek, so as to pull the bit up into the angle of the mouth. See the following patents: —

70,089. Hannaford .22, 10, '67
63,886. Harris .....16, 4, '67
56,213. Haines.....10, 7, '66
64,970. Graham....21, 5, '67
43,308. Hartman ...28, 6, '64
65,216. Hartman (anti-friction rollers) ....28, 5, '66
59,596. Hartman...13, 11, '67
50,822. Hartman... 7, 11, '65
79,334. Ferry ......30, 6, '68
72,729. Fink.......31, 12, '67
72,831. Ferry ......31, 12, '67
66,312. Donehoo ... 2, 7, '67
59,965. Chapman ..27, 11, '66
59,819. Clark ......20, 11, '66
73,875. Clark ......28, 1, '68
61,522. Donehoo ...29, 1, '67
52,139 Christ and Stehman.........23, 1, '66

Running-Rein.

67,837. Andrews (over-head) ......20, 8, '67
69,893. Beans......15, 10, '67
66,941. Brown .....23, 7, '67
80,897. Barnes.....11, 8, '68

Running-Reins to pull on the Bit to check Horses, mostly in connection with Gag and Check Hook.

74,623. Smokey ....18, 2, '68
Seitz.......25, 9, '48
56,619. Sayre ......24, 7, '66
2,780. Smith (driving-rein runs to martingale; does not involve the check)...........17, 9, '42
2,510. Smith .....23, 8, '42
73,042. Rice and Leach .... 7, 1, '68
59,937. Albright and Burns .... 27, 11, '66
79,932. Alexander..14, 7, '68
32,837. Marshall (running-line halter)...............16, 7, '61
59,316. Kendig ....30, 10, '68
69,106. Lindeman..24, 9, '67
59,996. Haberbush and Kuckel...... 27, 11, '66

Run'ning-rig'ging. (*Nautical.*) Ropes for arranging the yards and sails, as —

Braces.	Inhauls.
Sheets.	Outhauls.
Halyards.	Brails.
Clewlines.	Leech-lines.
Bowlines.	Slab-lines.
Buntlines.	Tripping-lines.
Lifts.	Reef-tackle.
Tacks.	Tyes.
Downhauls.	Vangs, etc.

See RIGGING; also the above under their respective heads.

The term is in contradistinction to standing-rigging, which includes stays, shrouds, etc.

Run'ning-ti'tle. (*Printing.*) A line at the head of a page indicating the subject. *Headline.*

Run of Stones. A pair of mill-stones in working order. See GRINDING-MILL.

Run Through. (*Founding.*) A mold is said to be *run through* when a quantity of metal is made to enter at one gate and out at another, to remove sullage, air, etc., and make the casting solid. Also called FLOWING.

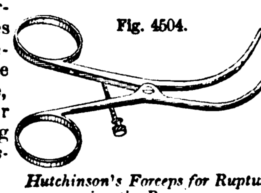
Run-up. (*Bookbinding.*) A fillet-mark which runs from head to tail on the back, without mitering with the horizontal cross fillets on the panels.

Ru'pert's Drop. A tear-shaped drop of unannealed glass. On breaking a piece from the point or tail the whole drops to pieces. This philosophical toy was first brought into notice, perhaps invented, by Prince Rupert, nephew of Charles I. of England.

"Mr. Peter did show us the experiment of the chymicall glasses, which break all to dust by breaking off a little small end; which is a great mystery to me." — PEPYS, 1662.

Rup'tur-ing-for'ceps. (*Surgical.*) An instrument used in rupturing the prepuce in cases of phimosis. It is introduced between the glans and the prepuce, distending the latter to rupture or forming a director for the *bistoury*.

Fig. 4504.



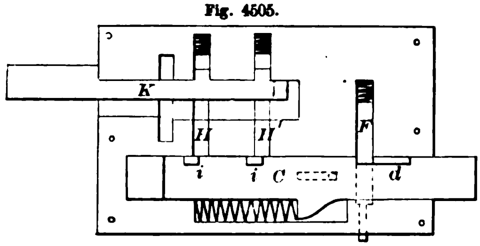
Hutchinson's Forceps for Rupturing the Prepuce.

Ru'ral Lock. (*Locksmithing.*) A cheap kind of lock with a wooden case. In Fig. 4505, K is the key having studs which lift the spring tumblers H H' out of the notches i i in the spring-bolt C. The spring-tumbler F is raised from the notch d when used as a latch.

The illustration shows a late invention, agreeing in all substantial respects with the locks of Egypt, 3,500 years ago, and those of Syria, yet used. See *A*, Fig. 2980, page 1339.

Rush-light. A tallow candle with a rush wick. Rush-lights are made in the same manner as dip-candles, a peeled rush being used for a wick. One

Fig. 4505.



Rural Lock.

narrow ribbon of the rind is left on the pith to hold it together. The rushes thus prepared are bleached and dried. They are dipped vertically in the melted tallow several times, as usual with dip-candles. Fifteen inches of rush-light is said to burn about 30 minutes. There are 1,600 rushes in a pound, and it takes 6 pounds of fat to dip them; the cost is thus very low. So says Gilbert White.

Rus'set. (*Leather-manufacture.*) The condition of leather when it is finished, excepting the operations of coloring and polishing the surface, either the *flesh* or *grain*, as the case may be, according to the purpose for which the skin is intended. This is called *russet-finish*, and in this condition leather is stored to be completed in *fair* leather, that is, uncolored, *black on the flesh* or *black on the grain*, for harness, boots or shoes, or for other purposes.

Rus'sia-duck. (*Fabric.*) Fine white linen canvas.

Rus'sia-leath'er. *Russia-leather*, also known as *jucten*, has a peculiar faculty for resisting moisture and the ravages of insects. As its name indicates, it was originally made in Russia, all kinds of hides being employed, but it is now made in Paris, where only goat and sheep skins are employed for the purpose.

The following is a summary of the Russian process: —

1. The dried skins are softened by steeping in water for from 5 to 12 days, according to temperature.
2. Unhaired by a lime bath, 8 feet in diameter, 7½ feet deep, and containing 185 pounds of slaked lime.
3. When the hair slips, the epidermis is scraped off on the beam.
4. The flesh side is cleaned by a fleshing-knife.
5. Steeping and beating to remove the lime.
6. The remainder of the lime neutralized and the hides swelled in a vat containing a fermented menstruum of rye-meal, 1,100 pounds; oatmeal, 450 pounds; salt, 6 pounds. Leaven to ferment.

The acetic acid developed *raises* the hide and counteracts the lime. An infusion of white gentian for 24 hours is sometimes used to get rid of the alkali.

7. The skins are steeped in an infusion of willow-bark.
8. The skins are placed in a pit, interstratified with layers of willow-bark and subjected to the pressure of planks and stones for from 15 to 28 days, the steep of the former process being employed.
9. The skins are *drawn*, fresh bark and solution being employed, and the skins packed into the pit, as before.

This is repeated till from 3 to 6 such changes have been made, according to the thickness of the skin.

10. The tanned skins are softened by maceration in a paste of oatmeal, 130 pounds; salt, 9 pounds; warm water.

This quantity serves for 150 skins.

11. The leather is cleaned and drained.
12. The leather is curried; a mixture of seal-calf oil 2, birch-bark oil 1, being employed, and carefully spread on to the extent of 9 ounces of oil to a skin.
13. The skins are stretched upon cords in an open shed and dried.

The French plan is as follows: —

1. Unhairing by a weak steep of lime and potassa.
2. Scraping on the beam.
3. Rinsing and fulling.
4. Washing in hot water.
5. Steeping 8 days in a farinaceous fermenting liquor.
6. Washed, and scraped with a fleshing-knife.
7. Immersed 48 hours in a paste of rye flour, fermented, and then diluted.
8. 15 days' steeping in a similar steep.
9. Washed previous to tanning.
10. Steeped for from 7 to 14 days in a warm infusion of willow-bark.

The skins are handled twice a day, and pressed for an hour each time.

11. Drawn and dried.
12. Curried. *a*. Treated with fish-oil; the hide being sheaved to equalize it, stretched and pommeled to supple it.

b. Grained by weighted rollers, whose surfaces have raised parallel and intersecting threads, so disposed as to give the desired pattern.

c. Treated with oil of birch on the flesh side.

13. Colored · Pommeled, slicked, and hard brushed.

The *red* color is given by alum and a decoction of Brazil and sandal woods; the *black* by a solution of sulphate of iron and sandal-wood. It is evident that the sandal-wood has something to do with the peculiar fragrance.

Rus'sia-mat'ting. Matting manufactured in Russia from the inner bark of the linden (*Tilia Europæa*). This matting is much used for packing, and the *bast* of which it is composed is used for tying up plants.

Rus'sia Sheet-i'ron. Sheet-iron made in Russia, and having a smooth, glossy surface of a purplish color, sometimes mottled. The process has been long supposed to be a secret, or it has been supposed that certain secret compositions are used. There may be some truth in this, and it does not appear that all the manufactories follow exactly the same order of treatment. The process has been observed by many travelers, among whom may be cited Pumpelly. One authority states that the metal is not subjected to any secret process, but that the iron is, in the first place, a very pure article, rendered exceedingly tough and flexible by refining and annealing. Its peculiar surface is a combined silicate and oxide of iron, produced by passing the hot sheet, moistened with a solution of wood ashes, between polished steel rollers.

Most of the attempts to imitate the Russia sheet-iron have been to give it a surface of carburet of iron.

Probably the most reliable description accessible is that given by Captain Meshtcherkin, a Russian mining-engineer conversant with the manufacture, to Dr. Percy.

According to this officer, the manufacture is principally confined to the eastern or Asiatic side of the Ural Mountains.

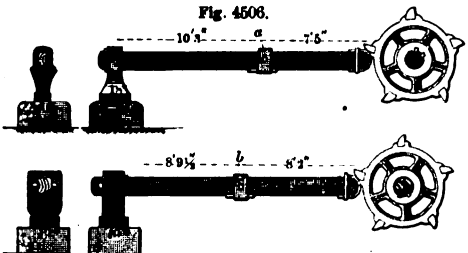
Charcoal iron from magnetic ore, carbonate, or red and brown hematite, and refined in the charcoal finery or the puddling-furnace, is employed. It should be rather crystalline than fibrous, and contain sufficient carbon to render it somewhat "steely." The puddle-balls are rolled into bars 5 inches wide by ¼ inch thick. Either one or two pairs of rolls, making not less than 50 revolutions per minute, are employed.

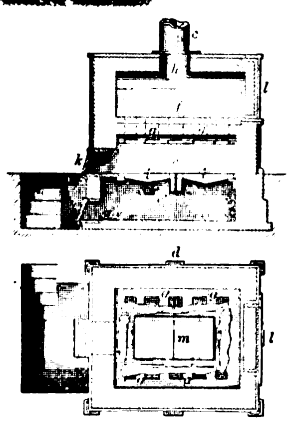
The sheets are extended under a trip-hammer (*a*, Fig. 4507) having a wrought-iron head faced with steel, and weighing about 60 poods (2,160 pounds); the anvil is of white cast-iron; both should be quite hard. Another trip-hammer (*b*), having a broader face, weighing 40 to 50 poods (1,440 to 1,800 pounds), attached to a lever fulcrumed more nearly at the center than the first, is employed in polishing.

The reheating furnace is shown in section at *c* and in plan at *d*. The fireplace *e* extends under the bed of the reheating-chamber *f* from end to end, and the gaseous products of combustion are carried into the chamber through five equal openings *g* on each side, and are finally carried off by the chimney *h*. *i* are the grate-bars, and *k k* the doors of the fireplace and ash-pit. *l* is the charging-door. This and the other doors are made as tight as possible, in order to prevent access of air to the plates being heated. Wood is the fuel used, and some of this also surrounds the pile in the reheating-chamber. The puddle-bars are cut into strips 29 inches in length, which are then heated to redness and cross-rolled some 12 or 14 times, until they are about 29 inches square. The sheets thus produced are then cleansed with a wet broom, arranged in packets of three, and passed through the rolls about ten times, powdered charcoal having been previously sprinkled in between them, and afterward sheared to the dimensions of 28 · 56 inches. Each sheet is then brushed all over with a mixture of birch-charcoal powder and water. From 70 to 100 sheets are made up into a packet *m*, which is bound with waste sheets and slowly heated for 5 or 6 hours in the furnace, surrounded by logs of wood, in order to consume any free oxygen present. The pile is then removed from the furnace and placed under the first hammer, being manipulated so that the blows fall upon it in successive rows from end to end. When it has been gone over about six

times in this way, it is removed and the sheets are alternated with some which are completely finished, making up a packet of from 140 to 200 sheets; these are subjected to the action of the second hammer, under which they are passed twice in a similar

Fig. 4506.





Russia Sheet-Iron (Hammers and Furnaces)

manner, which completes the smoothing process.

After the second hammering, the packet is opened, the surface of each sheet is again cleaned with a wet broom, and it is set in a vertical rack to cool: it is then sheared to the dimensions of 28 × 56 inches.

Professor Pumpelly, who witnessed the process employed in the works at Nijni Tagilsk, attributes the superiority of the Russian product in great part to the cleanliness observed and the skill and carefulness of the workmen. He states that when thin sheets are required, the rolling is repeated a third time in packages of four or six. The spotted sheets are separated into two inferior classes, and their diminution in value is deducted from the workmen's pay.

The fire-proof bricks used in lining the furnace are made of a fine quartz sand, merely sprinkled with lime-water before being molded and burned.

By another account, the rollers used are not formed in a lathe, but cast at once of the requisite smoothness and regularity in molds rubbed over with graphite. While the plates are being rolled, the edges are kept free from gaps by paring them with large shears. They are then placed in packs of from 10 to 20 on a moving bench, which passes them to and fro under a hammer of 40 poods' weight; both sides are alternately exposed to its action, and a man carefully brushes off the scales that are continually produced on the surface. The parings are mixed with half their weight of charcoal and converted into bar-iron.

Herbert Barry, late director of estates and iron-works of Vuicksa, thus describes the manufacture: —

The refined iron is hammered under the tilt-hammer into narrow slabs, calculated to produce a sheet of finished iron, 56 inches by 28 inches, weighing when finished from 6 to 12 pounds. These slabs are put in the reheating-furnaces, heated to a red heat, and rolled down to a sheet in three operations. These are subsequently hammered to reduce the thickness and confer the *glance*. A number of these sheets, having been again heated to a red heat, have charcoal-powder sifted between them. The pile, then receiving covering and a bottom in shape of a sheet of thicker iron, is placed under a heavy hammer; the bundle, grasped with tongs by two men, is pulled backward and forward by the gang, so that every part may be well hammered. When the redness goes off, they are finished, so far as this part of the operation goes, and have received some of the *glance* or necessary polish. They are then again heated and are rolled between cold finished sheets. They are again hammered, and, after this process, are finished as far as thickness and *glance* are concerned.

Thrown down separately to cool, they are taken to the shears and trimmed. Each sheet is then weighed, and after being thus assorted in weights, they are finally sorted into firsts, seconds, and thirds, according to their *glance* and freedom from flaws and spots. A first-class sheet must be like a mirror, without a spot in it.

The general weight per sheet is from six to twelve pounds, the larger demand being from ten to eleven pounds; but they are made weighing as much as thirty pounds, and may then almost be called thin boiler-plates, being used for stoves, etc.

The appearance of Russia iron is imparted to sheets (No. 22 wire gage) by dipping them while warm in a mixture, the consistency of molasses, of chalk, porcelain-clay, and graphite, in equal parts. When dried, they are further rolled and annealed, and afterward dipped in a pickle of 1 part sulphuric acid to 3 water till free from scales, then allowed to remain a short time in a lye of 1 potash to 20 water, filtered; afterward washed with clear water and smoked in an oven heated with light wood; the soot is burned off as the heat increases, and a carburet is formed on the surface with which it is closely combined. The plates are now gradually permitted to cool, and then hammered or rolled and tempered in a tightly closed chamber lined with fire-brick, when they may be again lightly hammered or passed through the polishing-rolls.

At the sheet-iron works in Brooklyn, an engine of 200 horse-power drives an automatic steam-hammer weighing seven tons. The rolled sheet-iron is greased and arranged in packages of thirty or more sheets. Each sheet is about 2½ feet wide and 7 feet long. The packs are then run into an oven and exposed to heat until the surface has attained the proper degree of oxidation. The packs are then transferred to the hammer, all the sheets in the pack being hammered at once. The anvil is movable, and the workmen change the position of the pack at each stroke of the hammer, so that every portion of the iron will be acted upon.

At the McKeesport Iron-Works, Wood's process is used. A heavy hammer falls vertically on the sheets with rapid blows as they are passed over an anvil, the face of the hammer and the anvil being pitted with small indentations. It is the passage under this hammer that does the planishing, giving the even surface, mottled finish, and density of fiber which characterize the Russian. The charcoal iron is rolled into bars and cut, the scale is removed, after which it is rolled into sheets of different thicknesses, then cold rolled, then heated to a cherry-red, and passed under the planishing-hammer three sheets at a time.

The following are condensed descriptions of United States patents for modes of making sheet-iron similar to the Russian:

No. 2,813, Wood, 10, 12, 1842. Rolled in usual manner, but left thicker; oxide removed by acid; cleaned and dried; coated with linseed-oil; two such plates placed between two others; the pack heated to a cherry-red and rolled repeatedly till the gloss is obtained.

No. 2,824, Guilford, 22, 10, 1842. Scale removed by acid; washed and dried; subjected to mutual friction in a box with lid and stampers; heated to blue color; passed, while hot, through hardened and polished rolls.

No. 8,048, Wood, 15, 4, 1851. Similar to No. 2,813, but the pack is rolled between shield-plates. The latter eventually become inside plates, being scaled, oiled, heated, and rolled as the others. Smoothed and glazed by cold rolling between shield-plates.

No. 9,075, McCarty, 26, 6, 1852. Plates are scaled by acid bath and zinc in a lead pan during effervescence; washed and dried; heated to cherry-red in a lead bath; rolled while hot; mottled marks given by hammer-dressing on the rolls.

English patent, No. 14,244, 1852. The sheets are rolled, piled in fours, and rerolled, trimmed, heated, rolled in packs, heated, packed (20 sheets) with intervening charcoal, hammered with a 250-pound hammer; unpacked, packed (40 sheets) without charcoal, one hot and one cold sheet alternately; hammered by a 900-pound hammer; annealed and trimmed.

No. 10,047, McCarty, 27, 9, 1853. Planished rolls to give mottled marks to the iron sheets.

No. 10,482, Pomeroy, 31, 1, 1854. Iron plates painted with a composition of graphite, charcoal, and soot or boneblack, diluted with anything and put on with a brush; heat and roll.

No. 21,692, Morris, 5, 10, 1858. Making a mottled, chilled-iron roll for rolling sheet-iron. The rolls are chilled, turned, polished; dotted with wax according to taste; immersed in acid bath to etch in the intervals; placed in a lathe and rubbed with emery and oil to take off the sharp edges.

No. 21,772, Morris, 12, 10, 1858. Sheet-iron of carefully selected and prepared metal is passed between mottled rollers (as above), placed in a muffle, heated to redness in a furnace; made into a pack of ten, with intervening charcoal; the pack placed on an anvil, which is made to travel to and fro beneath a gang of hammers; reheated; rehammered; annealed.

No. 21,817, Chandler, 19, 10, 1858. Sheets are rubbed with or dipped into a paste of clay or peat, and metallic oxides; rolled, cleaned, made into a pack, and rerolled.

No. 31,184, Morris, 22, 1, 1861. Rolled sheets are coated with oil, boxed, placed in a muffle, and heated to 900° Fah.; hammered in the pack to combine the carbonized scale and form a carbureted surface.

No. 32,341, Wood, 14, 5, 1861. Rolled sheets are annealed at a dull white heat; cooled; rolled between corrugated rolls to break scale, then between plain rolls; no acids; coat surface with oil and graphite; heat to bright red; roll in packs; rolls covered with oil and graphite.

No. 33,341, Wood, 3, 9, 1861. Rolled plates are warmed and dipped in a bath of water, chalk, porcelain-clay, and graphite; withdrawn and dried; pack of ten plates heated to bright red and rolled; acid bath to remove scale; alkaline bath to develop color; water bath; dried; heated in a smoky oven to cover sur-

face with carbon deposit, which becomes embodied in the iron; cooled; planished or rolled; tempered.

No. 33,214, Riess, 3, 9, 1861. Rolled plates are dipped in a bath of chalk, porcelain-clay, and graphite; dried, packed, heated, rolled, and annealed.

No. 33,844, McDaniel and Harvey, 3, 12, 1861. Vacuum pressure in the removal of acid liquor, and subsequent alkaline treatment.

No. 34,294, Dixon, 4, 2, 1862. Rolled plates scaled by acid bath; washed with adhesive, or rye-water; swabbed at less than a red heat with an enamel composition; kept at that heat for ten hours in an oven; sheets placed in an annealing-box with interposed charcoal-dust, and heated; rolled in packs and annealed.

No 46,974, Pratt, 14, 2, 1865. Sheet-metal immersed in acid bath at a prescribed heat; removed, scrubbed, and immersed in alkaline bath; brushed with rotary brushes while wet; heated to dryness; immersed in oil bath at 100° to 150° Fah.; dripped, and passed between polished steel-rollers; buffed by leather-rollers and chalk-dust; colored over charcoal furnace.

No. 48,918, Ells, 25, 7, 1865. Sheets annealed; placed loosely in a cast-iron box, with scale of oxide, animal charcoal, coke, lime, or other decarbonizing or cutting agents; agitated while heated in the furnace.

No. 50,203, Grey, 26, 9, 1865. Heats the sheets previous to finishing; cools to a point below cherry-red; rolls without removing scale; repeats operation.

No. 52,647, Perkins, 13, 2, 1866. Cleans and brightens mechanically; then heats in an oven to develop color.

No. 53,476, Perkins, 27, 3, 1866. Sheets packed with intervening iron turnings; heated, rolled, annealed.

No. 53,253, Allen and Hinsdale, 20, 3, 1866. A fagot of iron has top and bottom steel-plates; heated, rolled into a bar; bar rolled into sheets; oxide removed by acid bath; washed; a pack of ten heated to redness and rolled.

No. 56,759, Jones, Spaulding, and Perkins, 31, 7, 1866. The wrought-iron melted in a crucible with nitrate of lead, muriate of antimony, bone-dust, and graphite; stir; remove flux from the top; run into molds and roll as usual.

No. 61,034, Wood, 8, 1, 1867. After removing from the alkaline bath, and washing as usual in hot water, the plate is dried and heated in an oven below redness; dipped in a bath of oil and turpentine.

No. 63,805, Miller, 16, 4, 1867. The rolled sheet, before a final rolling, is heated nearly to welding point by gas-jets, above and below the plate, just before entering between the finishing-rollers.

No. 77,111, Shaw, 21, 4, 1868. The heated iron, or the rolls, are mopped with a composition of graphite, animal fat, soda, and water.

No 81,903, Hinsdale, 8, 9, 1868. The bar-iron is scaled; washed; dipped in a bath of clay 100, lampblack 1, prussiate of potash .5; heated and rolled; the sheet-iron is dipped in same composition and rerolled.

No. 88,092, Atkins, 23, 3, 1869. Roll into sheets, scale with acid, neutralize with lime-water, oil; lay up the iron in packs with intervening charcoal and marble dust; raise to a red-heat, roll singly; reheat, and roll in pairs, and so on; rolling till cold to develop polish; heat in packs to anneal; roll, and cool slowly.

No. 95,554, Barker, 5, 10, 1869. Roll; remove scale by acid; wash; potash bath, in which they remain till rolled; roll in packs, cold; mottled rolls, made by a peculiar process of chill casting.

No. 98,364, Fields, 28, 12, 1869. Iron is of Franklinite 100, good pig-iron 400. Sheet-iron is scaled; dipped in a bath of flour of zinc 1, graphite 1, tallow enough to make consistence of cream, when melted; a pack of three sheets is placed beneath a steam-hammer with a hard-wood face; the anvil having a similar face; grain of wood vertical.

No 103,323, Grey, 24, 5, 1871. Scale removed by an acid bath and subsequent heating on racks in an oven to raise the scale in blisters. A thin, tenacious oxide forms on the surface and is preserved. Rolled cold, first singly, then in packs; annealed.

No. 103,577, Craig, 31, 5, 1870. Plates are built into packs with intervening charcoal-dust; heated nearly to welding heat; rolled in packs; reviving the metal of the superficial oxide.

No. 114,956, Marshall, 16, 5, 1871. Scale removed by *saline* bath and furnace heating; dipped in lime-water; heated to cherry-red and rolled in packs; anneal.

Rus'ti-ca'tion. (*Masonry.*) A general name for that species of masonry in which the surfaces of the stones are left rough, and the several courses and the stones in each course are distinctly marked by sunk joints or grooves, either chamfered or otherwise cut.

Contrary to the import of the name, *rustication* admits of great variety of expression and very elaborate treatment. The faces of the stones are sometimes vermiculated or otherwise made rough; the tooling occupying a panel surrounded by a smooth border terminating in the arris of the chamfer, which constitutes the projection of the face above the surface of the sunk joint.

The varieties of *rusticated* work are known as *vermiculated*, *punctured*, *frosted*, *stalactited*, *chamfered*, according to the character of the ornamentation of the face, or some peculiarity of the salient edge.

Vermiculated has contorted tooling distantly resembling worms, from which its name is derived.

Punctured is picked full of holes in lines or irregularly.

Frosted has a fine, even roughness, distantly resembling hoar frost.

Stalactited has ornaments like icicles, in imitation of those natural deposits from which the name is derived.

Chamfered; the salient panel has a beveled edge, having an angle of 135° with the face.

Rus'tic Cham'fered Work. (*Masonry.*) The chamfered edges of the face of the ashlar have an angle of 135° with the face, so that at the joint the beveling will form a right angle.

Rus'tic Joint. (*Masonry.*) A sunken joint between stones, either square or chamfered.

Rus'tic Or'der. That kind of building in which the faces of the stones are *hatched* or *nigged* with the point of the hammer.

Rus'tic Quoin. (*Masonry.*) The ashlaring at the corner of a house or wall, projecting from the face, and laid alternately stretcher and header with rustic joints.

The quoins may have edges chamfered to an angle of 135° with the face of the building, so as to make a right angular joint. The faces of the stones are usually tooled.

Rus'tic Work. 1. (*Wood.*) An imitation of rough or primitive work. Furniture for summer-houses and lawns, made of limbs of trees, taking advantage of natural crooks and crotches to form the shapes desired. See GARDEN-SEAT, Fig. 2159.

2. (*Stone.*) Masonry jagged over with a hammer to an irregular surface. A margin around the joints is recessed. This is known as the *margin-draft*. When the face is made in imitation of ice, it is called *frosted rustic-work*. When contorted, it is called *vermiculated* work.

Rust-joint. (*Metal-working.*) A joint made water-tight by a compound which oxidizes or sets on exposure to the air; as the following: —

Quickly setting. Sal-ammoniac in powder, by weight, 1 part; flour sulphur, 2 parts; iron borings, 80 parts. Make to a paste with water.

Slowly setting. Sal-ammoniac in powder, by weight, 2 parts; flour sulphur, 1 part; iron borings, 200 parts.

The latter cement is the better one if the joint be not required for immediate use.

Ru-the'ni-um. Equivalent, 52.1; symbol, *Ru.*; specific gravity, 11.4; nearly infusible. It is of a gray color, hard and brittle. A rare metal found associated with platinum. It was discovered by Claus in 1845.

Rynd. (*Grinding-mill.*) The ball which supports the runner on the head of the spindle. See BALANCE-RYND, *F F*, Fig. 536.

S.

Sa'ber. (*Weapon.*) A sword having a curved blade, specially adapted for cutting.

Three kinds are in general use in the armies of Europe and America.

That for heavy cavalry has a slightly curved, heavy blade.

The light-cavalry saber has a lighter blade somewhat more curved.

The horse-artillery saber is still shorter, lighter, and more curved, and has but one branch to the guard.

Sa-bot'. 1. A wooden shoe made of one piece hollowed out by boring-tools and scrapers.

We learn from Cicero that parricides at Rome were fitted with a pair of wooden shoes before they were sewn up in the sack in which they were drowned.

Sabots are cherished by the whole Gallic race, and might be used with advantage by other people for occasional protection on sloppy pavements and on wet ground, while about the duties of the kitchen, laundry, and kitchen-garden.

Sabots in France are divided into the *gros* and the *fins:* the former being coarse and sold at 14 cents per pair; and the latter at 40 cents, trimming extra.

The kinds of wood used, beginning with the commoner varieties, are willow, poplar (Lombardy), beech, birch, aspen, ash, hornbeam, walnut.

The wood is cut when it attains a certain size, and is sold on the spot by auction. The *sabotiers* attend in person and work up their purchases on the spot, giving the crude form to the *sabots*, which are afterward seasoned, and are then finished, carved, and blacked in Paris or some other mercantile center. The seasoning of the wood takes about twelve months. *Gros sabots* are sometimes dried and smoked to expedite the seasoning, and are finished and sold by country makers and venders in their own communities.

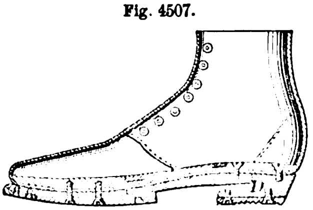
The timber is cross-cut in lengths for shoes and riven into blocks. They are rough hewn by a hand-axe, the operator being called a *tailleur*, or cutter. Another workman, the *paroir*, or parer, now takes them. The cutting-tool has a bent blade, a short handle, and its point has a hook which engages a ring attached to the bench. The block is held in the left hand and steadied by certain indentations and prominences on the bench while it is being pared, assuming somewhat the shape of a *last*.

The third workman is the *creuseur*, or scooper, who works with augers and spoon-shaped cutters, called *cuillères*. The blank is fixed by wedges between posts on the bench, the heel presented toward the workman, who scoops and gouges out the interior, testing his work by gages.

After drying, they are carved, painted, and trimmed.

Fig. 4507 is a compromise; a shoe with double wooden sole, having a double flexible shank *D* interposed between the toe and heel parts.

Fig. 4507.



Sabot.

2. (*Ordnance.*) *a.* A circular block, usually of wood, hollowed out and fixed by tin straps to a projectile, so as to maintain its proper position in the bore of a gun, to prevent its upsetting in loading, wobbling in discharging, and to decrease windage by occupying the bore more perfectly than can be done by the projectile itself.

b. A metallic cup or disk fixed to the bottom of an elongated projectile, so as to fill the bore and take the rifling when the gun is discharged.

Sa-bo-ti-ere'. A French apparatus for making ices. It consists of an outer pail of wood and an inner vessel of metal, to contain the cream to be iced. In the intervening space is a mixture of pounded ice and salt, or of sulphate of soda and hydrochloric acid. The contents of the inner vessel are agitated by a handle, and the frozen cream is occasionally scraped down.

Sab're-tasche. A leathern pocket suspended on the left side from the sword-belt of a cavalry officer.

Sac'cha-rom'e-ter. A hydrometer graduated to indicate the amount of sugar in worts and other saccharine solutions. Bate's is generally used in England.

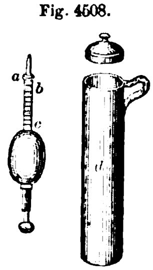
It consists of a brass ball with a cylindrical stem, graduated into 30 parts, each corresponding to $\frac{1}{1000}$ of the specific gravity of water, the relative length of the divisions being such as to compensate for the increased volume of the submerged portion as it sinks in the liquid. Tables are prepared, showing the percentage of sugar contained in worts of specific gravities corresponding to the indications of the scale.

The optical saccharometer is a form of polariscope devised by Mitscherlich with special reference to testing sugars by polarized light. It is provided with a graduated circle for measuring the angles of polarization, which serve as a basis of comparison for the different qualities.

The saccharometer usually employed in this country and on the Continent of Europe is Baumé's. It consists of a bulb having a smaller bulb beneath, weighted with mercury or shot, and a graduated stem above. In water it sinks to a certain mark, but in sirup it rises in proportion to the density of the latter. It is a *hydrometer* with marks which render it specially applicable to the uses of determining percentages of sugar in solution or in sirups. The *alcoholmeter*, and others of this class differ in their graduations, which render them specially applicable to a specific class of liquids or solutions. A degree on the scale of the saccharometer marks 0.019 parts of sugar in the sirup. Thus, if the saccharometer, floating in sirup, marks 10° B., we have $.019 \times 10 = .19$, and know that there is 19 per cent of sugar in that sirup. If the sirup is boiling, however, it is lighter than when cold by about 3°. Thin juice is of the same density, hot or cold. See HYDROMETER.

A saccharometer commonly employed by brewers in England for testing worts is of copper, and has a flat stem having a projection *a* at the upper part to receive a series of weights marked 1, 2, 3, 4, 5, 10, 20, 30. At the temperature of 62° Fah., the instrument sinks in distilled water to the mark *b*. A barrel (36 gallons) of pure water at this temperature weighs 360 pounds. If the instrument be placed in a liquid weighing 361 pounds to the barrel, it will sink only to the mark *c*. The distance between these two marks is divided into 10 equal parts, each equivalent to a difference of $\frac{1}{10}$ of a pound in the weight of the liquid. The number of pounds and tenths which a barrel of wort weighs over 360 is ascertained by placing weights over the projection sufficient to sink the stem to one of the points *b c* or one of the intermediate graduations. Thus, if the weights 10, 5, 2 be required to sink the instrument to the mark numbered 3 on the stem, the weight of the wort will be 377.3 pounds per barrel. *d* is a vessel for containing the wort to be operated on.

Fig. 4508.



Wort-Saccharometer.

One mode of detecting the character of a saccharine solution is by the polarization of light, observation being made of the extent to which a given volume of a saccharine solution twists a ray of polarized light.

By peculiar operations, the presence, quantity, or relative proportions of cane and grape sugar may be determined. Both cane and grape sugar twist the ray to the right, but the former alone has this power inverted on ebullition with hydrochloric acid. This furnishes experimental data for the quantities of each present

Another mode consists in converting the cane-sugar into grape-sugar by boiling with dilute sulphuric acid for two or three hours and then heating with solution of potash or soda, and comparing the depth of color of the resulting dark brown

liquid with similar liquids prepared from known weights of sugar.

Grape-sugar will also reduce an alkaline solution of tartrate of copper with precipitation of orange-yellow suboxide of copper. This reaction is perfectly definite, and may be applied in the estimation of grape or cane sugar, or both.

Sack. A bag of leather or fabric, used for holding grain, salt, coal, and innumerable other articles.

The word *sack* is said to be the only one which survived the confusion of tongues at Babel, being the same in all languages. Each man, as soon as he found something was going wrong, called for his *sack* to carry home his tools in.

Sacks are made in Western India from the inner bark of the *Antiaris saccidora*. A section of the tree about one foot in diameter is cut off, of the length required for a sack; soaking and pounding loosens it, and it is stripped off as a squirrel is skinned. Sew up the end, and the thing is complete. The bark is also used, pounded thin, cut up to the pattern required, and sewn together like any other fabric.

The Spanish wine called *sack*, which would appear to have formed the principal nutriment of Falstaff, is said to derive its name from the leathern sacks containing it; others, however, think it a corruption of *sec* (dry).

Sack'but. (*Music.*) *a.* An ancient wind-instrument mentioned in Daniel iii. 5 – 15.

b. A wind-instrument of the trumpet species. It is of a low pitch, and the tone is modulated by lengthening and shortening by means of sliders. See TROMBONE.

Fig. 4509.

Sack-Hoist.

Sack'cloth. (*Fabric.*) Coarse stuff for sacks.

Sack-fil'ter. See BAG-FILTER, page 209.

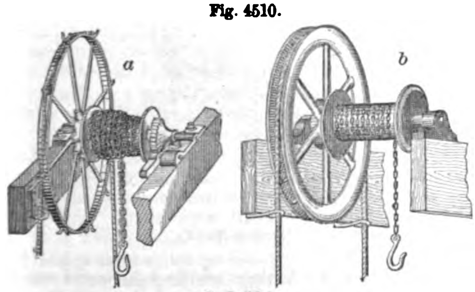
Sack-hoist. An adaptation of the wheel and axle to form a continuous hoist for sacks and packages in warehouses, etc. In Fig. 4509, the wheel is turned by pulling on the endless chain *a*; the links of the hoisting-chain *b* engage sprockets on the axle; while one end is ascending with a sack attached, the other descends to receive another sack.

The apparatus may have a friction-brake and a ratchet and pawl to prevent the weight falling should the hoisting be suspended for a moment.

The *dispatch-hoist* (*a*, Fig. 4510) is specially intended for sacks of corn, bales of leather, and other articles not liable to injury if let down quickly. The load remains suspended just where left, until released by reversing the action of the main wheel. The descent can be regulated by this wheel, the rope remaining stationary.

The *safety-hoist* (*b*) is adapted for goods requiring care in lowering. The main wheel, on being reversed, causes the load to descend at a moderate speed, and can be kept going by an occasional pull at the rope. If the load be allowed to run, it will gradually check itself until it stops. If the rope is suddenly "let go" while lifting, the load will remain suspended just where it is. The principle of this latter is found in the differential pulley.

Fig. 4510.

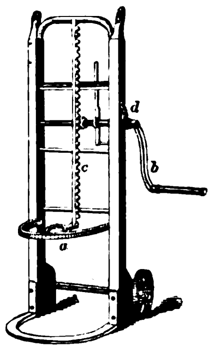


Sack-Hoist.

Sack'ing. (*Fabric.*) A coarse hempen or flaxen fabric, made for bags and bed-bottoms.

Sack-lift'er. The apparatus (Fig. 4511) is used as a lifter and a truck. It is turned up on end to receive the full sack, which is placed on the movable platform *a*; it may then be wheeled to the wagon or storehouse, and the sack raised shoulder-high by turning the winch *b*, which operates the rack *c* attached to the platform. A pawl *d* prevents the descent of the platform when the winch is let go.

Fig. 4511.



Sack-Lifter.

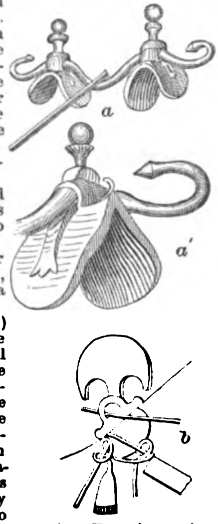
Sac'ris-ty. (*Architecture.*) That apartment of a church in which the consecrated vessels and the vestments of the clergy are kept.

Sad'den-ing. (*Dyeing.*) A method of applying several mordants to cloth to be printed.

Sad'dle. 1. (*Saddlery.*) A seat or pad to be placed on the back of an animal to support the rider or the load. Besides the ordinary kinds, the man's saddle, and the *side*-saddle for women, there are *cart, gig, pack, ambulance, camel*, and *ox* saddles. The camel is used in Asia and the northern part of Africa. The ox is the ordinary beast for riding and for burdens in the interior of Africa, as witness Livingstone, Speke, Grant, Baker, Barth, Chaillu, Reade.

The earliest saddles on record are those of Egypt (*a*) and Persepolis. They were not for riding, but were analogous to our harness-saddles, except in their position. They rested on the withers of the horses, and were secured in place by belly and collar bands. They were attached to a yoke which passed over the shoulders of the horses, and at its midlength was attached to the pole or tongue of the chariot. The saddle had a hook for the bearing-rein, and had a single trace, on the side of the horse against the pole. See page 1062.

Fig. 4512.



Ancient Egyptian and Persian Saddles.

The Persian saddle (*b*) was substantially the same.

Equestrians used cloths secured by girths. The Persian seat-cloths were abundant, but they had no *tree*.

The saddle referred to in our translation of the Bible, 1890 B. C., and subsequently, was doubtless a cloth fastened by a surcingle.

The saddle of Alexander (320 B. C.) was without a tree or stirrups; the cloth on which he rode was secured by girth and breast-band. The equestrian represented on the Etruscan vase of Cardinal Gualteri rode on a naked horse. Even after the introduction of cloths, it was esteemed manly to do so. The Roman cavalry, until the time of Nero, paraded and reviewed without cloths or coverings, in order to show plainly the condition of the animals. Nero added cloths for show, and in the time of Alexander Severus (A. D. 222) they were splendidly accoutered. Pliny states that one Pelethronius first introduced seat-cloths. Xenophon speaks of the gorgeous and excessive coverings of the Persian horses. The Germans despised them after they were fully adopted in the Roman army. What may be termed *pad-saddles*, of leather, are mentioned A. D. 304.

The invention of the saddle has been attributed to the *Selians*, a people of ancient Franconia. Hence, perhaps, the Latin *sella*.

Leaving a doubtful passage in Zonaras referring to the fall of Constantine the Younger (A. D. 340) from the *sella*, which may mean a *saddle*, but more probably means his seat on horseback, we find the saddle fully described in the time of Theodosius. In the code of this monarch, published about the year 385, there is a rescript which directs that the weight of a saddle and bridle for post-horses should not together exceed 60 pounds, — a very good order.

The Emperor Leo I., in the fifth century, interdicted the use of pearls and jewels in the decoration of saddles.

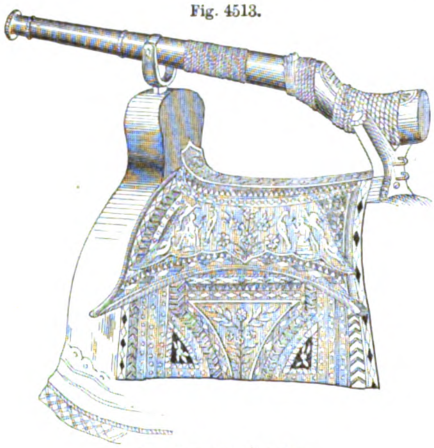
Mauritius, in the sixth century, ordered the saddles of the cavalry to be covered with fur.

It appears that the Greeks and Romans mounted from what we call the *off* side of the horse.

The difference between a pad and a saddle consists in the presence of a tree in the latter. The monuments and coins show a gradual change, from the mere cloth to a padded seat and surcingle; then appear rolls, which may be considered incipient pommel and cantle. The word in early use was *ephippium;* it was afterward *sella*. Perhaps the latter was the true saddle.

The saddle was known in England among the Saxons, and was probably introduced by the Romans during the latter portion of their occupation. According to Strutt, who is, perhaps, the best authority, the Saxon and Norman ladies rode sideways, as at present. Other authorities state that the side-saddle was introduced by Anne, daughter of the king of Bohemia and queen

Fig. 4513.



Camel Saddle and Gun.

of Richard II. Previous to that time, a lady rode on a pillion behind her cavalier or a servant, or else in the masculine manner still customary in some parts of Europe.

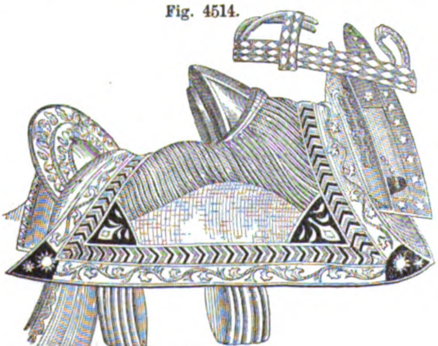
Queen Elizabeth rode on a pillion behind the Lord Chancellor from London to Exeter, and this was common till the beginning of the present century.

Stirrups were invented about 200 years after riding-saddles. See STIRRUP.

The Tartar saddles are of wood, carefully adapted to the shape of the animal's back. The fitting is done by a knife, by successive parings and trials.

The Japanese saddle is of wood, with a cushion underneath, and a cloth at the rear, covering the horse's loins. It is secured by a girth, a *poitral*, or breast leather, and a crupper. The civilian traveler uses a pair of saddle-bags, an *adofski* or trunk laid over them, and sits upon a cloth spread over all.

Fig. 4514.



Camel's Saddle.

The dignitary or cavalry soldier rides upon a saddle with high ridges for pommel and cantle. The stirrup is shaped like a shoe-sole, and is open at the side. The stirrup-leathers are short. The rider mounts from the *off* side.

Fig. 4513 is a view of a camel's saddle and gun, from Lahore in the Punjaub. The drawing is from the article which was contributed from India to the London Exhibition of 1851.

Fig 4514 is also a camel's saddle from Lahore.

The Icelandic side-saddles, like those of some other nations, resemble an ordinary chair-seat with a foot-piece, as in the annexed cut from a drawing by J. Ross Browne.

Fig. 4515.

Icelandic Side-Saddle.

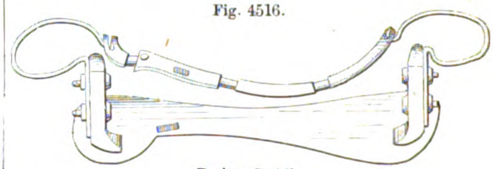
The Prussian cavalry-saddle has a wooden tree in two parts, attached at the ends by cast-iron forks, forming a high pommel and cantle. The seat is covered with a padded leathern cushion. A padding of straw is used with the saddle.

Among some nations, as the Hungarians, Mexicans, and others, the saddles are extremely elaborate. An enumeration of the parts and appurtenances of a Hungarian saddle may be interesting: —

Tree.	Stirrups.
Straining-leather.	Stirrup-leathers.
Seat.	Carbine bucket and strap.
Lacing-thongs.	Carbine stay-strap.
Holster.	Baggage-straps.
Girth.	Cloak-straps.
Girth-strap.	Horseshoe-case.
Pilch (*pelt*) fur covering.	Shabraque strap.
Flaps.	Wanty, for binding on a load.
Crupper dock, body, and strap.	Blanket, folded beneath the tree.
Breast-plate.	

The parts of a saddle are the *tree* or foundation, the *padding*, *skirts*, *seat*, *girth*, *stirrup-strap*, and *crupper-loop*.

Fig. 4516.



Spring-Saddle.

The tree consists of *pommel*, *cantle*, and *side-bars*. To the latter are attached the *stirrup-loops;* the *crupper-loop* is attached to the cantle. See SADDLE-TREE.

In Fig. 4516, the seat is suspended above the tree from springs attached to the pommel and cantle

Fig. 4517.

Riding-Saddle.

Fig. 4517 has an elastic seat *H* strained between the pommel and cantle, and has an additional support by transverse, arched springs *G G*, whose ends rest upon the side plates.

Fig. 4518 is a harness-saddle.

Fig 4518.

Harness-Saddle.

2. (*Nautical.*) A piece or block hollowed out to fit another portion, which is seated thereon, as —

a. The block on a yard-arm which receives the studding-sail boom.

b. The block on the upper side of the bowsprit to receive the heel of the jib-boom. It is situated at a distance one third of the length of the jib-boom inward from the outside of the bowsprit-cap.

3. (*Ordnance.*) A support on which a gun is placed for bouching.

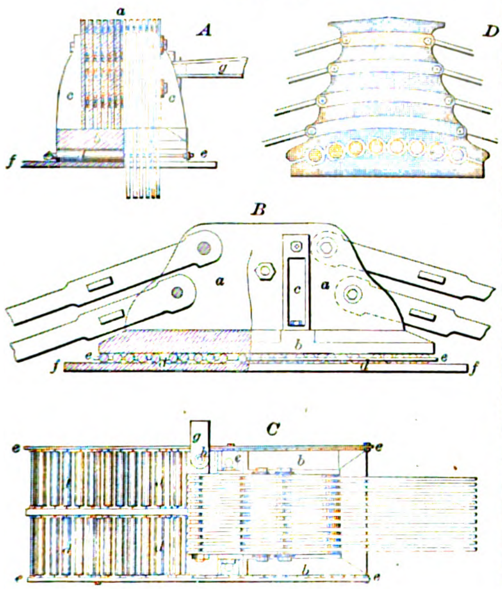
4. (*Railway.*) *a*. The bearing or *brass* resting on the journal of a car-axle in the axle-box. See CAR-AXLE BOX.

b. A chair or seat for a railway-rail. See RAILWAY-CHAIR.

5. (*Machinery.*) A block with a hollowing top to sustain a round object, as a rod upon a bench or bed.

6. (*Bridge-building.*) A block on the summit of a pier over which suspension cables pass or to which they are attached. In the illustration, *A* is a section, *B* an elevation, and *C* a plan of the saddles of Charing Cross Bridge. The plates *a a*, to which the upper and lower chains are connected, rest upon a cast-iron plate *b*, to which they are fixed by the standards *c c*; this plate is supported upon rollers *d d* held in place by a frame *e e*. The lower plates

Fig. 4519.



Saddle for Cable of Suspension Bridge.

f f, on which the rollers run, are supported on a platform of timber and iron girders, by which the weight is distributed over four pillars of brickwork, which support the whole. There are two saddles on each pier, connected together by a bar *g* working on a center at *h*, so that while the saddles are maintained at a proper distance apart, they are allowed the requisite freedom of motion.

D is a saddle on the apex of one of the piers of the Menai Suspension Bridge. It is of cast-iron, resting on wrought-iron rollers with brass boxes, so that as the temperature varies some play is allowed to the chains. There were 16 chains, each weighing 120 tons 299 pounds. Total, 3,876,784 pounds. The bridge was built over the Menai Straits by Telford, in 1829. Each of the eight cast-iron saddles weighed 3,248 pounds, and the cast-iron bed-plate on the apex of each pier, supporting the saddles at that end of the catenary, weighed 46,080 pounds.

Sad'dle-back. (*Building.*) A coping with a double slope to shed rain.

Sad'dle-bags. (*Saddlery.*) A pair of bags or pouches, connected by a leathern seat, carried on the back of an animal, being laid over or behind the saddle.

Sad'dle-bar. 1. (*Carpentry.*) An iron bar crossing a window-frame and serving as a stay for the *fretwork* or glass secured in leaden *cames* or bars. See FRETWORK.

2. (*Saddlery.*) The *side-bar*, *side-plate*, or *spring-bar* of a saddle-tree, one on each side connecting the pommel and cantle.

Sad'dle-bow. (*Saddlery.*) The upper, front part of a saddle-tree formed of two curved pieces united so as to form an arch. The *pommel*.

Sad'dle-cloth. (*Saddlery.*) A cloth attached to a saddle and extending over the loins of the horse. A *housing*. A *shabrack*.

Sad'dle-girth. (*Saddlery.*) A band of leather or webbing which is attached on one side of the saddle, and, passing under the horse's belly, is secured to the other side by a buckle and strap, serving to keep the saddle in place.

Sad'dle-joint. A form of joint for sheet-metal, in connecting adjacent boiling-pans or adjoining strips in roofing. One portion overlaps and straddles the vertical edge of the next.

Fig. 4520.

Saddle-Joint.

Sad'dle-nail. (*Saddlery.*) A short nail having a large, smooth head, used in making saddles.

Sad'dle-rail. (*Railway Engineering.*) A railway rail which has flanges straddling a longitudinal and continuous sleeper. See RAIL.

Sad'dle-reed. (*Saddlery.*) Small reeds used in the place of cord to form the edges of gig-saddle sides.

Sad'dle-roof. (*Building.*) A double-gabled roof.

Sad'dler's Knife. (*Saddlery.*) A *half-round* knife. The semicircular knife, so familiar as a leather knife, is shown in the paintings of ancient Egypt.

Fig. 4521.

Saddler's Pinchers.

Sad'dler's Pinch'ers. (*Saddlery.*) A tool somewhat resembling the shoemaker's, but heavier, and having straighter grasping jaws. It has a lug on its lower side, serving as a fulcrum in drawing nails, etc., and straining leather tightly into position for tacking or stitching.

Sad'dler-y and Har'ness. See —

Apron.
Awl.
Back-band.
Back-strap.
Beam.
Bearing-rein.
Belly-band.
Billet.
Bit.
Bitting-rigging.
Blind.
Blind-bridle.
Block.
Boot.
Branch.
Breaking-harness.
Breast-band.
Breast-chain.
Breast-collar.
Breast-strap.
Breast-strap harness.
Breast-strap slide.
Breeching.
Bridle.
Bridoon.
Bristle-boot.
Brow-band.
Buckle.
Butt-chain.
Canon-bit.
Cantle.
Caparison.
Carbine-thimble.
Card.
Cart-saddle.
Causson.
Cavesson.
Chaff-halter.
Chamfering-tool.
Channeling-tool.
Chape.
Chapelet.
Check-hook.
Check-rein.
Check-rein hook.
Cheek-strap.
Chin-strap.
Choke-strap.
Clipper.
Cock-eye.
Collar.
Collar-awl.

Collar-block.
Collar-harness.
Collar-stuffing machine.
Creaser.
Cross straining.
Cross-webbing.
Crown-piece.
Crupper.
Crupper-loop.
Curb.
Curb bit.
Currycomb.
Currying glove.
Dash.
Dashboard.
Dog-muzzle.
Draw-gage cutter.
Edge-tool.
Fetlock-boot.
Fetter.
Fly-net.
Foot-stall.
Fore-bow.
Fore piece.
Gag-rein.
Gag-runner.
Gambado.
Gears.
Gig-saddle.
Gig-tree.
Girth.
Ground-plate.
Gullet
Halter.
Hame.
Hame-fastener.
Hame-lock.
Harness.
Harness-clamp.
Harness-hook.
Harness-pad.
Harness-saddle.
Harness-snap.
Heading-knife.
Head-stall.
Hip-strap.
Hitching clamp.
Hold-back
Hollow punch.
Holster.
Hood.
Hopple.
Horn.
Horse-collar.
Housing.
Interfering attachment.
Jockey-pad.
Knee-cap.
Lariat
Lasso
Leash.
Leather-gouge.
Leg and foot guards for horses.
Leg-guard.
Line.
Lunette.
Mail-bag.
Martingale.
Men's harness.
Mousing-hook.
Musrole.
Muzzle.
Neck-yoke.
Nose-bag.
Nose-band.
Open link.
Over check.
Ox-yoke.
Pack-saddle.
Pad.
Pad crimp press.
Pad for horses.
Pad-hook.
Pad-saddle.
Pad-screw.
Pad-tree.
Picket-pin.
Pillion.
Piping.
Poitral.
Pommel.
Pricker.
Pricking-wheel.
Rein.
Rein-slide.
Rein-snap.
Round knife.
Rounding-tool.
Saddle.
Saddle-bags.
Saddle-bow
Saddle-cloth.
Saddle-girth.
Saddle-harness.
Saddler's knife.
Saddler's pinchers.
Saddle. Side
Saddle-tree
Saddle-tree harness.
Safe.
Safety-rein
Scalloping tool.
Scribing-compass.
Set.
Setting-punch.
Sewing-clamp.
Sewing-horse.
Shabrack.
Shaft-tug.
Side-bar.
Side-flap.
Side-plate.
Side-saddle.
Side-strap.
Single line.
Skirting
Sleigh-bell.
Slitting-gage.
Snaffle.
Snap-hook.
Snap-link.
Spur.
Stiff-bit.
Stirrup.
Stitching-clamp.
Stitching-horse.
Stitch wheel.
Straining.
Straining-fork.
Straining-reel.
Stuffer.
Surcingle.
Swivel.
Tack-claw.
Tether.
Terret.
Thill-tug
Throat-latch.
Throwing horses. Apparatus for
Trace.
Trace-fastener.
Trace-hook.
Traveling-bag.
Tree.
Trunk.
Trunk-brace.
Tug.
Tug-carrier.
Tug-slide.
Twitch.
Valise.
Valise-saddle.
Watering-bridle.
Webbing.
Whip-rack.
Wood-cock eye.

An English saddler publishes the following list of articles needed in a stable by a gentleman keeping a carriage and one horse : —

Set of single harness.
Driving-whip.
Carriage-mats.
Whip-socket.
Loin-leather.
Suit horse-clothing.
Night-rug.
Pair knee-caps.
Set flannel bandages.
Set linen bandages.
Exercising-bridle.
Head-collar.
Pair head-collar reins.
Pair pillar-reins.
Roller.
Lamp.
Horse-brush.
Currycomb.
Water-brush.
Spoke-brush.
Dandy-brush.
Composition-brush.
Oil-brush
Bass-broom
Inside carriage-brush.
Set shoe-brushes.
Crest-brush.
Brass-brush.
Rack-chains
Six rubbers.
Four leathers.
Two sponges.
Mane-comb.
Trimming-comb.
Pair scissors.
Dung-fork.
Singeing-apparatus.
Dung-shovel.
Dung-basket.
Corn-measure.
Corn-sieve.
Picker.
Stopping-box.
Lantern.
Pail.
Burnisher.
Setter.
Oil can.
Oil-bottle
Scraper.
Clipping-machine.
Hemp head and reins.
Cleaning materials, viz. : —
Soap.
Oil.
Dye.
Carriage-candles.
Blacking.

Sad'dler-y-hard'ware. (*Saddlery.*) A general name for all metallic goods used in making saddles and harness.

Sad'dle-tree. (*Saddlery.*) *a.* The frame forming the support of a saddle ; usually made of wood. The parts are secured together by tenons and mortises, and held in place by a covering of canvas or wet raw-hide, which is tacked tightly and then shrunk by drying.

The tree consists of a *pommel*, *cantle*, two *side-bars* ; two *stirrup-bars* are added and iron staples for the valise, if required.

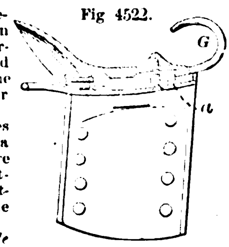
The kinds are numerous, according to the purpose, taste, or fashion of saddles. We may enumerate —

Spanish.
Half-Spanish.
English.
Side.
McClellan.
Somerset.
Jockey, etc.

The tree is the basis of the saddle, and determines its shape, as well as to a large extent its efficiency. It is usually of beech, strengthened by iron plates : the *gullet-plates* under the head, plates over the head and under the cantle.

Kelly, 1810, made saddle-trees of whalebone lined in part with metal

Fig 4522.



Harness Saddle-Tree.

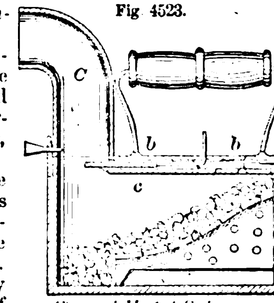
Thompson, 1825, made a saddle-tree of steel or iron. Bielefeld, in 1855, one principally of gutta-percha. Brooman, 1865, of wood and leather. Another man, in 1865, one of papier mache and horsehair combined and molded.

As a means of making saddles adjustable to fit different horses, a Mr. Smith, in 1786, made the fore points of steel springs with gullet-plates set out or narrowed by set-screws. Dunn, in 1791, made jointed gullet-plates.

b. The frame of a *harness-saddle* or *gig-saddle*. In the example, the check-rein hook *G* is secured between the seat and the tree by means of a lug or projection *a* passing through the leather at the upper surface of the tree, combined with a screw, flush with the under surface ; and another screw passes through a lip placed at the rear of the tree and into a pendant projection, for the purpose of securing the rear portion.

Sad'i-ron. An iron with a flat face, used for smoothing clothes. A *flat-iron*. A *smoothing-iron*.

Fig 4523.

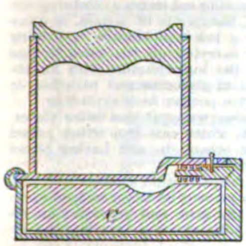


Charcoal-Heated Sadiron.

Besides the ordinary laundry-iron are many others, heated by incandescent charcoal, by iron-heater, by gas, lamp, etc.

In Fig. 4523, the body of the iron is hollow and has a perforated curved plate supporting the fuel. The top is formed by two plates *b c*, one of

Fig. 4524.



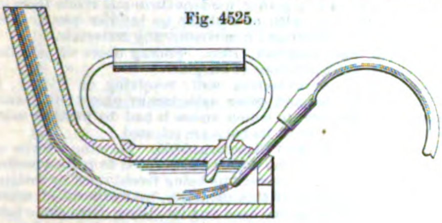
Heater Sadiron.

which serves as a damper. The products of combustion are carried off by the flue *C*.

In Fig. 4524, the cover is hinged at the back and held shut by a spring-bolt at the fore end. The heater *C* is replaced by a hot one when it becomes cooled.

In Fig. 4525, the hollow iron has an opening for the admission of a gas-burner, the flame of which is directed against the bottom of the iron. An elastic tube connects the gas-bracket with the sadiron.

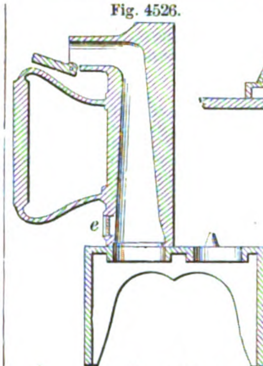
Fig. 4525.



Gas-Jet Sadiron.

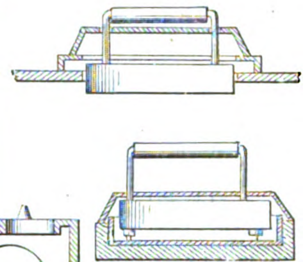
In Fig. 4526, the iron is perforated longitudinally and turned up at the forward end, where it has a lid. The iron is supported on a stand, so that the chimney of a coal-oil lamp may occupy the perforation of the iron. The window *e* allows a view of the flame.

Fig. 4526.



Lamp-Heated Iron.

Fig. 4527.



Sadiron Heaters.

Sad'i-ron Heat'-er. 1. A block to be made red-hot in a fire and placed in a box sadiron.

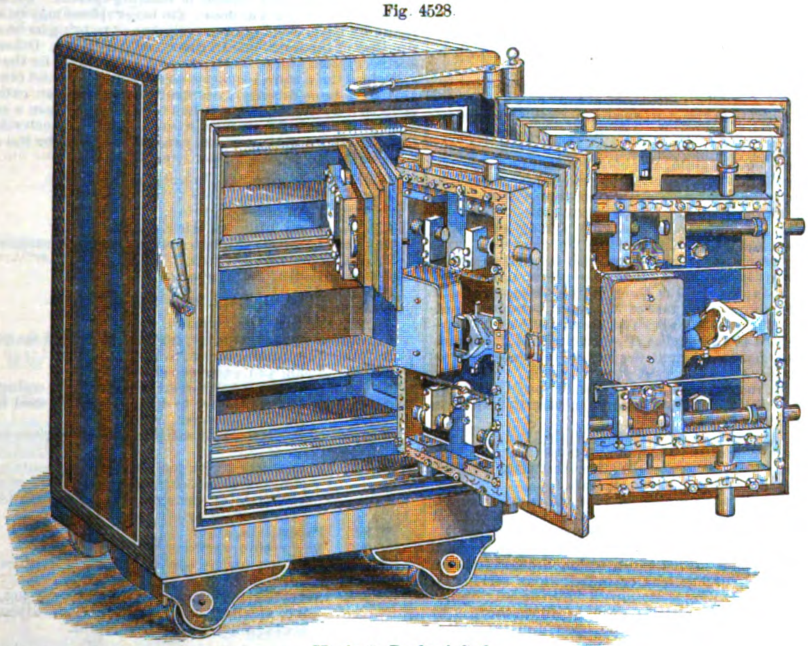
2. A device for heating a sadiron, as a lamp (Fig. 4526) or a gas-jet (Fig. 4525). A stool (Fig. 4527) for holding a flat-iron suspended over the pot-hole of a stove.

3. A heated block (lower part of Fig. 4527) in which an iron is placed to heat.

Sad'wei. (*Glass-making.*) A corruption of *Suint-de-verre* (Fr.). The saline scum or alkaline sulphates formed on glass-pots. Glass-gall. *Sandiver.*

Safe. 1. A strong case for containing money, account-books, and other valuable articles, to guard them from the attacks of burglars, and generally provided with means for protecting them against the action of fire.

Fig. 4528.



Herring's Bankers' Safe.

Safes are of various kinds for different purposes, as, —

Burglar-proof.	Kitchen.	Milk.
Coin.	Marine.	Portable.
Fire-proof.	Match.	Steam fire-proof.
Floating.	Meat.	Water-proof.

Fig. 4528 is an illustration of a modern form of safe, built of wrought-iron, high and low steel welded, and franklinite iron. It has hooped body and solid corners, tongued and grooved door with a lever hinge. The joints are packed with rubber to prevent the operation of the air-pump, — a new and

dangerous resort of burglars in introducing explosives at the cracks, to blow open the doors. The view shows the outer and inner door open, and also the door of the inclosed coin-safe.

The crown jewels of Scotland were, at the time of the Union, in 1707, deposited in an oaken chest. Its lid was secured by three locks, which were forced open in 1818, because the keys could not anywhere be found, leaving us to infer that locksmiths at least were not at that time very expert in the mystery of lock-picking.

Old muniment, deed, and cash chests of this kind were strengthened by iron bands, and generally elaborately carved. They were fastened by several padlocks, or by a multiplicity of bolts shot by a single lock; were formerly considered as secure as first-class safes are at present.

The first examples of metallic safes are coffers, consisting of iron frames, covered with sheet-iron, and strengthened by hoop-iron crossed at right angles on the outside and riveted through. These were common during the last century.

The first English patent for a fire resisting safe was to Richard Scott, in 1801. It consisted of an inner and outer casing of iron or other metal, between which was an interspace on all sides, filled in with charcoal or wood treated with a solution of alkaline salt. The door was made in a similar way.

The next was to William Marr, 1834, who introduced a second metallic lining, so as to form two interspaces within the safe, the inner of which was lined with mica or talc, and filled in with a non-conducting material. These were known as "double-chests," and a variety of non-conducting materials were used for filling, — clay, lime, graphite. Asbestus was used in 1834.

Chubb, 1835, patented a process of rendering woolen safes burglar-proof by lining them with steel or case-hardened iron plates, and fire-proofing iron safes by means of several linings, the interspaces between which were filled with granulated brick, pottery, or other slow conductor of heat.

Milner, 1840, filled the spaces between the linings with an absorbent material, in which were placed vessels containing an alkaline solution or other liquid which could be vaporized by heat, so that in case of fire these would burst and saturate the porous material with vapor.

In 1843. Wilder made a safe of heavy plates of iron, with a filling of hydrated gypsum, hydraulic cement, steatite, alum, and the neutralized and dried residuum of the so-called soda-water manufacture.

Lillie used slabs of chilled cast-iron and flowed cast-iron over wrought-iron ribs. Herring made safes with boiler-iron exterior, hardened steel inner safe, and the interior filled with a casting of franklinite around rods of soft steel.

Tann, 1843, used an outer and an inner metal casing filled in with a composition of equal quantities of alum and gypsum, or Austin's cement; within the inner casing was a wooden lining separated from the casing by a space filled with the same compound.

Sherwood, 1850 to 1854, mentions a safe within a safe, with a filling of fire-brick, melted alum, and clay. Steam or water, or carbonic-acid gas, injected or evolved in the safe. Safe in a safe, intervening space filled with water; corners of angle-iron, and other points of construction. Safe burns loose (in case of fire) and falls into a protected place. An arrangement of a cooling passage around a safe *in situ*.

Newton, 1853, formed a burglar-proof safe consisting of an exterior shell of cast-iron, within which was placed a network of wrought-iron rods; a core was built within these, and fluid iron poured in, filling up that part of the space between it and the shell not occupied by the rods; this became chilled by contact with the surface of the shell. The whole thus formed a compound mass, offering different degrees of resistance, so as to turn aside burglar's tools.

Gulick, 1857. A marine safe, rendered water-proof and having compartments filled with air or cork, so that it may float when thrown overboard.

Chubb, 1857. Inserting plugs of hardened steel into the iron plates of which a safe is made, at short intervals, apart or back of the exterior iron plate, with a corrugated steel plate or strips of steel, so as to prevent drilling into the safe.

Rhodes, 1859. Admitting a flow of cold water to circulate between the inner and outer walls of a safe and its door by a valve which opens when the temperature reaches 212°.

Chatwood, 1860. Backing corrugated or indented iron plates by pouring in fluid metal behind them, which becomes chilled on the face; the hard corrugations or indentations serving to break the drill in case drilling is attempted; also so affixing the lock-chamber that it will partially open to allow the gas to escape if it is attempted to blow the safe open, and then close automatically.

Stocker, 1861. Method of partially converting, piling, and rolling bars and plates for safes, so that their outer surfaces may have the hardness of steel while the inside retains the fibrous nature of iron.

Chatwood, 1862. Mode of making safes from "iron-steel," composed of a plate of steel welded in between two of iron, by forming the top, bottom, and two sides from a single piece, the ends being welded or riveted together; also by casting in one piece of homogeneous or other ductile metal; fire-proofing by lining with wood saturated with solution of sulphate of iron, sulphate of copper, alum, etc., and filling in cavity between the body and lining with non-conducting substance containing vessels filled with sulphurous acid, bisulphide of carbon, or other substance which vaporizes at a low temperature; providing safety-valves and apertures for carrying off the gases in case gunpowder be used, and filling the lock-chamber with an absorbent containing a compound of glycerine and paraffine, or other substance which hinders the powder from exploding.

Price and Dawes, 1863. Backing wrought-iron outer plates, having inward projections, with white cast-iron either joined immediately by pouring or cast separately, and having pieces of hard mineral substance interposed.

Chubb, 1865. Placing the safe door within a recess, and providing it with an exterior bar to prevent its being wedged open.

Thompson, 1865. Recessing the door and providing an interior flange, behind which the bolts shoot to prevent the introduction of wedges.

Varley's, 1865, is the first patent for an electro-magnetic alarm for safes. The signal is given by means of a bell caused to ring when the circuit is broken by moving the safe or opening its door at an improper hour.

Tann, 1865, in order to render safes burglar-proof, welds bars of iron and steel together, hardens them and rivets them on the body of the safe, with or without an interior plate. Also fire-proofing with alum and non-conducting materials.

Hill, 1865, and Hodgson, 1865. Sliding doors of peculiar form to resist the operations of burglars.

Loysel, 1865. A protecting wall, revolving or sliding, is placed between inner and outer cylinders or plates; the inner one contains the door, to which access is had by pushing aside the protecting wall when its bolts are released.

Parrish, Thatcher, and Glasscock, 1865. Forming a series of dovetail projections on the door frame, which fit corresponding mortises in the door to prevent its being forced open by wedges.

Other modifications of this principle, in the form of serrations or undulations in the door and its casing, have since been embraced in various patents. Another method is to form a bead around the door, fitting a groove in the casing. Besides this, various special arrangements have been adopted to prevent the entrance of wedges.

Other methods of combining and arranging metals of different degrees of hardness, so as to break the drill or turn it aside, to render it impossible to drill a continuous hole, have also been contrived.

Billing, 1866. Two hollow spheres, one placed concentrically within the other, and capable of rotating therein. Each is provided with a cylindrical door; the inner sphere may be made to rotate by bevel gearing, or arranged so as to bring its door opposite that of the outer one in the act of unlocking. Other forms, as the ellipsoid and cylinder, may be substituted for the sphere.

Besides the electro-magnetic alarms of Varley and others, signals have been devised to indicate by the sudden extinguishment of a light if an attempt has been made to open a safe.

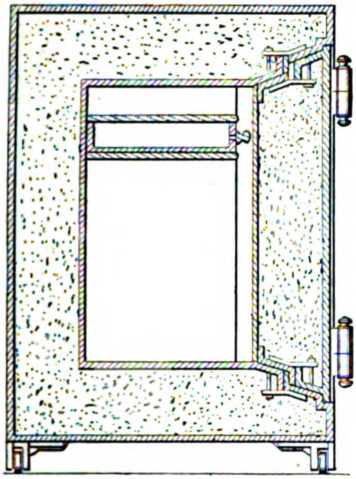
As filling for safes, we meet with the following materials. The numbers of the United States patents are cited for the convenience of farther reference: —

8,952.	Residuum of soda-water manufacture.
10,661.	Soapstone.
11,842	Tiles, alum, and clay.
12,594.	Alum, pieces of brick, alkali.
28,459.	Alumina, sulphates of alumina, and ammonia.
28,756.	Copperas, gypsum.
39,920.	Starch, water, gypsum.
40,800. 41,521.	Alum in pieces, imbedded in gypsum.
46,228.	Epsom salts, gypsum.
51,937.	Hydraulic cement, sawdust, lime, and sand-mortar.
59,529.	Paper-pulp, alum.
66,790.	Steam and water vessels.
67,154.	Removable water-vessels between the casings.
67,629.	Moistened sponge to dampen powder used for blowing the safe open.
70,390.	Nest of pipes in safe; fusible plug gives way with heat.
76,183.	Vials stopped with fusible alloy and containing sulphuric acid, which reaches carbonate of soda and carbonate of ammonia, generating carbonic-acid gas.
85,893.	Paper-pulp, alum.
87,140.	Raw cotton, sawdust, whiting.
100,632.	Asbestus, earths, such as cement or gypsum, chemical salts, alum.
101,268.	Asbestus, marble-dust, pipe-clay, gypsum, glycerine, mucilage, sulphate magnesia, sulphate soda, borax, alum, sal-soda, paraffine.

Safes and vaults using water or steam for protection in case of fire: —

Horsford	No. 39,919	Eaton and Ireland	No. 71,288
Sanborn	" 63,331	Bryant	" 79,808
Ashcroft	" 66,062	Bryant	" 79,809
Bryant	" 66,790	Bryant	" 86,356
Bryant	" 67,154	Robertson	" 101,044
Sanborn	" 67,220	Putnam	" 104,352
Bryant	" 67,629	Short	" 116,227
Ashcroft	" 70,390		

Fig. 4529.

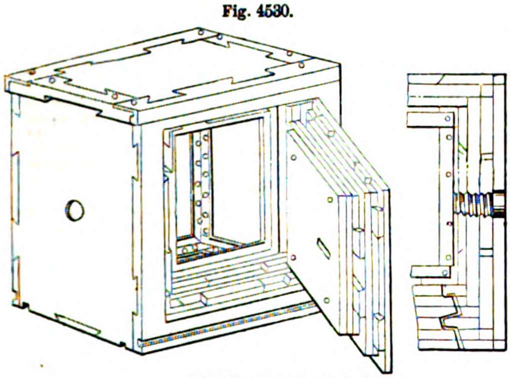


Fire-Proof Safe.

Fig. 4529 shows a safe with exterior and interior walls, with intervening non-conducting filling. The door is also double.

Fig. 4530 is a view of Hall's safe, in which the

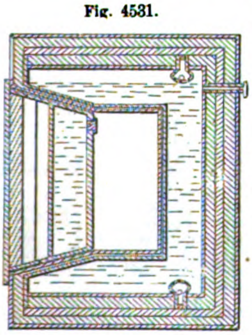
Fig. 4530.



Hall Burglar-Proof Safe.

plates are dovetailed together, and angle-irons are tenoned into the corners to make them mutually sustaining.

Fig. 4531.

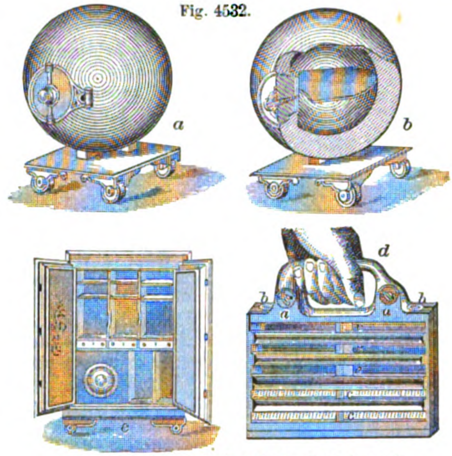


Fire-Proof Safe with Water-Jacket.

Fig. 4531 is a safe having hollow walls connected with the city main.

Marvin's burglar-proof safe (*a b*, Fig. 4532) is of globular form, having no salient points to facilitate the action of a tool for opening it. It is made of chrome-iron, whose extreme hardness renders it impervious to the drill, and the door, which is conical and of cast-steel, is accurately fitted to its opening. It may be simply mounted on a platform with rollers, or fitted within a special compartment of a fire-proof safe, as shown at *c*. The fire-proofing material is a composition of calcined plaster of Paris and alum, which, on being

Fig. 4532.



a b c, Marvin's Spherical Safe; d, Coin-Safe.

heated, gives up its water of crystallization; this is converted into steam, which prevents access of fire to the interior.

The portable coin-safe (*d*, Fig. 4532) is of cast-iron, and opens in the middle like a portmanteau. The two halves are secured together by screws *a a*, and have depressions *b b* to receive seals. The inside has a series of racks *c c*, which may be of different sizes to suit different coins.

2. A ventilated receptacle for meat and other articles.

Safes for meat, etc., have a wooden frame covered with wire gauze or perforated sheet-metal (usually tin-plate), to permit a free circulation of air but prevent the entrance of insects. If the latter material be employed, the perforations are made by a number of dies set in a press and so arranged as to form lines and geometrical figures by turning the sheet on its supporting block or die.

3. (*Saddlery.*) A piece of leather placed under a buckle, to prevent it from chafing.

4. A smooth edge to a file.

Safe-a-larm′. An *alarm-lock*, or other contrivance, to notify a watchman or the police of the tampering with a safe. Alarms for this purpose are usually electro-magnetic, but are also operated by the escape of a body of water or of air confined within the outer shell of the safe.

Safe-edge File. One having a smooth edge, which does not cut a surface against which it impinges.

Safe-guard. 1. (*Railway Engineering.*) *a.* A *rail-guard* at a switch or crossing.

b. A contrivance attached to a locomotive for throwing stones and other obstructions off the track.

2. (*Paper.*) See SAFETY-PAPER.

Safe-lock. A complex lock for a safe. See list under LOCK.

Safe′ty-arch. (*Architecture.*) One placed in a wall to receive a weight of superincumbent masonry and relieve a transom or beam. A *discharging* arch.

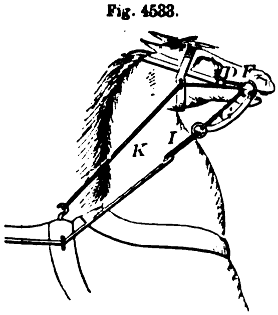
Safe′ty-beam. (*Railway.*) A beam in some forms of railway car-trucks which has straps to catch on in case of breakage. A similar duty is performed

by the safety-stirrups *s v* in Fig. 1159, page 488.

Safe'ty-belt. A belt with cork lining, or made of inflatable material, used to keep a person from sinking beneath the surface of the water. A *life-preserver.*

Safe'ty-bri'dle. (*Saddlery.*) A bridle designed to afford the means of promptly checking horses in the event of their attempting to run away.

Fig. 4533.



Safety-Bridle.

In the example, the bit-ring *F* is suspended on each side from a ring *D* on the cheek-strap by a running-strap *G*, which is connected primarily to the bit-ring, passes up and through the cheek-ring; the running-strap is then carried down through the bit-ring and connected to a safety-rein *I*; the latter is also connected to the gag-rein, so that pulling upon the safety-rein shortens up the gag-rein *K*, and at the same time draws up the bit toward the ring on the cheek-strap. See BRIDLE.

Safe'ty-buoy. A float to be attached to the person to prevent drowning.

Safe'ty-cage. A hoisting and lowering chamber for mines, having guards which arrest the descent if the rope break or overwind. See CAGE; ROPE-ELEVATOR; SAFETY-STOP, etc.

Safe'ty-car. 1. A marine car adapted to be drawn ashore on a hawser connecting a stranded vessel with the land. See LIFE-CAR, Fig. 2927, page 1302.

2. A hoisting cage with stops to arrest its fall if the rope break. See CAGE; SAFETY-STOP.

Safe'ty-chain. (*Railway.*) A slack chain which attaches a truck to a car-body and limits the excursions of the former as it slues round.

Safe'ty-fun'nel. A glass funnel with a long neck for introducing acids, etc., into liquids contained in bottles or retorts, and under a pressure of gas.

Safe'ty-fuse. A water-proof tube, ribbon, or tape containing an inflammable composition for igniting a blasting-cartridge. The composition has a regular rate of burning, say two or three feet in a minute, allowing the miners or quarrymen time to reach a place of safety previous to the explosion. In some cases, however, a much more rapidly burning composition is employed, a much greater length of fuse being used, and fire being communicated at the spot where the men have taken refuge.

Safe'ty-guard. (*Railway Engineering.*) An axle-guard to keep the car-wheels on a track at a switch.

Fig. 4534.

Safety-Hook.

Safe'ty-hoist. 1. A hoisting-gear on the differential-pulley principle, which will not allow the load to descend by the run. See SACK-HOIST.

2. A catch to prevent the fall of a cage when a rope breaks. See Fig. 4539.

Safe'ty-hook. A device to prevent a watch from being detached from its chain by accident or by a sudden jerk. In the figure, this is effected by screwing down the nut *d* against the shoulder *o*; this prevents the tongue *i* from turning open on its pivot.

Safe'ty-lamp. A lamp surrounded by a cylinder of wire gauze, invented about 1815 by Sir Humphry Davy, to obviate the danger of fire-damp explosions in mines. A similar contrivance was, about the same time, invented by the elder Stephenson.

Davy, after numerous experiments upon the passage of flame through narrow apertures, found that wire gauze of sufficient fineness acted as a complete barrier to its transmission, and that the gas in question could not be exploded unless absolutely in contact with the flame.

The principle may be readily demonstrated by holding a sheet of wire gauze above a flame and bringing it down gradually till it divides the cone of inflammable vapor and matter by a horizontal section. That which is below the gauze will continue to burn, but that above may be blown out and relit; but the flame will not communicate through the gauze to the vapors above.

Sir Humphry Davy gave some offense to the faculty, who could not keep up with his discoveries, and especially a patriarch in Aberdeen, who ignored Davy's researches for some years. The discovery of potassium was so palpable a hit that the sage had to relax the quarantine, and announced: "Gentlemen, both potash and soda are now said to be metallic oxides; the oxides, in fact, of two metals, called potassium and sodium by the discoverer of them, — one Davy, in London, — *a verra troublesome person in chymistry.*"

Davy's lamp (*a*), sent to the mines for experimental use, has 748 apertures to the square inch, the wire being $\frac{1}{70}$ of an inch in diameter. The cage or cylinder has double joinings, the gauze being lapped over at that point. The parts are fastened by hard solder. The limit of size is 2 inches in diameter; that of the meshes $\frac{1}{20}$ of an inch. The number of meshes was subsequently increased by Dr. Clanny, who also made other improvements in the lamp, to 1,296 per square inch.

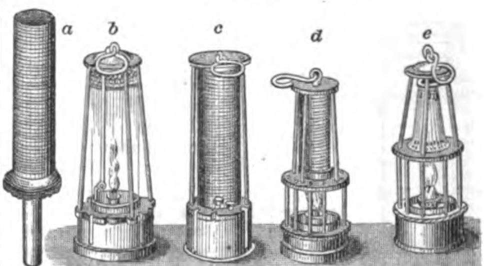
In Mueseler's safety-lamp, Belgian, a part of the metallic covering which surrounds the flame and forms the chimney is replaced by glass, affording more light than that yielded by the Davy lamp. The air for supporting combustion is admitted from above through two wire gauze diaphragms at right angles to each other.

Eloin's lamp, also Belgian, has a concave glass at its lower part, to disperse the rays of light.

Messrs. Liaute and Denoyel, students in L'Ecole Polytechnique, of Paris, have devised a lamp in which the gas necessary to support combustion is generated in the lamp itself. In an experiment made at Paris, one of the lamps was burned for three quarters of an hour eight feet under water, and when drawn up was burning as brightly as at first.

a represents the first Davy safety lamp, in which a wire cylinder was placed as casing over the flame. It is now in the possession of the Royal Society.

Fig. 4535.



Safety-Lamps.

b, English lamp. The light inclosed in a glass cylinder, the upper end of which is protected by wire gauze.

c. English lamp. The gauze cylinder protected

d, French lamp, Mueseler's. Glass and gauze cylinders.
e, petroleum lamp. Glass and gauze.
See also PHOTO-ELECTRIC LAMP.

Safe'ty-lock. 1. (*Lock.*) A lock so contrived as not to be opened by a picklock or without the proper key. See LOCK.

2. (*Fire-arms.*) One provided with a stop or catch to prevent accidental discharge.

Safe'ty-pa'per. A paper chemically or mechanically prepared, so that its color or texture will be changed by being tampered with; or a paper so difficult of production as to give an additional measure of safety.

Of safety-papers there are several kinds: —

1. Paper made with distinguishing marks to indicate proprietorship, as with the Bank of England water-mark, to imitate which is felony. Or the paper of the United States currency, which has silk fibers united with the pulp, the imitation of which is felony.

2. Paper made with layers or materials which are disturbed by erasure or chemical discharge of written or printed contents, so as to prevent fraudulent tampering.

3. Paper made of peculiar materials or color, to prevent copying by photographic means.

A number of processes may be cited: —

One kind is made of a pulp tinged with a stain easily affected by chlorine, acids, or alkalies, and is made into sheets as usual.

Water-marks made by wires twined among the meshes of the wire cloth on which the paper is made. See WATER-MARK.

Threads embodied in the web of the paper. Colored threads systematically arranged were formerly used in England for post-office envelopes and exchequer bills.

Silken fibers mixed with the pulp or dusted upon it in process of formation; as used in the United States paper currency.

Tigere, 1817. Treating the pulp or the paper, previous to sizing, with solution of prussiate of potash.

Sir Wm. Congreve, 1819. A colored layer of pulp in combination with white layers.

Printing upon one sheet and covering with an outer layer plain or water-marked.

Glynn and Appel, 1821. Mixing a copper salt in the pulp and afterward adding an alkali or alkaline salt to produce a copious precipitate. The pulp is then washed, made into paper and dipped in a saponaceous compound.

Stevenson, 1837. Incorporating into paper a metallic base, as manganese, and a neutral compound, as prussiate of potash, to protect writing from being tampered with.

Varnham, 1845. A paper consisting of a white sheet or surface on one or both sides of a colored sheet.

Stones, 1851. An iodide or bromide in connection with ferrocyanide of potassium and starch are combined with the pulp.

Johnson, 1853. Employing the rough and irregular surface produced by the fracture of cast-iron or other brittle metal to form a water-mark for paper by taking an impression therefrom on soft metal, gutta-percha, etc., and afterward transferring it to the wire cloth on which the paper is made.

Scoutteten, 1853. Treating paper with caoutchouc dissolved in bisulphide of carbon, to render it impermeable and to prevent erasures or chemical action.

Ross, 1854. Water-lining or printing the denomination of the note in colors while the pulp is yet soft.

Evans, 1854. Embodying a lace or open-work fabric in the pulp when making.

Courboulay, 1856. Mixing in the pulp, or applying to the paper salts of iodine or bromine.

Loubatieres, 1857. Manufacturing paper in layers, any or all of which might be colored, or have impressions or conspicuous marks for preventing forgery.

Herapath, 1858. Imbuing paper during or after its manufacture with a solution of a ferrocyanide, a ferrid-cyanide, or sulpho-cyanide of potassium, sodium, or ammonium.

Seyd and Brewer, 1858. Applying aqueous solution of ferrocyanide of potassium or other salt, which forms an indelible compound with the ferruginous base of writing-ink.

Sparre, 1859. Opaque matter, such as Prussian blue, white or red lead, insoluble in water, is stenciled on one layer of the paper web, forming a regular pattern; this is then covered by a second layer of paper.

Moss, 1859. Coloring-matter prepared from burned china or other clay, oxide of chromium or sulphur, is combined with the pulp.

Barclay, 1859. Incorporating with the paper, 1, soluble ferrocyanides, ferrid-cyanides, and sulpho-cyanides of various metals, or forming dibasic salts with potassium, sodium, or ammonium, in conjunction with vegetable, animal, or metallic coloring-matters.

2. Salts of manganese, lead, or nickel not containing ferrocyanogen.

3. Ferrocyanides, etc., of potassium, sodium, and ammonium, in conjunction with insoluble salts of manganese, lead, or nickel.

4. Insoluble ferro- or ferrid-cyanide of manganese, or soluble sulpho-cyanide of manganese alone, or forming double salts with potassium, sodium, or ammonium.

Hooper, 1860. Oxides of iron, either alone or dissolved in an acid, are mixed with the pulp.

Nissen, 1860. Treating paper with a preparation of iron, together with ammonia, prussiate of potash and chlorine, while in the pulp or being sized.

Middleton, 1860. One portion of a bank-note is printed upon one sheet of thin paper and the other part on another; the two are then cemented together by india-rubber, gutta-percha, or other compound. The interior printing is seen through its covering sheet, so that the whole device on the note appears on its face.

Olier, 1861. Several layers of paper of various materials and colors are employed; the middle one may be colored with a deleble dye, whose color will be changed by the application of chemicals to the outer layer.

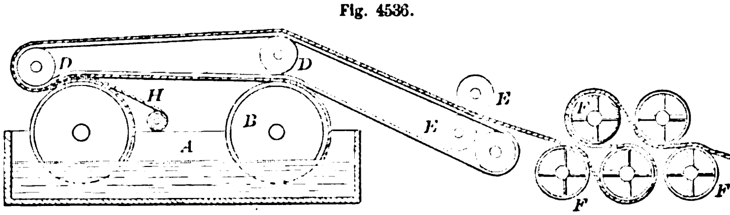
Olier, 1863. A paper of three layers of different thicknesses, the central one having an easily removable color, and the external layers charged with silicate of magnesia or other salt.

Forster and Draper, 1864. Treating paper during or after its manufacture with artificial ultramarine and Prussian blue or other metallic compound.

Besides these, are numerous devices for preventing copying by photographic means, certain colors being employed in parts of the genuine note which are not capable of giving a photographic image with the distinctness required.

In a paper made by the apparatus shown in Fig. 4536, threads of rubber or gutta-percha from the roll *H* are inserted between the two layers of the double web, formed by the making cylinders *B D D*, compacted by the press-rolls *E E*, and softened and united to the paper fiber on passing through the heated drying-cylinders *F F*.

Fig. 4536.



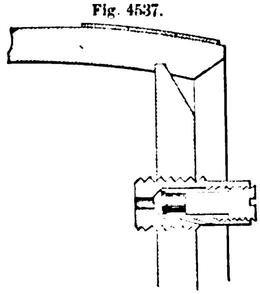
Safety-Paper Machine.

Safe'ty-plug. 1. (*Steam-boiler.*) A bolt having the center filled with a fusible metal and screwed into the top of the fire-box, so that the metal may melt out when the temperature of the inside of the boiler reaches a certain limit.

2. A device to prevent barrels from bursting by the expansion of their contents, or gases generated therein.

It consists of a hollow metallic screw-plug, having a valve, which is supported against its seat by an adjustable spring of india-rubber, or other elastic material, which will yield when the pressure in the vessel from any cause exceeds a certain limit.

Fig. 4537.



Safety-Plug for Barrels.

Safe'ty-rail. (*Railway Engineering.*) A guard-

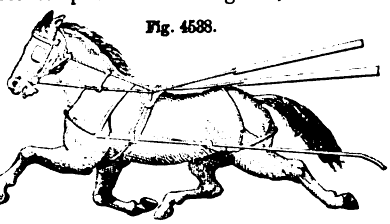
rail at a switch to bear against the inside edge of a wheel-flange to keep the tread on the *track*-rail.

Safe'ty-ra'zor. A razor having guards at each side of the edge to prevent nervous and infirm persons from accidentally cutting themselves in shaving. See RAZOR.

Safe'ty-rein. (*Saddlery.*) A rein to be used in case the horse attempts to run away. It usually has a special purchase of some kind intended to draw the bit violently into the angles of the mouth; to throw a blind over the eyes; to draw a choking-strap around the throat, etc., etc.

In the example, the gag-rein passes through a loop above the bit-ring, and is connected to the cheek-piece by the brow band. It is also connected by cross strap to the driving-rein, which has a

Fig. 4538.

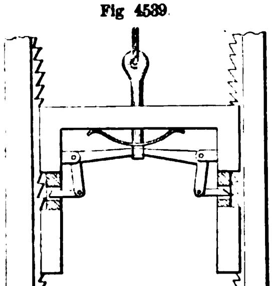


Safety-Rein.

spring section next the bit. The driving and gag-reins exert their usual functions until the horse is restive, when severe draft on the driving-rein stretches the elastic section and transfers the power to the gag, which draws the bit into the angle of the mouth.

Safe'ty-stop. (*Hoisting-machine.*) Provision is made in hoisting-machines which are hoisted by a rope for being automatically stopped when the rope breaks.

Fig 4539.

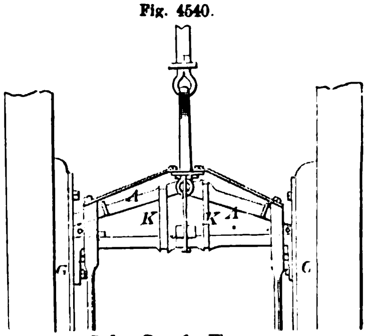


Safety-Stop.

Otis's apparatus for this purpose (Fig. 4539) consists of a pair of pawls which engage ratchet teeth in the bars attached to the uprights on the side of the shaft. The pawls are held out of engagement with the racks so long as the weight of the platform is suspended from the rope, but if the rope break the spring comes into action and depresses the elbow levers, which force out the pawls and prevent the farther descent of the platform. See ROPE-ELEVATOR.

In Fig. 4540, the rubber springs *K K*, in case the rope breaks, draw down the inner ends of the arms *A A*, forcing their beveled outer ends into a rack on the guides *G G*.

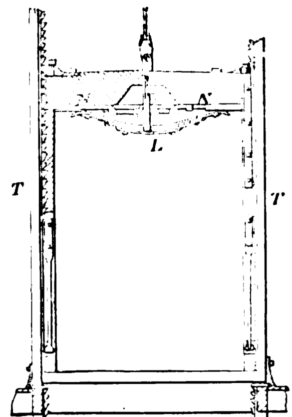
Fig. 4540.



Safety-Stop for Elevators.

In Fig 4541, the pressure of the elliptic spring *L* against the levers *N N* is relieved sufficiently to allow them to clear the notches in the guides *T T* so long as the hoisting-rope is kept tense by the weight of the cage; but in case of breakage the spring acts to force out two sliding catch-bolts into the notches, preventing farther descent.

Fig. 4541.



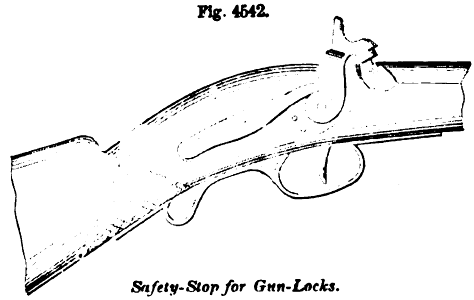
Miller's Safety-Stop.

2. (*Fire-arms.*) A device to prevent the accidental discharge of a gun. In Fig. 4542, a flat spring catches against the rear of the hammer and locks it against the nipple; when the spring is pressed against the stock, the hammer is free to be cocked.

3. A device on a pulley or sheave, to keep it from running backward.

4. A stop-motion in a spinning-machine, knitting-machine, loom, etc., which arrests the motion in

Fig. 4542.



Safety-Stop for Gun-Locks.

case of the breakage of a sliver, yarn, or thread, as the case may be.

Safe'ty-strap. (*Saddlery.*) An extra back band passing over the seat of a gig-saddle, having holes through which the terrets pass to keep it in position, the ends being buckled to the shaft-tug; used as a safeguard on light trotting harness.

Safe'ty-switch. (*Railway.*) A switch which returns automatically to its normal position after having been moved to let a train on to or off of a siding.

Safe'ty-tube. A tube used in chemical operations to prevent the bursting of a vessel from the sudden disengagement of gases, accession of air, or the mingling of fluids in vessels connected together.

Safe'ty-valve. (*Steam-engine.*) A valve which automatically opens to permit steam to escape or air to enter the boiler in order to prevent its explosion or collapse.

Internal. Opens to the inner side when the pressure of steam is less than a given weight.

External. Opens to the outside when the pressure of steam is greater than a given weight.

The latter is more important, and is an indispensable attachment to every boiler. It consists commonly of a lever of the third class pivoted at one end; the valve, which is on a stem projecting from the lower side of the lever, is conical, and fits into a corresponding seat. The lever has notches for receiving the hook or loop of a weight which is suspended

therefrom, and may be moved from one notch to another, like the weight of a steelyard, so that a greater or less amount of steam pressure may be required to lift the valve from its seat.

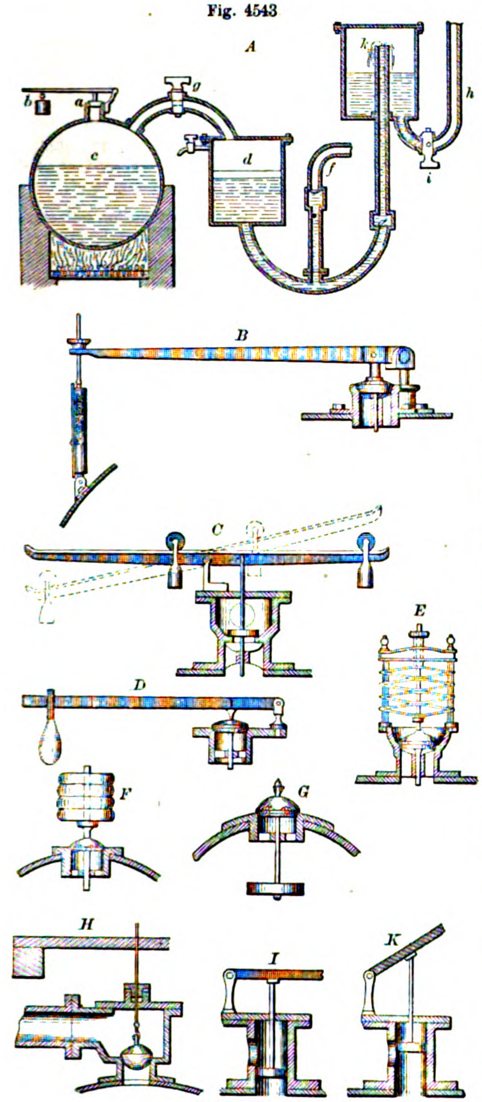
The safety-valve is also used with boilers of various kinds, air and gas engines, proving-pumps, hydraulic-presses.

Locomotive-engines have two valves placed on the boiler for the escape of steam when it exceeds certain limits. One of them is placed beyond the control of the engineer, and is called the lock-up valve. The other is regulated by a lever and spring-balance at a little lower pressure than the lock-up valve.

It was invented by Papin, 1695, and was originally applied to his *digester*.

A, Fig. 4543, shows Papin's safety-valve in connection with his engine for raising water. *a* is the valve, which is a conical stopper, representing the power in a lever of the third kind, weighted at *b*, lifted by the valve when the steam pressure in the boiler *c* exceeds a fixed limit. For raising water by this machine, a vacuum was produced over the float *d* in the chamber *e*, causing the water to rise through the induction-pipe *f* and fill the chamber; on turning the cock *g*, steam was admitted above the float, forcing the water out through the discharge-pipe *h*, the cock *i* being opened for that purpose. An air-chamber *k* made the discharge continuous.

Fig. 4543



Safety-Valves.

B, safety-valve for high-pressure boilers. The weight is replaced by a spiral spring whose tension is adjusted by a thumb-nut.

C, French safety-valve. The lever has two equal arms, having weights traversing on rollers; when the pressure reaches the fixed limit, the weights roll down the tilted lever, leaving the valve opening free until they are replaced.

D, common safety-valve with graduated lever, on which the weight may be set at any required number of pounds' pressure.

E, the valve is held to its seat by bent springs.

F, a series of removable perforated weights on the valve-spindle are employed.

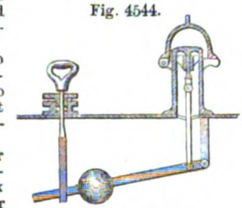
G, the weight is attached to a stem projecting downwardly into the boiler.

H, Nimmo's valve for steamboat boilers; a modification of the above.

I, *K*, valve used by Mr. Southern in his experiments on high-pressure steam; the first in closed, the second in open position.

In the conditions of competition for the £500 prize for the best locomotive-engine, offered by the Liverpool and Manchester Railway Company, and won by Stephenson's "Rocket," it was stated that one of the safety-valves should be "locked up." See also LOCK-UP SAFETY-VALVE.

Fig. 4544.



Lock-up Safety-Valve.

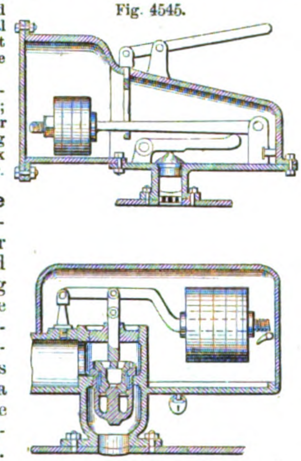
A British form of the lock-up safety-valve, which is inaccessible to the engineer, except to lift it to ascertain that it is not set fast, is shown in the illustration (Fig. 4544).

Fig. 4545 shows two other forms of safety-valves for steam-boilers; one from Burch's work on "Steam-Boilers"; the lower one is Cameron's valve.

In Fig. 4546, the lever and weight are toothed on their under surfaces, engaging the teeth of a spur-wheel, to whose axis an index is attached which indicates on a dial the steam pressure at which the safety-valve is set.

Fig. 4547 is a safety-valve, or blow-off valve; operated in the latter case by a stem passing through a stuffing-box in the front of the boiler.

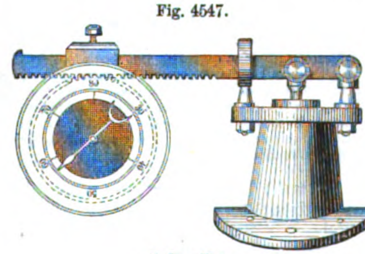
Fig. 4545.



Safety-Valves.

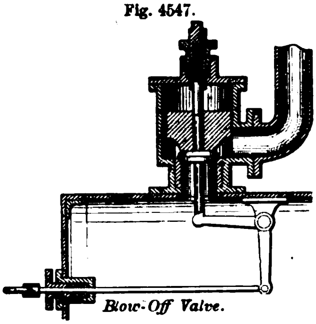
Safe′ty-valve Le′ver. (*Steam-engine.*) The lever to which is attached the weight or spring that controls the opening of the safety-valve. In locomotive-engines, it is fixed at one end to a stud and rests on the valve at a short distance from this stud. Its length is proportioned to the area of the valve, and a spring-balance indicates the pressure

Fig. 4547.



Safety-Valve.

Fig. 4547.



Blow-Off Valve.

in pounds per square inch on the boiler above atmospheric pressure.

Saf'fi-an. (*Leather.*) A dyed leather made at Astracan and other parts of Asiatic Russia. The skins of bucks and goats are used for the purpose, and the colors used are red and yellow. The articles used in its preparation are lime, dog's dung, and bran. Honey is used after the bran. After three days' fermentation, the skin is salted and dried. The skin is then dyed, and tanned with sumach. The red color is given by cochineal and *ericoides*, an alkaline plant growing plentifully on the Tartarian salt deserts. The color is finished with alum. For the finest qualities, sorrel is added in the cochineal bath, and the tanning is done by galls. The roughness is given by a heavy iron rake with blunt points.

Sag. 1. The bending downward of the middle of a beam or other object supported at both ends. Sometimes beams are framed with a slight *camber*, which neutralizes the *sag*.

Hogging is the depression of the ends when supported in the middle. See HOG-FRAME.

2. The movement of a ship when making considerable *lee-way*. It is the opposite of *holding* a good wind, or bearing up well to *windward*.

Sag'a-thy. (*Fabric.*) A mixed fabric of silk and cotton.

Sag'ger. (*Porcelain.*) Saggers for earthenware hold a pile of ware in the *biscuit* or *white* condition, but china and fine porcelain articles are contained separately in small *saggers* called *setters*, which are of a shape to suit the article. They are *reared* in *bungs* in the *kiln* where they are *fired*. *Saggar; seggar.* See SEGGAR.

Clay for making pots to be used as *saggers*.

Sag'ging. (*Nautical.*) A term the reverse of *hogging*. Applied to a ship when the middle portion of the keel and bottom arch downward.

Sa-git'ta. (*Masonry.*) *a.* The keystone of an arch.

b. The versed sine of an arch; from the resemblance of an arrow standing upright on the string of a bow.

Sa'go-mak'ing. Sago is a variety of starch prepared from the pith of palms belonging to the genus *sagus*, and employed in various culinary preparations, particularly for invalids.

At the proper age, the sago-palm is cut down, the wood being a mere shell around a most abundant pith. A strip of the bark and shell of the trunk is removed, and the interior pulp beaten up with stone hammers until only a trough about half an inch thick is left. The pulp is then taken in baskets made of sago-palm leaves, and washed in troughs made from the trunks of the tree, strained through sieves made from the fiber and allowed to settle, this part of the process resembling the manufacture of starch. When a sufficient quantity has been obtained, it is made into thirty-pound rolls, wrapped in sago leaves, and is ready for market under the name of raw sago. By the Malays this farina is broken up into powder and dried in the sun. This is baked in shapes in an oven. The cakes are dried in the sun, tied in bundles, and packed away. They are eaten dry, wet, toasted, or boiled like rice.

Sa'ic. (*Vessel.*) A Levantine vessel like a ketch, but without top-gallantsail or mizzen-topsail.

Sail. A canvas cloth spread to catch the wind.

1. (*Nautical.*) It is supported by the masts, spars, or stays of a vessel.

2. The propelling sheet of a wind-driven carriage.

3. The clothing on the radial arms of a windmill.

4. A funnel-shaped bag on the deck of a vessel to intercept or gather air and lead it below deck for the purpose of ventilation. A *wind-sail*.

The Greek tradition that Dædalus, the Athenian, 1240 B. C., first contrived sails, is disproved by the expeditions of the Phœnicians around the Mediterranean previous to that time, by the fact that the Nile had been for over 1,000 years the great highway of Egypt, and the rivers of China for an equal or greater period had run through a well-peopled country.

"Sails come from Egypt, and this paper too."
HERMIPPUS; quoted by ATHENÆUS, A. D. 220.

The Veneti, a tribe of the Belgæ, had leathern sails managed by chains. The Romans tore them by scythes on the ends of long poles. — STRABO.

Sails take their names from the mast, yard, or stay on which they are stretched. Some of the names indicate relative elevation: —

Mainsail.	Foretopmast-staysail.
Foretopsail.	Maintopmast-studdingsail.
Mizzen-royal-sail.	Main-skysail, etc., etc.
Main-staysail.	See Fig. 4549.

They also differ in their mode of extension: —

A *square sail* is extended by a *yard* or *boom* (see Fig. 4548).
A *fore-and-aft* sail is extended by a *gaff*, *stay*, *sprit*, or *yard*.

Names indicative of form: —

Square sail.	Shoulder-of-mutton sail, etc.
Lateen-sail.	

Specific names of various derivations: —

Bonnet.	Driver.
Jib.	Lug.
Ring-tail.	Save-all.
Skysail.	Spanker.
Spencer.	Trysail.

Names derived from normal position: —

Fore-and-aft sail.	Studdingsail.
Water-sail.	Bonnet.

By position before or abaft the *center of effort* of the vessel: —

Head-sail.	After-sail.

The *square* sails are: *courses*, *topsails*, *top-gallantsails*, *royals*, and *skysails*, on each mast. *Lug* and *studding* sails are also enumerated among the *square* sails.

The *fore-and-aft* sails are: *staysails*, *trysails*, *jibs*, *drivers*, *spankers*, *gaff-topsails*; and in sloops, cutters, and schooners, the main and fore sails, and frequently the topsails.

Trysails are bent to small spars abaft the lower masts. That of the mizzen is called the *spanker*.

Staysails are those hoisted on the *stays* of the masts. The *foretopmast-staysail*, *jib*, *flying-jib*, and *jib-of-jib* are of this kind. Some jibs do not run on a stay. See CUTTER.

The *courses* are the sails sustained by the lower masts, as the *foresail*, *mainsail*, and *spanker*.

The parts and accessories of a sail are: —

Head; the upper edge.

Foot; the lower edge.

Leech; the vertical edge. The *weather-leech* is the *luff*. The *lee-leech* is the *after*-leech.

Clew; one of the lower corners of a square sail; the lower after-corner of a fore-and-aft sail.

Tack; the lower weather-corner of a square sail; the lower forward corner of a fore-and-aft sail.

Bunt; the middle part of a sail, vertically.

Bolt-rope; sewed round the edges of a sail; it is called the *head*, *foot*, or *leech rope*, according to position.

Earing; the upper corner of a square sail.

The *depth* of a sail is from the *head-rope* to the *foot-rope* of a square sail; the length of the after-leech of a fore-and-aft sail.

Tabling; an additional thickness of canvas on the *roped* side of a sail.

Reef-band; a strengthening band across the sail at the eyelet-holes for the *reef-points*.

Reef-points; tapering pieces of braided cordage called *sennit*, which pass through the eyelets and hang down an equal distance before and abaft the sail. The length is such as to enable them to reach twice round the yard.

Reef-line; a substitute for *reef-points*, consisting of a rope rove through the eyelets of a reef-band and over the yard.

Reef-tackle; a purchase by which the *reef-cringles* on the leech of the sail are hauled up to the yard in reefing.

Belly-band; a strengthening band of canvas running horizontally midway between the lowest reef-band and the foot of the sail.

Buntline-cloths; bands of canvas running up and down from the belly-band to the foot of the sail.

Reef-tackle patch; a strengthening piece of canvas at the reef-cringle on the leech of a sail.

Top-lining; a patch on the lower part of a topsail where it chafes on the *top* of a lower mast.

Cringle; a loop on the leech of a sail to which the reef-tackles are attached. The head-cringle is a loop on the upper corner of a sail by which it is lashed to the *head-earing strops* on the yard-arms.

The *head-rope* of the sail is secured to the *jackstay* on the yard by *robands* passing through eyelet-holes.

The *roach* of the sail is the concave curve of the foot.

A *save-all* is a piece which fills up the *roach* when required.

For the ropes to operate yards, sails, etc., see RUNNING-RIGGING.

A sail is —

Bent; that is, fastened to its yard or other spar; or

Unbent; cast loose therefrom.

Furled; drawn up to the yard or spar and secured by gaskets.

Reefed; reduced in area by tying up a portion of the *foot* or of the *head*, as the case may be.

Atrip; hoisted and sheeted home ready for trimming.

Trimmed; when the yards are braced up in the most advantageous position to catch the wind.

To *set* sail; to expand it on its yard or stay.

To *make* sail is to spread all or a part of the sails or shake out the reefs.

To *shorten* sail is to furl, reef, or clew a part of the sails.

To *strike* sail is to lower it suddenly by letting run the halyards.

To *loosen* sail; to shake it from the yard to dry.

To *back* sail: to handle the sail so as to catch the wind in a direction to force the ship astern.

To *hand* sail is to *furl* it.

To *brace* a sail is to move it by bracing the yards; to *brace about* is to brace them in a contrary direction; to *brace in* is to haul in the weather-braces; to *brace up* is to haul in the lee-braces.

To *brail* is to haul up the foot and leeches of a sail by its brails.

To *fill* is to brace the yards so that the wind will act upon the after surface of the sails.

To *settle down* a sail is to lower it to the cap handsomely.

Square sails are worked by the motions of the yards which are effected by those parts of the running-rigging known as

Halyards.	Lifts.
Braces.	

The ropes especially devoted to the sails are the

Sheets.	Buntlines.
Jacks.	Downhauls.
Clewlines.	Brails.
Bowlines.	Outhaulers.

Canvas or sail-cloth is made in grades of quality and strength. Of the latter it is Nos. 1 to 8. The first number is the strongest, and is used for storm-sails; No. 8 for small sails and studdingsails.

The seams of the cloth in a square sail are vertical. In a fore-and-aft sail they are parallel with the after-*leach*.

In Cowan's patent (English) the seams are horizontal.

The seams have also been made diagonal, with no improved effect, but rather otherwise.

Some of the terms employed by sail-makers are, —

Seaming; sewing the breadths together.

Goring; cutting out the wedge-shaped pieces where the sail narrows.

Tabling; putting on the strengthening strips around the edge, where the cringles are inserted

Sewing on the *reef*, *belly*, *lining*, and *buntline bands*.

Roping; sewing on the *bolt-rope*.

Marling on the clews and foot-rope.

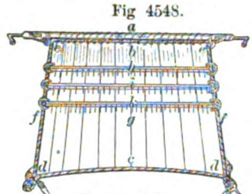
Many attempts have been made to avoid the necessity of going aloft to set or furl sails, which is a dangerous duty, especially in stormy and wintry weather.

Cunningham's patent (English) is for a yard, rotated by ropes from the deck, so as to wind on or unwind the sail in furling or setting. The plan involves a vertical division of the sail, and has not been generally adopted.

Fig. 4548 is a *course* or lower square-sail.

a, yard.
b, head-rope.
c, foot-rope.
d d, clews.
e e, earings.
f f, leeches.

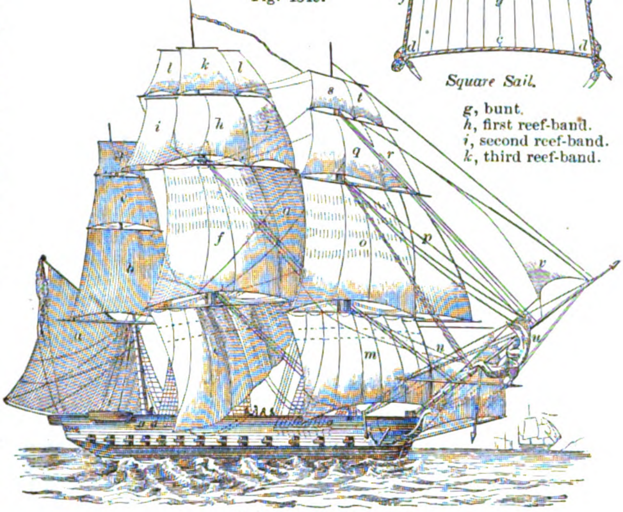
Fig 4548.



Square Sail.

g, bunt.
h, first reef-band.
i, second reef-band.
k, third reef-band.

Fig. 4549.



Frigate under Full Sail.

a, spanker.	*m*, foresail.
b, mizzen-topsail.	*n*, fore-studdingsail.
c, mizzen-top-gallantsail.	*o*, foretopsail.
d, mizzen-royal.	*p*, foretopmast-studdingsail.
e, mainsail.	*q*, fore-top-gallantsail
f, main-topsail.	*r*, fore-top-gallant-studding-sail.
g, maintopmast-studdingsail.	*s*, fore-royal.
h, main-top-gallantsail.	*t*, fore-royal-studdingsail.
i i, main-top-gallant-studding-sails.	*u*, jib.
k, main-royal.	*v*, flying-jib.
l l, main-royal-studdingsails.	

Sail-cloth. (*Fabric.*) A canvas for sails, made of flax, hemp, cotton, or jute. In thickness, and consequent weight, it varies from 22 to 44 pounds per bolt of 38 yards, 24 inches wide.

Sail-clutch. An iron band fastening a sail; a substitute for hoops or lashing.

Sail-hook. (*Nautical.*) A small hook for holding the sail-cloth while sewing.

Sail-hoop. (*Nautical.*) The wooden rings by which fore-and-aft sails are secured to masts and stays.

Sail′ing-car′riage. A wheeled vehicle propelled by sails. Such appear to have been used by the Chinese, and at the present day a kind of sled provided with sails is sometimes met with on our northern rivers. They are capable of great speed. See ICE-BOAT; KITE.

Sail-loft. A large apartment where sails are cut out and made.

Sail-nee′dle. (*Nautical.*) A large needle with triangular tapering end, used in sewing canvas.

Sail-room. (*Nautical.*) An apartment or bunk on board ship where spare sails are stowed.

Sail-wheel. A name sometimes applied to the tachometer of Woltmann. See TACHOMETER.

Sa′ker. (*Ordnance.*) An old form of cannon, 8 or 9 feet long, and of 5 pounds' caliber.

> "The cannon, blunderbuss, and saker,
> He was the inventor of and maker."
>
> HUDIBRAS.

Sal′a-man′der. 1. A circular iron plate used in cooking. A *griddle*.

2. A term sometimes applied to a fire-proof safe.

3. A heated iron for firing cannon, called on shipboard a loggerhead. Not now in use.

Sal'a-man'der's Hair. Asbestus, amianthus, mineral flax. See pages 167, 168.

Sa'li-ent An'gle. (*Fortification.*) Two united faces, presenting the vertex outward, as in the *redan* and *bastion*. See Fig. 4218.

Sal'i-nom'e-ter. An instrument for ascertaining the saltness of water.

The *thermometrical* method is by ascertaining the boiling-point of the brine. This is used in salt-works, the scale being graduated to indicate percentages.

The *hydrometric* method is by finding its specific gravity at a given temperature.

The following table shows the boiling-points and specific gravities of sea-water (at 60° Fah.) of different degrees of saturation, expressed in parts of salt contained therein, the barometer indicating 30 inches of mercury: —

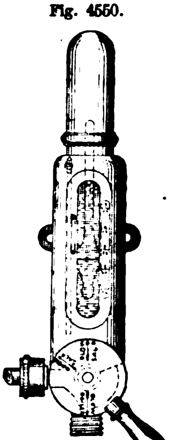
	Saltness.	Boils.	Sp. Gr.
Pure water.......	0	212°	1.
Common sea-water	$\frac{1}{32}$	213 2°	1.029
	$\frac{2}{32}$	214.4°	1 058
	$\frac{3}{32}$	215.5°	1.087
Up to this point no deposit will be formed.			
	$\frac{4}{32}$	216.7°	1.116
	$\frac{5}{32}$	217.9°	1.145
	$\frac{6}{32}$	219.1°	1.174
	$\frac{7}{32}$	220.3°	1.203
	$\frac{8}{32}$	221 5°	1.232
	$\frac{9}{32}$	222.7°	1 261
	$\frac{10}{32}$	223.8°	1.290
	$\frac{11}{32}$	225.0°	1.319
	$\frac{12}{32}$	226.1°	1.348 saturated solution.

As a general rule, the boiling-point of the water, when subjected to a pressure of one atmosphere, should never be allowed to exceed 216°. The temperature must be ascertained by drawing off a small quantity of the brine, and boiling it in a deep copper vessel in the engine-room, a correction being made, if necessary, for the state of the barometer.

The following table shows the hight of the boiling-point in Fahrenheit's scale at different hights of the barometer: —

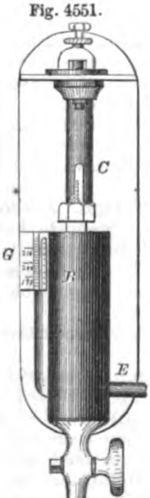
Barometer.	Boiling-point.	Barometer.	Boiling-point.
27 inches.	206.96°	29½ inches.	211 20°
27½ inches.	207.84°	30 inches.	212°
28 inches.	208.69°	30½ inches.	212.79°
28½ inches.	209 55°	31 inches.	213.57°
29 inches.	210.38°		

Fig. 4550.



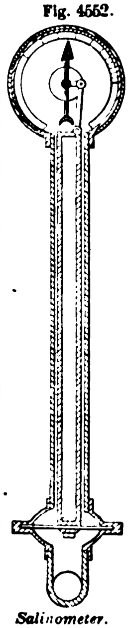
Salinometer.

Fig. 4551.



Salinometer.

Fig. 4552.



Salinometer.

An ordinary form of marine salinometer is a graduated glass tube, whose bottom swells into two bulbs, the lower the smaller, and containing shot, to cause the instrument to float vertically. The greater the degree of saturation, the heavier the liquid, and the consequent hight of the graduated stem relatively to the water's surface.

The water-chamber of Gamble's salinometer (Fig. 4550) is connected to the boiler, so as to give a constant indication of the degree of saturation, and contains a thermometer for showing the temperature of the water in the boiler. The case has a glass face, through which the salinometer can be seen, and the bulb has a horizontal line, whose coincidence with one of the graduations at the side of the case shows the proportion of salt contained in the water, as $\frac{1}{32}$, $\frac{2}{32}$, etc.; intermediate proportions may be estimated by the eye.

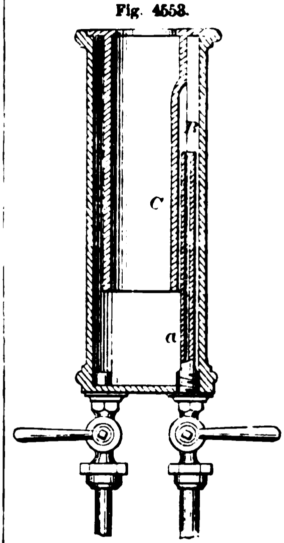
In Fig. 4551, water from the boiler is drawn through the pipe *E* into the cylinder *B*. The upper end of the hydrometer is visible through an opening in the tube *C*, so as to expose the graduations. A thermometer *G* indicates the boiling-point.

In Fig. 4552, an inner tube is weighted to balance a column of water of known hight and density, and rests upon a flexible diaphragm, through which the pressure of the water is transmitted. Variations of pressure are indicated by an index connected with the upper end of the tube and traversing the dial.

Sal'i-nom'e-ter-pot. A vessel into which water from the boiler is drawn, in order to be tested by the salinometer.

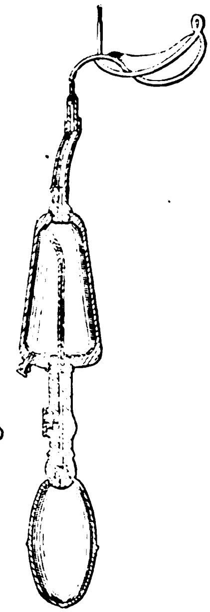
In Sewell's, the water entering at the induction-pipe *a* is received in the outer chamber *B*, and thence passes downward and around the lower edge of the inner chamber *C*, so as to prevent a scalding jet flying out at the top.

Fig. 4553.



Salinometer-Pot.

Fig. 4554.



Saliva-Pump.

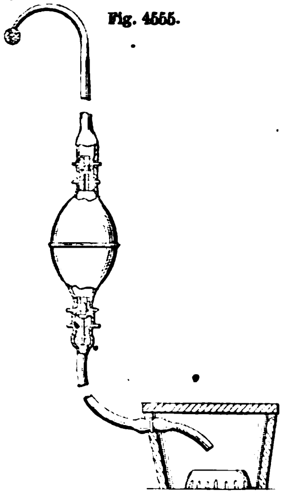
Sa-li'va-pump. (*Dentistry.*) A device to remove the saliva from the mouth during dental operations. The tongue and cheeks are kept from contact with the teeth of the lower jaw, and the saliva drawn off by an air-pump through a perforated tube into a receiver. The air-escape valve is between the receiver and the exhaust-bulb of the pump.

In Fig. 4555, the rebent upper end of the pipe has a rose head to take up the saliva. A compressible bulb and two valves form the operative mechanism.

Sal'ly-port. 1. (*Fortification.*) An opening cut in the glacis, through which a passage leads by a ramp from the terreplein to the covered way of the interior. A *postern*. An underground passage from a fortification for making sallies from the covered way.

2. (*Nautical.*) A port for entering or leaving a vessel.

Fig. 4555.



Saliva-Pump.

Sal'ly-port Sledge. (*Fortification.*) A sledge used for hauling ordnance, ammunition, etc., up the ramps, etc., in fortifications.

Sal'mon-lad'-der. A chute for salmon to ascend falls and weirs. It has usually a broken or a sinuous descent. A *fish-ladder* or *fish-way*.

Sal'mon-stair. A zigzag channel on the face of a weir to assist fish in ascending the same. A *fish-ladder*.

Sa-loon'-car. (*Railway Engineering.*) A passenger-car fitted up with sofas and chairs, to afford first-class accommodation for those able and willing to pay extra for it. A *drawing-room* or *palace car.*

Salt-block. An apparatus for evaporating the water from a saline solution. The technical name for a salt-factory.

Salt'ern. A salt manufactory where water is evaporated from brine and dry salt obtained.

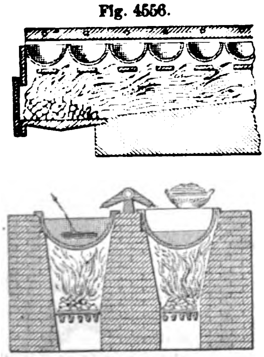
More especially a plot of retentive land, laid out in pools and walks, where the sea-water is admitted to be evaporated by the heat of the sun's rays.

The operation is concluded in boilers.

Salt-fur'nace.

The simplest form of this apparatus, where artificial heat is employed, is probably that of West Virginia or Syracuse, N. Y., where the brine is pumped from a great depth of the earth and conducted by pipes to the kettles, which are in two long rows, built into the top of a furnace, which is 150 feet in length, having the furnace doors at one end and a chimney at the other. The iron pans are heavy and shallow, and may be from 80 to 100 in number. As the water evaporates, the salt is precipitated, and is dipped out into baskets, which are placed in pairs over the pans, in order that the salt may drip and dry. The salt is then emptied into the bin and shoveled into barrels for transportation.

Fig. 4556.



Salt-Furnace.

The brine which supplies the salt-works of Moutiers, in the Tarantaise, Switzerland, has only 1.83 per cent of saline matter, $1\frac{1}{2}$ pounds to 13 gallons of water. (The water of the North Sea in Europe has 2.25 per cent.)

To condense this attenuated solution, the brine is repeatedly trickled over fagots of thorn placed in frames, being condensed by aërial evaporation to 22 per cent. Another plan there adopted is to trickle the brine down vertical cords, upon which it crystallizes, and the saline cylinder is then broken off. The cords are renewed every 25 years; the fagots, every 7 years.

Salt-gage. A SALINOMETER. See Figs. 4450, 4451, 4452, previous page.

Salt-glaz'ing. (*Pottery.*) A glaze for earthenware, prepared from common salt.

Salt-pan. A salt-pit, or salt-works. An evaporating-pan for salines.

Sal'vage. (*Nautical.*) A skein of hemp, not twisted, but simply bound with yarn; used for tackling of cannon, and other purposes where great pliancy and strength are required. *Selvagee.*

Sal'ver. (*Household.*) A kind of tray or waiter, used for table service.

Sa'mite. (*Fabric.*) A heavy silk embroidered stuff. *Samette.* The name is from the Greek *ἑξάμιτος*, six-threaded, which indicates a peculiar twill in the original goods, given by floating the weft over 5 warps. See DIMITY; TWILL.

"Clothed in white *samite*."
TENNYSON.

Sam'pan. A Chinese punt used on the rivers for conveying merchandise, and also frequently for habitations.

Sam'son-post. 1. (*Shipbuilding.*) A pillar resting on the keelson and supporting a deck-beam.

2. (*Nautical.*) A spar sustained in a vertical position by guys, and used as a *jib* for the suspension of hoisting-tackle, for getting boats or blubber aboard, fishing the anchor, etc.

Sa'nat. (*Fabric.*) An Indian calico.

Sand. (*Founding.*) The sand used by the molder, while it consists essentially of crystalline particles of silica, must contain other substances as well, to give it tenacity when damp, and when subsequently dried. Clay plays the most important part; it is a common constituent of the sand as found in its natural bed. In this respect, different kinds of sand differ exceedingly, and they have to be mixed in suitable proportions, and (for iron molding) additions of powdered coal or coke made to adapt the sand to each specific purpose.

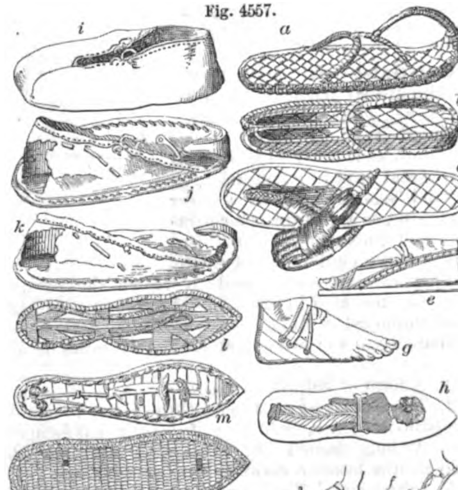
Sands for different purposes or kinds of work receive specific names, as, —

Core-sand, *dry* sand, *facing*-sand, *green* sand, *new* sand, *old* sand, *strong* sand, etc., which see under their respective heads. See also LOAM.

San'dal. A protection for the sole of the foot. It consists merely of a sole, with sometimes a shield at the toe and heel, leaving the upper part of the foot bare, and is secured by straps passing over the instep and around the ankle. Sandals were worn by the Jews, and most Oriental nations, as well as by the Greeks and Romans, but appear to have been to a great extent supplanted, even among the Orientals, by shoes.

The sandals of the ancient Egyptians are shown in many of their paintings at Medinet-Aboo and elsewhere.

Fig. 4557.



Egyptian and Assyrian Sandals and Shoes.

In the Abbott Collection (New York Historical Society) are old Egyptian sandals made from date-leaves, papyrus, leather, and raw-hide. Also boots and shoes of purple leather, white kid, and red leather.

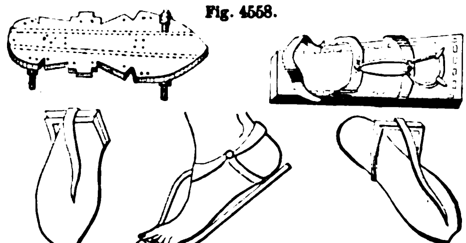
Their common sandals were of papyrus or palm-leaves; those of the Greeks and Romans of willow. The *baxa* was the sandal of the comedian; the *cothurnus*, of the tragic actor.

The priests of Egypt eschewed leather for sandals, as the contact of anything that had died was defilement.

A number of examples are given in the cut annexed. *a* is a handsome sandal with the usual instep strap and the cord which reached from the latter to the sole, passing between the great toe and the second one. *b* assumes the shape of a shoe, having sides and no straps between the toes. *i j k* are distinctly shoes. *c* is the common sandal of the people.

The common sandal, in Oriental countries, is made of a piece of hide from the neck of a camel, and sometimes of several thicknesses sewed together. It is fastened by two straps, one of which passes between the great and the second toe, and the other

Fig. 4558.



Sandals.

around the heel and over the instep; hence it was easily slipped off when the "latchet" was "unloosed" (Mark i. 7). The direction of the angel to Peter, "Bind on thy sandals" (Acts xii. 8), indicates the style of fastening, even did not contemporary statuary show the form with perfect clearness.

While many ladies were shod with ornamental sandals, which were sometimes like pattens to raise them above the dirt of the street or the dampness of the bath-room floor, it is probable that some wore buskins, or moccasins, as we should term them, and that such were alluded to in Canticles vii. 1: "How beautiful are thy feet with shoes." They were probably worn by Judith when, as it is said, her sandals ravished the eyes of Holofernes. Badger's skin is referred to by Ezekiel (xvi. 10) as a choice material therefor.

On the sculptures of Nimroud the king is represented wearing sandals. Those of the Emperor Augustus were *rights* and *lefts*. He esteemed it an ill omen that he accidentally misplaced them. The pillar or thong between the big toe and its neighbor would early suggest making them specially for each foot.

The Assyrian sandal *e* had a long counter and a sole, fastened to the foot by means of bands around the instep, in some cases aided by straps which passed forward to the ball of the foot or between the largest and the second toes. They were of wood or leather. In Egypt, palm-leaves and papyrus-stalks were employed in addition to leather. The soles of the Assyrian sandals were flat; those of the Egyptians were frequently turned up at the toes, as at *f*. *g h* are also Assyrian; *l m n*, Egyptian.

San'dal-brick. A local name for imperfectly burnt brick. *Sandel, samel, place, pecking* brick.

Sand-bag. 1. (*Fortification.*) A canvas sack filled with sand or earth, and used in fortification.

Sand-bags are used as a cover for troops, as a revetment for parapets and embrasures. They usually contain a cubic foot of earth.

They are extensively used to crown the parapet of earth excavated in *sapping*. 1,000,000 sand-bags were employed in the offensive works at Sevastopol, principally in the protection for the 70 miles of *approaches*.

2. A form of ballast for boats.

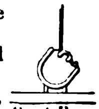
3. The ballast of a balloon, thrown out to enable the balloon to rise, or to keep its level as gas escapes.

4. A long flannel bag filled with sand, used to stop chinks beneath doors or between sashes.

5. (*Sheet-metal Working.*) A flat sack filled with sand on which work is supported while being chased.

6. (*Engraving.*) A similar bag on which the plate is laid and turned about while being operated on with the graver.

Fig. 4559.



Sand-Bag.

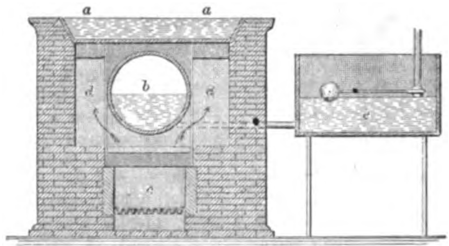
Sand-ball. Soap made up into a ball with fine sand, for washing the hands.

Sand-bath. 1. A vessel of heated sand, used as an equable heater for retorts, etc.

A form of evaporator largely used in laboratories.

Fig. 4560 represents a form of sand-bath in which *a a* is a trough for sand; *b*, a small steam-boiler,

Fig. 4560.



Sand-Bath.

which has a safety-valve not shown; *d d* are hot-air and smoke flues; and *e* a reservoir from which the boiler is supplied with water.

By the use of this or a similar arrangement, an equable temperature may be attained in the bath, and the chemist has always at hand a supply of hot water for purposes of the laboratory.

2. (*Medical.*) A form of bath in which the body is covered with warm or with sea sand.

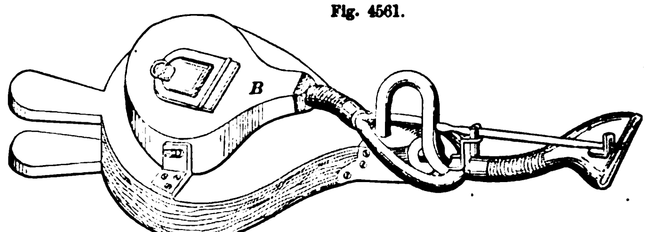
Sand-bed. (*Founding.*) *a.* The floor of sand at a smelting-furnace in which the metal from the furnace is run into pigs.

b. The floor of a foundry in which large castings are made, or on which the flasks are laid, rammed, and poured.

Sand-bel'lows. A hand-bellows used for sprinkling sand on a freshly painted surface to give it the appearance of stone.

The sand from box *B* sifts down into the spout as the upper valve is opened, and is ejected by the blast as the bellows are closed.

Fig. 4561.



Sand-Bellows.

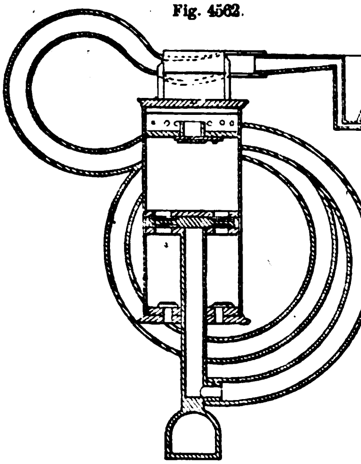
Sand-blast. A method of engraving and cutting glass and other hard materials by the percussive force of particles of sand driven by a steam or air blast. See GLASS-CUTTING, page 978.

For cutting an ornament or inscription on stone, an iron pattern is fastened to the stone, and a movable jet-pipe is caused to traverse the surface of the stone, which it abrades, leaving intact the portions protected by the pattern. Common hard sand is the material employed; but small granules of iron, about $\frac{1}{25}$ inch in diameter, have been found to act more rapidly on granite. Crushed agate is also used.

Sand-blow'er. A device for powdering with sand a freshly painted surface, in order to make it resemble stone.

The piston is chambered, and has inwardly opening valves in its two disks, so that when moving in either direction the air is forced through the tubular piston rod and pipe to the discharge-mouth.

Fig. 4562.

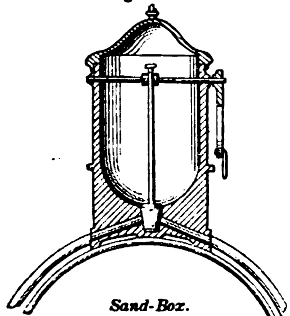


Sand-Blower.

Sand-board. (*Vehicle.*) A bar over the hind axle and parallel therewith. It rests upon the hind hounds where they cross the axle.

Sand-box. 1. A box filled with sand, usually placed in front of the driving-wheel, with a pipe to guide the sand to the rail, to be used when the drivers slip on the rails, owing to frost or wet.

Fig. 4563.



Sand-Box.

In the West, railway-trains have been stopped on a grade by locusts. When the dew falls and the rails are warmer than the grass, these insects have a fancy for sitting on the rails, and when the engine-wheel touches them they are crushed, leaving the rails so soapy that the wheels slip. Sand-boxes are used with the locomotive.

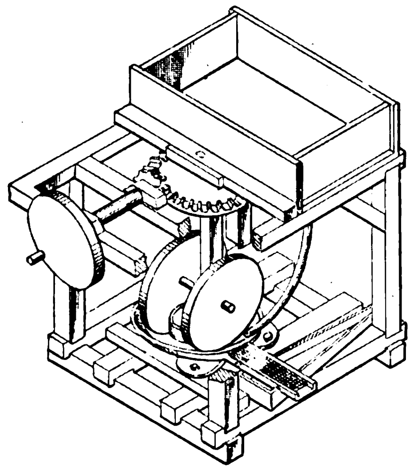
In Fig. 4563, the box has a hemispherical bottom, in the lower part of which is a conical valve-seat, which is closed by a valve of the same form. This valve-seat has two apertures, one on each side of the engine, through which the sand passes, and is conveyed to the rail in front of each driving-wheel.

2. A box with perforated top, for sprinkling paper with sand in manner of a pounce-box.

Sand-burned. (*Founding.*) When the heat of the melted metal cast into a mold affects the surface of the sand so as to subject it to a partial fusion, whereby it adheres to and even unites more or less with the surface of the metal, giving a rough result, the casting is said to be *sand-burned.* This defect is caused by the unsuitable nature of the sand or the want of proper *blacking* on the mold.

Sand Crush'er and Wash'er. A machine for breaking nodules of sand, reducing it to a fineness and washing away foreign matter. The axis of the wheel is attached to a vertical shaft, which rotates in the central opening of the pan, while the wheels traverse in the annular trough, the water assisting in comminuting the mass and washing off the earthy particles. It is especially used in preparing sand for glass-making.

Fig 4564



Sand Crusher and Washer.

Sand-glass. A time-measurer, consisting of a vessel containing a measured amount of sand, which is allowed to escape through a hole of definite proportions so as to occupy a certain time in so doing.

The sand-glass was derived from or suggested the clepsydra, or water-clock, in which the lapse of time was indicated by the escape of water from a hole in a vessel. This was probably the first time-measurer acting mechanically. Previous to this the lapse of time was counted by the dial, by devices such as the counting of pebbles from one helmet to another by the Franks and Norsemen; a measured tread and counted paces; the time required to recite the prayers, as indicated by the beads. See CLEPSYDRA.

The clepsydra assumed various forms.

1. In one case a brass dish with a hole in the bottom was floated in a cistern, and the time required for its filling and submergence formed a unit of time.
2. The emptying of a large brazen vessel, the side of which was pierced with a small hole.
3. A vessel similar to the foregoing, with a float and graduated stem, indicating time by its subsidence.
4. The device No. 3, with the addition of a string from the float, to turn an axis and a pointer finger on a figured dial.
5. A clepsydra in which the escaping water turned a wheel which communicated motion to a hand on a dial. See CLEPSYDRA.

These devices were subject to many difficulties, such as the evaporation of the water, which affected those depending upon the measured amount, and the unequal rate of flow at different stages of fullness of the discharging-vessel.

At what period toothed gearing was invented cannot be readily ascertained. Archimedes used it 220 B. C., and probably saw it in Egypt.

Sand, as the flowing material, is stated by some authorities to have been introduced in France about the time of Charlemagne, but this is an error.

On an ancient bas-relief in Rome an hour glass is placed in the hands of Morpheus. Athenæus says that the ancients carried portable hour-glasses with them.

The term translated *hour-glass* does not warrant the idea that glass was used. The probable material was horn, or the mineral then so much used for windows, laminated mica, the *lapis specularis* of Pliny. The two chambers were probably separated by a plate having a drilled opening. See HOUR-GLASS.

It may be mentioned in this connection that the first dial on record is that of Ahaz, 742 B. C. It was probably derived from Assyria. See DIAL.

The dial is mentioned in the book of Tobit. The date of the writing of this book is not certain, but it details the experiences of an Israelite of Naphtali, a prisoner in Nineveh in the reigns of Shalmanezer and Sennacherib.

The statement of Herodotus that the Greeks derived the sun-dial from the Chaldeans is no doubt correct. In the time of

Ahaz, the communications between Assyria and Palestine were open and well traveled, as the Israelites well knew and felt.

Homer describes the sun-dial, 950 B. C.

The dial was introduced in Athens by Meton, 433 B. C.

By L. Papirius Cursor into Rome, 293 B C

Hipparchus used a dial at Alexandria, 130 B. C.

Augustus set one up on a magnificent scale in the Campus Martius. See DIAL.

San'di-ver. (Fr. *Suint-de-verre.*) A saline scum which rises to the surface of fused glass in the pot, and is skimmed off. Called also *glass-gall; sadwei.*

Sand-jet. A process for grinding and abrading hard substances by the impact of a stream of sand propelled by an air or steam jet.

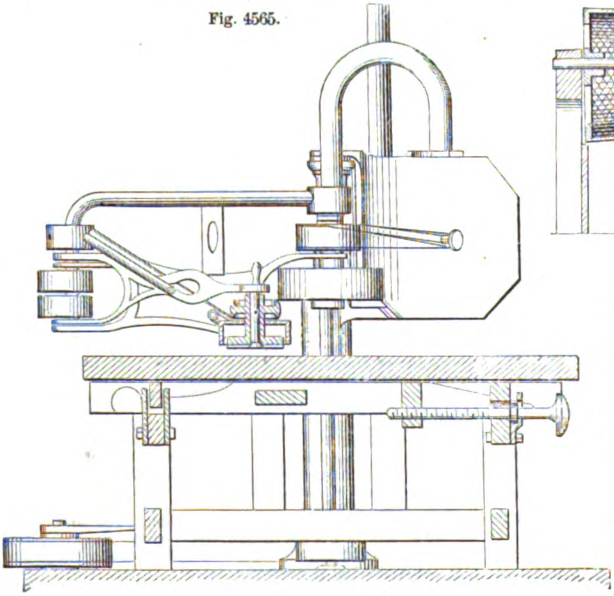
In depolishing glass, the stream of sharp sand is projected by a fan thirty inches in diameter, making thirty revolutions per minute. The air is driven through a chute into which the sand is fed, and from which it is thrown forcibly down upon the glass below the mouth of the chute. From ten to fifteen seconds' exposure to the shower of sand is sufficient to depolish the surface of ordinary glass; and sheets of the latter may be conveniently treated by being passed slowly under the sand by means of endless belts. For cutting stone, the impelling jet is steam; the force given to the sand, and, of course, the rapidity of the cutting effect, being proportioned to the steam pressure. For one hundred pounds' pressure, the sand is most advantageously applied by drawing it through a three-sixteenth inch tube; the steam issuing through an outer tube concentric with that which conducts the sand. This is for drilling holes in hard material; and, with a pressure one fourth greater than that just indicated, one and a half cubic inches of granite are worn away per minute, three inches of marble, and ten inches of soft brown-stone. In cutting corundum with sand driven by steam at three hundred pounds' pressure, a hole an inch and a half in diameter was cut through a piece one and a half inches thick in twenty-five minutes. The process is also used in cleaning the internal surfaces of hollow ware preparatory to tinning. See GLASS-CUTTING, page 978.

Sand-pa'per. An abrading agent made by coating paper with glue and dusting fine sand over it with a sieve. Thin cotton cloth is sometimes used instead of paper. Sand-paper is intermediate between glass-paper and emery-paper in its action on metals, but is less energetic than glass-paper in its action on wood.

GLASS-PAPER (which see) is prepared in a similar way from pounded glass, and is sometimes termed sand-paper.

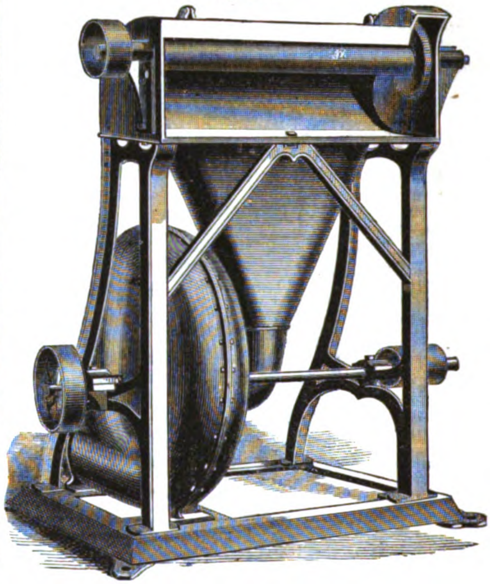
Sand-pa'per Hold'er. A block or pad on which a piece of sand or glass paper is wrapped for use.

Fig. 4565.



Sand-Papering Machine.

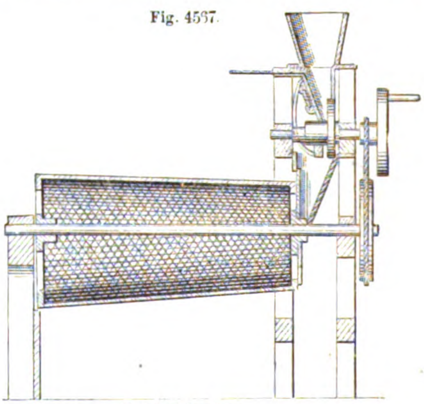
Fig. 4566.



Sand-Papering Machine (Shoe Machinery Manufacturing Co).

Sand-pa'per-ing Ma-chine'. 1. (*Joinery.*) A device for sand-papering flat surfaces. The work is laid on the table, which is vertically adjustable; the sand-paper disk is rotated at the end of a jointed tubular extension arm, which also conducts the dust away, through the hollow arm, to the exhaust-fan.

Fig. 4567.



Sand-Pulverizer.

2. (*Shoemaking.*) For buffing the soles of boots and shoes. Sometimes called *whitening.*

An exhaust fan or blower creates a draft which conducts away the dust caused by the action of the sand-paper roll upon the bottoms of the shoes.

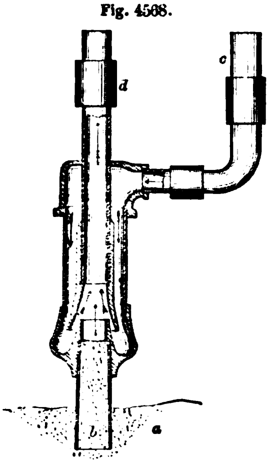
Sand-pul'ver-iz'er. A machine to grind and sift sand for use in glass-making and for other purposes. Fig. 4567 has a grinding-plate working against a vertical yielding bed and a revolving wire-gauze cylinder, by which the sand is sifted.

Sand-pump. A cylindrical case or metallic tube having a valve at bottom opening upwardly. Its office is to remove the sand which collects in the bore when a well is being drilled; the drill being temporarily removed, and as the sand-pump is lowered, the dirt and water force up the valve and enter the tube, the valve dropping again to prevent their return. This being repeated again and again, the barrel of the sand-pump becomes filled, is drawn to the surface and emptied. When the detritus is all removed from the bore, the drill is reintroduced and the operation proceeds.

The sand-pump is described in Good's English patent, 1823. It is there called a *shell* or *shell-pump*. It is called by the French, *emporte-pièce*. See SHELL-PUMP.

The Chinese have had deep-bored wells for ages; we cannot suppose that they have failed to use this device for withdrawing the detritus. The wells of Ou-Tong-Kiao in China are numbered by hundreds, are 5 or 6 inches in diameter, and over 1,000 feet deep.

Fig. 4568.



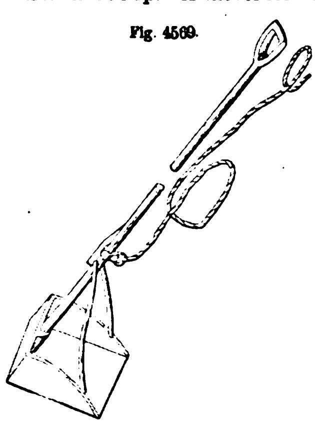
Sand-Ejector (*St. Louis Bridge Caisson*).

The sand-pumps, used for removing the sand from the caissons of the St. Louis and Illinois bridge, as the piers descended, were of three-inch bore, each discharging ten cubic yards of sand in an hour, and gravel stones two and a quarter inches in diameter. A stream of water was forced down through one pipe, and caused to discharge near the sand into another pipe in an annular jet, and in an upward direction. The jet created a vacuum below it, by which the sand was drawn into the second pipe or pump, the lower end of which was in the sand. The force of the jet drove the sand up to the surface as fast as it entered the second pipe. See AIR-LOCK; CAISSON.

Sand-roll. One for a rolling-mill, for instance, — cast in sand, as distinguished from a *chill-roll*, one cast on a chill.

Sand-scoop. A shovel for obtaining sand from the bottom of a river. A form of dredge. In Fig. 4569, the staff rises perpendicularly from the rear end of the scoop, and has a collar to which the hoisting-rope is attached. The rope has a series of loops to engage over a pin on the boat, and the rope attachment to the staff forms a fulcrum in the use of the scoop. See Fig. 517, DREDGING-MACHINE, page 747.

Fig. 4569.



Dredging-Scoop.

Sand-shot. (*Ordnance.*) Small cast-iron balls, such as grape, canister, or case, cast in sand. Larger balls are cast in iron molds.

Sand'stone. An aggregation of siliceous grains, sometimes cohering without visible cement, but usually bound together by a slight quantity of siliceous or calcareous matter, or by iron or clay.

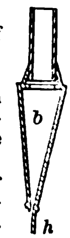
Nature shows all gradations in texture. When coarse-grained, it is called *grit.* When the fragments are so large as to form pebbles, it is called *conglomerate* or *pudding-stone*, which may consist of one or several kinds of rock.

Micaceous sandstone has little plates of mica, which are sometimes in layers parallel to the stratification.

Calcareous sandstones are those in which the siliceous grains are cemented by carbonate of lime, or in which the particles are partly siliceous and partly calcareous.

Sand-throw'er. An implement for sanding sized or painted surfaces. The example has a hollow handle, which contains a supply of sand that is received in a V-shaped box *b*, having a narrow slit with a projecting lip *h*, by which the sand is distributed.

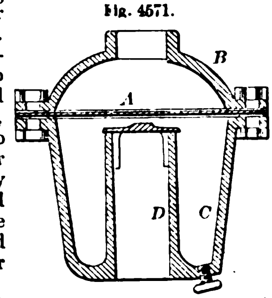
Fig. 4570.



Sand-Thrower.

Sand-trap. (*Hydraulic Engineering.*) A device for separating sand, etc., from water flowing through a pipe. In Fig. 4571, the water enters the trap through the valved induction-pipe *D*, and, flowing upwardly into the dome-shaped cover *B*, is conducted off by another pipe; the sand is detained by the diaphragm *A*, and settles in the annular reservoir *C*.

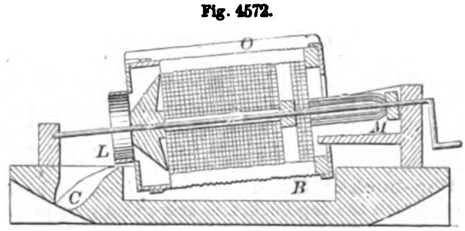
Fig. 4571.



Sand-Trap.

Sand-wash'er. A device for separating earthy matters from sand. In Fig. 4572, a cylindrical wire screen having exterior wings *O* is rotated in a trough *B*, to which a constant supply of water is admitted through a chute *M*; soluble matters passing through the meshes of the riddle are carried off by the chute *C*, and other foreign particles are discharged by the tail-spout *L*.

Fig. 4572.



Sand-Washer.

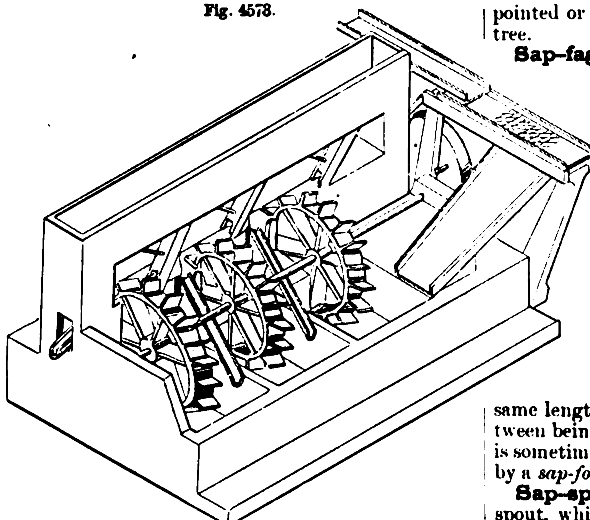
In Fig. 4573, the sand, after being screened by a shaking riddle, passes down a chute to a series of troughs having wheels rotating on a common axis, by which it is agitated and successively transferred from one to the next, being cleansed by the action of water at each step.

Sand'wiched. Said of a rail or lamina which is interposed between two sleepers or thicknesses.

Sap. (*Fortification.*) An excavated trench or tunnel, for the purpose of approaching a fort under cover of the scarp and parapet formed by the ditch and excavated earth.

At the head of the sapping party is a bullet-proof *sap-roller*, which is pushed along as the sap advances, affording protection to the men.

Fig. 4573.



Sand-Washer.

The *sap* advances by a series of zigzags, so directed as not to be exposed to an enfilading fire from the fortress.

The *approaches* and the parallels are made by sapping, and these sunken roads afford the means for conveying ordnance, ammunition, and stores to and from the advanced batteries, and for marching bodies of troops to and fro.

Sand-bags, gabions, and fascines are employed as revetments or to crown the parapet formed by the excavated earth.

The works in front of Sevastopol consisted of 70 miles of sunken trenches; and no less than 60,000 fascines, 80,000 gabions, and 1,000,000 sand-bags were employed to protect the men working in the trenches and at the different batteries.

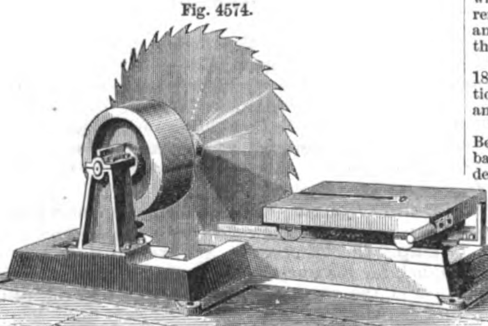
The *double sap* has a parapet at each side.

Sap-boil'er. A furnace with pans for evaporating the sap of the maple. See EVAPORATOR, pages 811 - 813.

Sap-buck'et. (*Sugar Manufacture.*) A bucket for receiving the sap of the sugar-maple as it runs from the tree. Tin pans, earthenware pots, and wooden troughs hollowed out from the log are also employed.

Sap-buck'et Hook. (*Sugar-making.*) A hook from which the sap-bucket is suspended; it has a pointed or screw-threaded end for attachment to the tree.

Fig. 4574.



Sapping-Machine.

Sap-fag'ot. (*Fortification.*) A fascine about 3 feet long, used in sapping, to close the crevices between gabions.

Sap-fork. (*Fortification.*) A forked lever used for advancing the sap-roller.

Sap'ping-ma-chine'. A circular saw for slabbing balks and sawing bolts for shingle stuff.

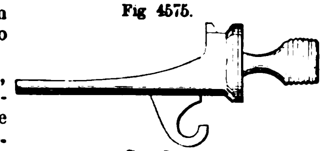
Sap-roll'er. (*Fortification.*) A large roller kept in advance of the men engaged in sapping. It is rolled along at the head of the sap for the protection of the excavators.

The sap-roller is a gabion, 6 feet long and 4 feet in diameter, rendered bullet-proof by an internal gabion of the same length and 2½ feet in diameter, the space between being filled up with stout wooden pickets. It is sometimes stuffed with wool. It is pushed forward by a *sap-fork.*

Sap-spile. (*Sugar-making.*) A small wooden spout, which is driven into an auger-hole bored in the sugar-maple tree, and serves to conduct the sap to the trough or bucket. It is sometimes made of an elder with the pith pushed out; sometimes of wood, bored out.

Sap-spout. (*Sugar-making.*) A device for conducting sugar-maple sap from the tap-hole to the bucket.

Fig 4575.



Sap-Spout.

The spout has, between the holding-screw and the collar, a perforated neck which gives free communication with the outer layer of the alburnum. A hook gives means of suspension for the bucket.

Sar'ce-net. (*Fabric.*) A thin grade of silk goods used for linings, etc. Named from the Saracens. (*Saracenicum,* Latin. Cloth made by the Saracens.) *Sarsenet.*

"With my wife to the new Exchange to buy her some things; where we saw some new-fashion petty coats of sarcenett, with a black broad lace *printed around the bottom* and before, very handsome." — PEPYS'S *Diary,* 1662.

How about balmorals?

Sar-coph'a-gus. A stone coffin.

Sarcophagi were anciently in general use, at least with the wealthy, among the Orientals, particularly those inhabiting the eastern shores of the Mediterranean, and were often ornamented with elaborate and expensive sculptures. Large numbers yet remain in that part of Syria which formerly belonged to Tyre and Sidon, though the ancient cemeteries have for ages supplied the later inhabitants with stone for economic uses.

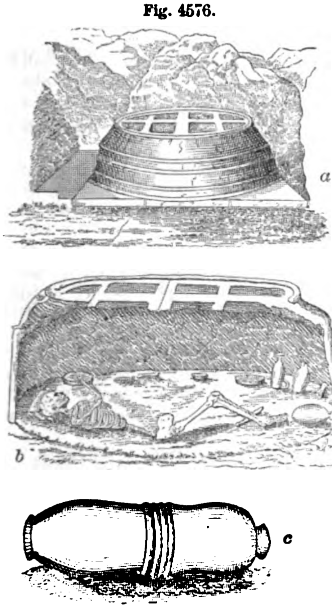
The sarcophagus of King Ashmunazer, discovered at Sidon in 1855, is interesting as containing the longest Phœnician inscription known to exist, until the Moabite stone, since discovered, antedated it. See PEN.

The sarcophagus of Setei-Menephthah was discovered by Belzoni in a deep recess of a tomb. It is of Oriental alabaster, and is covered with some thousands of figures, evidently a funeral procession. It was long in the museum of Sir John Soane, Lincoln's Inn Fields, London. It had been broken open by robbers, probably many centuries before the visit of Belzoni. The body was gone, and the lid broken into five pieces.

In Fig. 4576, *a* represents a Chaldæan clay coffin or vault-cover found at Mugheir, eight feet below the surface of the soil. *b* shows the interior on an enlarged scale. On a platform of sun-dried brick is laid a mat, on this the skeleton or pair of skeletons, surrounded by utensils or ornaments. A huge cover of burnt clay inclosed the whole. In the particular instance illustrated, the contents, besides the skeleton, were a sun-dried brick for a pillow; a copper

bowl; small cylinders of meteoric stone; pieces of bamboo; baked clay jars and utensils for food and water; remains of date-stones in a shallow dish. *c* is another kind of Chaldæan sarcophagus, formed of two large open-mouthed jars, two and a half to three feet in depth and two feet in diameter. The mouth

Fig. 4576.



Chaldæan Sarcophagi.

of the smaller is inserted in that of the larger, and luted with bitumen. In each coffer is a small hole for the escape of the gases of putrefaction. This form is common at Mugheir and Tel-el-Lahm. — *Journal of the Asiatic Society*, XV. 413, 414.

Sa'ree. 1. A cotton fabric worn by East-Indian women wrapped about the person.

2. A long scarf of embroidered gauze or silk.

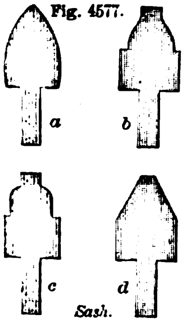
Sark'ing. (*Building.*) The sheathing of a roof above the rafters, and affording a hold for the nails which secure the shingles or slates.

Sar-rus'o-phone. (*Music.*) A form of wind-instrument of the horn class, made by Gautrot Ainé and Cie, Paris. They are made *en suite*, of sizes and compass to take different parts in concerted pieces of music, and are known as the cornets and saxhorns by names, as soprano, contralto, tenor, barytone, bass, etc.; or by the pitch, as *b* flat, *e* flat, etc. See *a*, Fig. 2564.

Sarse. A fine sieve.

Sash. 1. (*Carpentry.*) A frame for holding the glass of a window. The side pieces are the *stiles;* the top and bottom pieces, *rails;* and the interior pieces, which hold the panes, *bars.*

Fig. 4577.



Sash.

There are two kinds of sash:

1. *French sash* or *casement;* hung upon hinges so as to swing open like doors.

2. *Sliding sash;* opening and shutting vertically. When suspended by weights and cords passing over pulleys, they are said to be *hung.*

a. Double hung; both sashes being movable.

b. Single hung; one sash only being movable.

c. Balanced; when each sash has a counterpoise weight, so that it is readily lifted; or the two sashes are made to counterbalance each other. In the former case, the sashes may be lifted or depressed independently; in the latter case, they move together, closing or opening simultaneously and in the same degree.

a, Gothic sash. *c*, ovolo sash.
b, ogee sash. *d*, square-bevel sash.

2. The *gate* in which a mill-saw is strained and reciprocates.

3. An ornamental girdle worn over the shoulder like a baldric or around the waist.

Sash-bar. (*Carpentry.*) The vertical and transverse pieces within a window-frame which hold the panes of glass in place. They are rabbeted or grooved on one side to receive the glass, and are mitered to each other and to the frame. See SASH.

Those for the Crystal Palace, in 1851, were made by a special machine devised by Paxton and Birch, in which a series of revolving cutters shaped a piece which was afterward divided by circular saws into four parts, each constituting a complete bar, other saws of less diameter at the same time making the grooves for the glass.

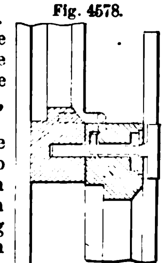
They were painted by drawing them through a trough filled with color, and afterward passing them between a series of brushes set at right angles to each other, which removed the superfluous paint.

Sash-bor'ing Ma-chine'. A machine for boring holes in the stiles of sashes for reception of the bars. It may be preliminary to mortising.

Sash-chis'el. (*Carpentry.*) A chisel having a narrow edge and a strong blade, for making the mortises in blind and sash stiles.

Sash-fas'ten-er. (*Building.*) *a.* A device at the meeting rails of sashes, to prevent a sash from being opened. Usually a sort of turn-button on one sash which locks over the top of the lower sash. In the example, the sashes are locked together by a pin, which transfixes them.

Fig. 4578.



Sash-Fastener.

b. A device on the edge of the sash which locks against it, to maintain it at a given hight. In Hammond's, the edge of the sash is notched and engaged by a spring piece, which may be withdrawn when the sash is to be lowered.

An ordinary form is a snail-shaped piece on the sash which locks against the jamb.

Sash-fil'lis-ter. (*Carpentry.*) A plane for rabbeting window-sash to receive the panes of glass and the putty, which holds them in place; the illustration shows the rabbet made by the sash-fillister, and also the ovolo molding.

Fig. 4579.

Sash.

Sash-frame. 1. The frame, within the window-casing, in which a sash slides.

Sash-frames are *cased* or *solid.* The former have boxes at each side for the weight. The latter consist merely of strips fastened to the window-jambs. A *sash-casing* consists of four pieces, — the *pulley-piece* and *inside, outside,* and *back-lining.*

The strips which form the sash-slides are the *inside* and *outside beads* and the *parting-bead.*

The parts of a *sash-frame* are the *head, sill,* and *sides* or *casings.*

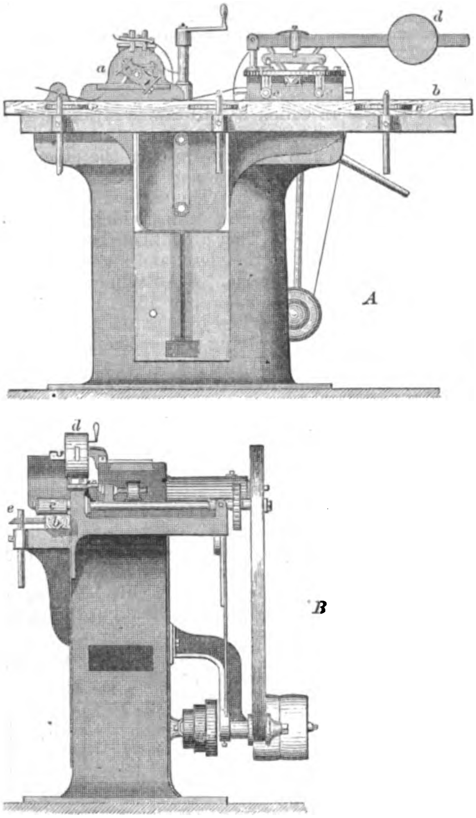
2. The rectangular frame, in which a mill-saw is strained.

Sash-gate. (*Hydraulic Engineering.*) A stop-valve sliding vertically to and from its seat.

Sash-lock. A fastening for the meeting rails of window-sashes.

Sash-mold'ing Ma-chine'. (*Wood-working.*) A machine for planing molds on sash bars and stiles.

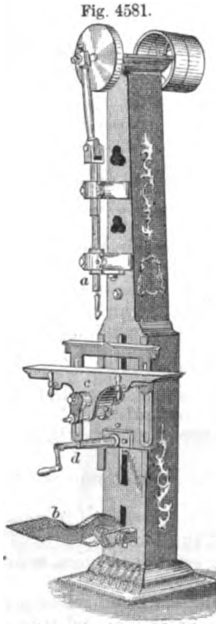
Fig. 4580.



Sash-Molding Machine.

Its size, hight, and proportions particularly adapt it for the work on this small stuff. The views *A B* are respectively side and end elevations of the machine. *a* is the rotary cutter, having bits of such shape as the molding requires; *b* is the stuff going through beneath the rollers *c c*, the pressure of which is determined by the adjustable weight *d*; *c c e* are spring-pieces to keep the stuff against the fence.

Fig. 4581.



Sash-Mortising Machine.

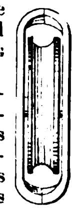
Sash-mor'tis-ing Ma-chine'. (*Wood-working.*) A machine for forming mortises in stiles and rails of doors, sash, and other small work.

In that illustrated, the chisel-holder is reciprocated by pitman connection with a crank on a wheel driven by pulley and belting. The chisel-bar *a* is reversed by a slight movement of the treadle *b*, and the bed *c* may be adjusted to mortise at any desired angle, and is raised or lowered by turning the crank *d*, to determine the depth of cut on work of any dimension within its capacity.

Sash'oon. (*Shoemaking.*) A soft leathern pad placed inside a shoe to ease the pressure on a tender spot.

Sash-plan'ing Ma-chine'. A small form of molding-machine adapted to make the rabbets and molding for the stiles and bars of window-sash. See SASH-STICKING MACHINE.

Fig. 4582



Sash-Pulley.

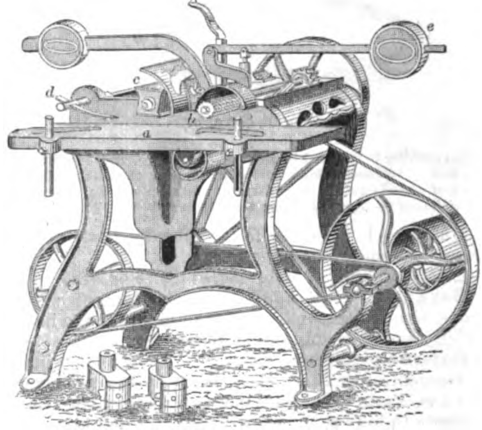
Sash-pul'ley. The sheave in the pulley-piece of a sash-frame over which the weight-cord runs. In the example, the sheave is held between two plates, which have counter projections and depressions on the edges of their incurved ends, and side perforations for reception of the sheave-pivots.

Sash-rail. One of the horizontal bars in a window-sash.

Sash-saw. 1. A mill-saw strained in a *gate*, or *sash*, as it is sometimes called, from the resemblance of its stiles and rails to the frame of a window-sash.

2. A particular size of *tenon-saw* used in making window-sash is known as a *sash-saw*. It is backed with brass instead of iron, and has 13 teeth to the inch. The *tenon-saw* has 8 teeth to the inch.

Fig. 4583.

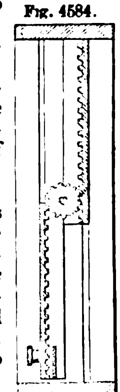


Fay's Sash-Sticking Machine.

Sash-sluice. A sluice with vertically sliding valves.

Sash-stick'ing Ma-chine'. A machine for planing the moldings on the edges of sash bars and rails. The example shows a table *a* on which the stuff slides beneath the feed-roller *b* and cutter *c*. A spring *d* rests on the stuff and prevents chattering. The cutter-head is provided with bits adapted to make the molding required. Two extra cutter-heads are upon the floor. The weight *e* is adjustable on its arm to press the feed-roller upon the work. The bed is gibbed to the frame and raised by a single screw. The machine is also used for planing up small stuff, such as slats and trunk-stuff.

Fig. 4584.



Sash-Supporter.

Sash-sup-port'er. (*Building.*) *a.* A device to hold a sash in an elevated

position. Frequently a spring bolt, which locks into a hole or notch in the sash. Or a cam-shaped piece, which binds against the jamb or strip.

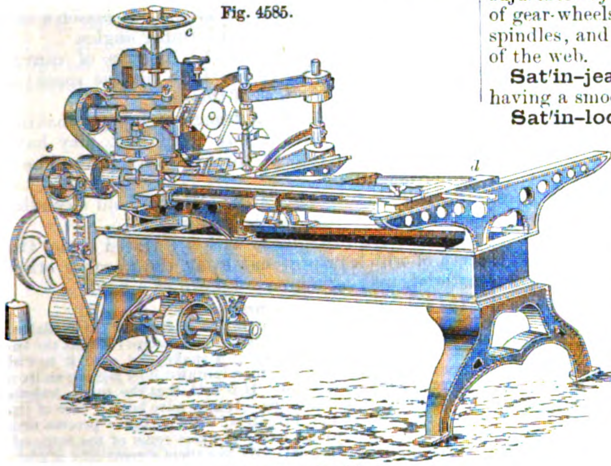
b. A suspension arrangement of cord, weight, and pulley.

A rack and pinion arrangement by which the sashes are made to balance each other.

Sash-ten′on-ing Ma-chine′. A machine for cutting the tenons on sash-slats. Machines of similar construction are used in cutting tenons on slats of Venetian blinds.

In the machine shown in Fig. 4585, the upper and lower cutter-heads raise and lower by a set-screw operated by a hand-wheel *c*, and by this adjustment any thickness of tenon may be made, the carriage *d* remaining stationary as to its vertical adjustment,

Fig. 4585.



Sash-Tenoning Machine.

but sliding easily across the bed of the machine, carrying the slats between the cutters. The upper cutter has an endwise adjustment on its arbor, so as to cut a longer tenon on one side of the slat if desired. The driving-belt *e* passes over the pulleys of both cutters, propelling them at uniform speed.

Sasse. (*Hydraulic Engineering.*) A weir with flood-gates; a navigable sluice.

Sat′in. (*Fabric.*) A silken fabric with an overshot woof and a highly finished surface. It was originally imported from China.

> "What said master Dumbleton about the *satin* for my short cloak and slops? — FALSTAFF.
>
> "The Duchesse of York, sitting in state in a chair, in white sattin." — PEPYS, 1662.
>
> "To church with my wife, who this day put on her green petticoate of flowred sattin, with fine white and black gimp lace of her own putting on, which is very pretty." — *Ibid.*

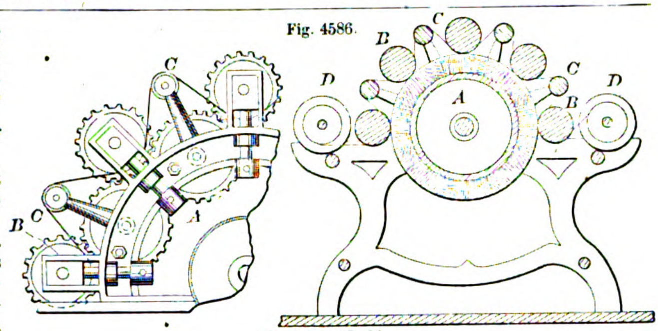
The woof of satin is coarse, and is hidden underneath the warp, which forms the surface. The *warp* is of *organzine;* the *weft* of *tram*. In a full satin twill there is an interval of fifteen threads. See TWILL.

Sat-i-net′. (*Fabric.*) *a.* A light kind of satin.

b. A glossy cloth made of a cotton warp and woolen filling to imitate *satin*.

Sat′in-ing-ma-chine′. (*Paper-making.*) A machine for imparting the "satin" finish to paper.

Fig. 4586.



Satining-Machine.

The web from the roller *D* is presented by the rollers *B B* to the action of the brush *A*, which rotates in the same direction, but with greater velocity, and is raised therefrom by the rollers *C C*, being finally wound upon the second roller *D*. The rollers *B* are adjustable by set-screws, and are rotated by a series of gear-wheels, while the rollers *C* run loose on their spindles, and are turned by the onward movement of the web.

Sat′in-jean. (*Fabric.*) A twilled cotton goods, having a smooth, satiny surface.

Sat′in-loom. (*Weaving.*) The satin-loom has at least a *five-leaved* set of heddles, with corresponding treadles, which are so operated that the shuttle passes over one and under four or more of the warp-threads at each throw. The upper is the glossy side.

Sau′cer. 1. (*Hydraulic Engineering.*) A flat caisson or camel which, being sunk and placed beneath a vessel, is then pumped out, so as to raise the vessel. By another mode of operating, the *saucer* is raised by the power of hydraulic presses, so that the water *runs* out of it.

2. (*Nautical.*) An iron bed bolted to the deck below that on which the capstan works, for the purpose of securing the pivot of the capstan.

3. A shallow piece of table service, forming a support for a teacup.

Sau-cisse′; Sau-cis-son′. (*Fortification.*) *a.* A powder-hose for communicating fire to a charge in military mining.

b. A stout and long fagot, larger than a *fascine*.

Sau′sage-fill′er. (*Domestic.*) A small machine for stuffing sausage-meat into intestines. See SAUSAGE-STUFFER.

Sau′sage-grind′er. (*Domestic.*) A machine for mincing meat for sausage.

Sau′sage-ma-chine′. A machine for grinding, mincing, or pounding meat to make sausages. In the vernacular, these are "either in guts or dabs."

Axionicus, in the "Chalcis," quoted by Athenæus, A. D. 220, says: —

> "I am making hash,
> Putting in well-warmed fish, and adding to them
> Some scarce half-eaten fragments; and the pettitoes
> Of a young porker, and his ears; the which I sprinkle
> With savory asafetida; and then
> I make the whole into a well-flavored sausage,
> A meat most salable. Then I do add a slice
> Of tender tripe; and a snout soaked in vinegar."

De gustibus non est disputandum.

The sausages of Heliogabalus were a compound of oysters, lobsters, crabs, and shrimps, flavored with delicious condiments, — black pepper, anise-seed, garlic, asafetida, ginger, rue, and anchovies.

Some people, following the Pennsylvania Dutch process, to go no farther back, use the anchydle or cœcum of the entrails

of the ox as an envelope for sausage. To such — and there are very nice people who stuff sausage into guts and things, even into linen bags — let us commend the following, which is a recipe as old as Heliogabalus: —

"A Hog's Paunch.

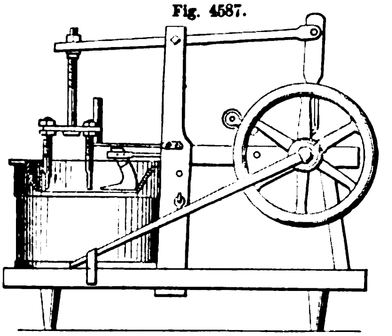
"Having cleansed it well, wash it, first with vinegar and salt, and afterward with water. Then take the hog's flesh pounded into a paste; mix it with the brains of three hogs, cleansed from the fibers, together with hard eggs. To this put cloves of garlic; add whole pepper, and make of a proper consistence with broth. Beat up pepper, lovage, assafetida, anise-seed, ginger, rue, anchovies, and a little oil. With this stuff the paunch. Tie the mouths of the paunch and boil. Prick with a pin to prevent bursting. Then smoke it."

"Here 's richness!"

The old plan was to cut the meat by means of cleavers, one in each hand, a practice in which some persons attained great dexterity. In early times in the West, sausage was cut on the block by an axe. This was much slower than the handy little pair of cleavers, which were kept for that purpose, and went the round of a settlement when hog-butchering began.

The earlier forms of sausage-machines used cleavers, which were at first on levers, tripped by cam movement from the main shaft (see Fig. 3106, page 1415). Afterward, knives were made

Fig. 4587.



Sausage-Machine.

to reciprocate vertically by means of crank and shaft. There are many modifications of this form. The tub usually rotates beneath the knives, so as to bring all the meat in succession beneath the cutters; a scraper lifts the meat and turns it over, so that the knives shall not repeat the blow in the same place. See Fig 4587, and Fig. 3107, page 1415.

The favorite domestic form is a compact little machine. It is either a spiral row of studs projecting radially from a barrel and forcing the meat between knives projecting inwardly from the casing;

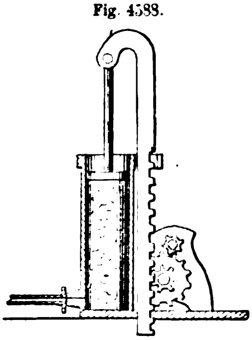
Or it has a series of radial knives on each of a pair of cylinders, and placed so as to make a shear-cut against each other (Fig. 3109, page 1415);

Or the single barrel has knives which cut against opposed edges inside the case (Fig. 3110).

In each case a spiral vane forces the meat through the machine, which is cut as it passes along, and is discharged at the end opposite that at which it was fed in.

Sau'sage-stuff'er. (*Domestic.*) A device for stuffing cleaned intestines with sausage-meat.

Fig. 4588.



Sausage-Filler.

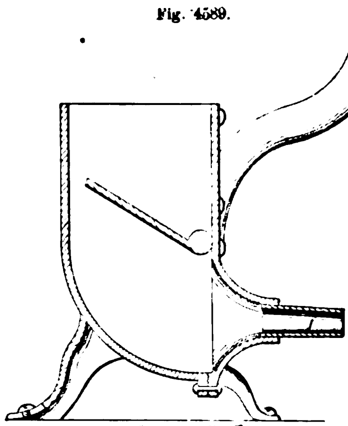
Among the kinds may be enumerated: —

The *piston*, which is moved by a lever or rack-bar, forcing the minced meat out at the spout, over which the gut is forced, and from which it slips as it is filled.

The *rotary*, which resembles in essential structure the rotary pump.

The *hinged valve* (Fig. 4589), which oscillates 180° in the hopper, folding against the side while filling, and then, as the handle is vibrated, forcing the meat out of the nozzle into the gut.

Fig. 4589.



Sausage-Stuffer.

Saute-relle'. (*Stone-working.*) A mason's implement, used in tracing and forming angles.

Save-all. 1. (*Nautical.*) A strip of canvas which may be laced to a sail to fill the *roach* or upward curve of the foot of the sail.

2. (*Paper-making.*) A trough in a paper-making machine which collects any pulp that may have slopped over the edge of the wire cloth in the Fourdrinier machine.

3. A little tube and flaring collar to hold a candle-end in a candlestick while burning.

Saw. An instrument with a serrated blade, the teeth of which rasp or cut away the wood or other material, making a groove known as a *kerf*.

The wasp was perhaps the first sawyer.

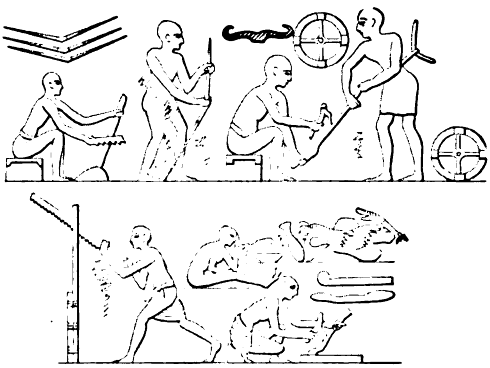
The Grecian myth of the invention of the saw (by Dædalus, *Pliny;* Talus, nephew of Dædalus, *Apollodorus*) is that the inventor once found the jawbone of a snake, and used it to cut through a piece of wood; he then imitated it by jagging an iron plate, and thus made a saw. It is said that the uncle, jealous of the discovery, killed Talus. It may have been a case of interference between two inventors, with irregular process and short shrift. Researches in Egypt upset some of the tattle of Pliny and others of his day. We owe them a great debt of gratitude, however.

Other writers say that Perdix, nephew of Dædalus, employed the backbone of a fish, and was thus led to the invention. Perdix raised the jealousy of somebody, and was changed into a partridge. Ovid mentions this, without assigning the name of the inventor.

Saws of the bronze age have been discovered in Germany and Denmark, but not in Great Britain. (Lubbock.) The metal was cast thin, and probably was serrated by chipping and grinding.

Saws of the stone age were made by setting flakes

Fig. 4590.



Egyptian Sawyer and other Mechanics (from Thebes).

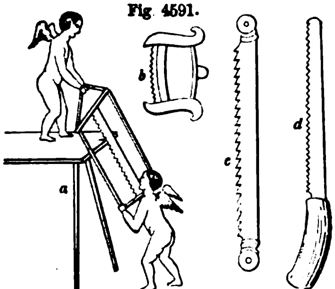
of flint in wooden handles and securing with bitumen. Obsidian was used in Mexico. Saws and knives of obsidian have been disinterred in the alluvial ground of New Jersey beneath the recent gravel. They are held to prove the existence of extensive coastwise trade, as no obsidian is found nearer than Mexico. The saws of the South Sea islanders in 1768, when Captain Cook went to Otaheite to observe a transit of Venus, were made of sharks' teeth lashed to a back-piece. The saws of the Lacustrians and other early inhabitants of Europe were of jagged flint; those of the Caribs, of notched shells. The saw is a very old device, as old as a knife with a ragged edge.

Fig. 4590 is from a group of persons represented in an ancient painting at Thebes, who are making poles or carriage-tongues.

In dividing a beam of moderate length into planks, it seems to have been usual with the ancient Egyptians to set it upright between posts, to which it was lashed. Wilkinson failed to find any saw adapted for use by two persons, like the pit-saw.

g, Fig. 3032, page 1379, represents a saw discovered by Mr. Burton at Thebes, and now placed in the British Museum. The owner had probably been dead several hundred years before Pythagoras, Solon,

Fig. 4591.



Ancient Saws.

or Plato visited Egypt to study science. The ancient saws were *hand* and *frame*.

a. From a painting at Herculaneum. Two genii working a frame-saw.

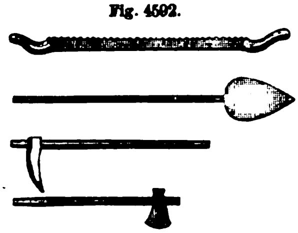
b. A frame-saw from a funeral monument.

c. A frame-saw blade detached; from a monument.

d. An Egyptian saw in the British Museum.

The implements of labor of the Assyrians are not so fully represented on the monuments as those of warfare. The cross-cut saw was two-handled, but not cross-handled, apparently. The shovels were heart-shaped, as at present used in Asia Minor. The picks had single heads. The hatchets had a poll.

Fig. 4592.



Tools of Babylon.

The modern Oriental saw is used with a *drag* rather than a *drive* motion, and the teeth are suitably inclined, raking toward the handle rather than away from it. The ancient Egyptian blade was of bronze, attached to the handles by leathern thongs, and was single-handled. Some of the blades, however, as in the instances of some of the Egyptian saws in the British Museum, are set into the handles with tangs, like our case-knives. The Egyptian saws were operated by the thrust movement, the edge curved or straight. Such are shown in the paintings of ancient Egypt.

St. Jerome is understood to have alluded to circular saws, but the point is not clear.

A double-handled iron saw has been discovered at Nimroud.

Sesorthus was called Aslepius by the Egyptians on account of his mechanical skill. The Greeks derived from him the name and attributes of Æsculapius. He introduced into Egypt the art of building with hewn stone, and, it has been supposed, used saws upon his blocks of stone. This is by no means certain, but we are told distinctly in the Hebrew history that the Phœnician architects of Solomon's temple built it of stone squared with the saw. The marble facing of the palace of Mausolus, king of Caria, described by Vitruvius, is believed by Pliny to have been faced with sawn slabs. This was erected 350 B. C.

Samuel (1033 B. C.) and Isaiah (742 B. C.) refer to saws.

The stone saws were commonly used, and the respective actions of the metal and sand were fully understood, in the time of Pliny. See STONE-SAW.

For *machines*, see SAWING-MACHINE; SAW-MILL; and list *infra*.

Japanese saws are shaped like butchers' cleavers. The handle is flattish, as if whittled out of a piece of inch board; the shank of the saw is driven into the handle, and the whole is secured by being wrapped with fine split cane. The metal of the saw is about the substance of our saws, but the teeth are narrower, giving more of them to an inch, and much longer. The teeth are pointed toward the handle. When a Japanese wants to rip a plank, he places it across anything which will elevate the end a few inches, then stands on the wood and cuts it by seizing the cleaver-looking saw in both hands, and pulling it toward him, working it by short, quick up-strokes.

The very distinguished place occupied by General Sir Samuel Bentham in the history of the invention and manufacture of wood-working machines is evinced by the list of sawing-machines invented and manufactured by him for the British Admiralty previous to 1800.

Circular saw.	Bevel saw.
Segmental circular saw.	Curvilinear saw.
Crown and cylinder saws.	Saw-blade grinding-machine.
Segment sawing-machine with radius arm.	Taper-gage for sawing-machines.
Saw for irregular forms with tracer-guide.	Double-grooving saws.

The circular saw is well described in Miller's English patent, No. 1,152, of 1777.

The band-saw is described in Newberry's English patent, 1808.

See also WOOD-WORKING MACHINES and list under SAW, *infra*.

A circular saw was made with blacksmiths' tools by Benjamin Cummins, at Bentonsville, N. Y., about 1814. This is supposed to have been the first made in this country.

Making a saw involves the following processes: —

1. Cutting out the blade from the sheet.
2. Toothing with a press and appropriately formed dies.
3. Hardening, by plunging while heated in an oil-bath. In this state the metal is extremely brittle.
4. Tempering and straightening; the latter is effected by hammering on an anvil or by compressing several blades, while hot, between two dies worked by a hydraulic press.
5. Grinding and polishing with emery-powder.
6. Filing and setting the teeth.
7. Reheating to restore the elasticity lost in tempering.
8. Removing the scale by immersion, first in dilute acid, and afterward in alkali to remove the acid.
9. The handle is attached and the blade tested.

The plates for saws are made of ingots of steel, carefully prepared to secure uniformity, and reduced to the proper thickness by rolling. Formerly, the larger portion came from Sheffield, England, but Philadelphia, Pittsburg, Cincinnati, and other places make them of the best quality, and from American steel of American iron. Circular saws were employed by Brunel in his block-making machine, and afterward came into general use. The plates for these vary in thickness from $\frac{1}{32}$ to $\frac{1}{4}$ inch, according to purpose, and the diameter from 8 to 72 inches; though sometimes they are made 88 or even 100 inches in diameter. The materials employed are steel and iron scraps of the best quality, melted together, and after casting reduced by repeated rollings. The hole in the center is drilled out, and the teeth roughly cut out by dies under a powerful press, after which the plate is firmly secured upon a heated table and the teeth pointed and sharpened by an emery-wheel; a farther grinding and polishing operation then ensues, a second and narrower wheel finishing the gullets. They are then tempered by heating until the film of oxide on their surface indicates that the proper temperature is attained, when they are immersed for about five minutes in an oil-bath. The oil is next removed by saw-dust, and the temper let down by reheating and gradually cooling. These processes tend to warp the plate, which must, therefore, be straightened by hammering upon an anvil, their

accuracy being tested by a level. This operation requires great care and judgment. The saw is then fastened centrally upon a shaft and caused to rotate rapidly against a large grindstone moving in an opposite direction, which dresses off one side to a perfectly uniform surface, when the saw is turned and the other side similarly treated, making the blade slightly thinner toward the center than at the circumference. They are again tested as to planeness, the straightening process repeated if necessary, and afterward polished by being caused to rotate in contact with wooden blocks coated with a composition of glue and emery.

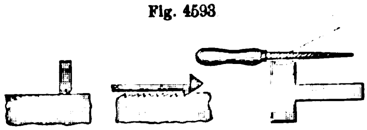
Straight saws are made in a similar manner, regard being had to the difference in shape. The edge intended for the teeth is trimmed true, the teeth punched by a fly-press, filed, tempered, wiped, heated until any remaining oil *blazes off*, hammered on an anvil or *smithed*, ground to a gradually decreasing thickness from front to back (this is now done on both sides at once), re-hammered, again ground or *drawn*, *glazed* or polished, again straightened on the anvil, grained with emery, the teeth set, the blade stiffened by a heating process, any discoloration thus occasioned removed by acids, and, finally, oiled.

For correctly spacing the teeth of fine saws, a double chisel (Fig. 4593) is sometimes employed.

For still more delicate saws, a small piece of steel, hooked rectangularly at one end, is used. Its end is hardened, and serves as a guide for the file.

Piercing and inlaying saws for wood, metal, and ivory are made from pieces of watch-spring; the teeth are laid off and

Fig. 4593



Spacing Teeth of Saws.

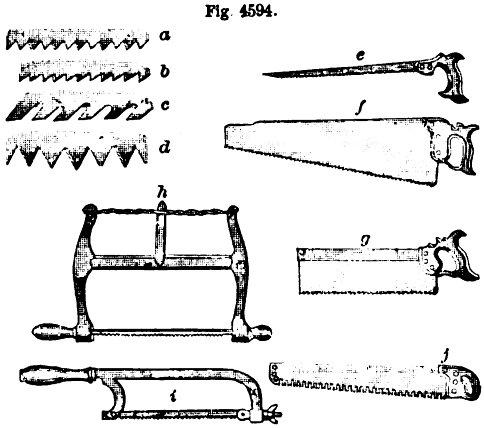
filed by laying the saw stretched in its frame flat in a grooved brass plate imbedded in a wooden block; as each tooth is formed the file is shifted angularly and returned to its former position, thus stepping off the interval of one tooth, the spacing being determined by the judgment and skill of the operator.

The French method is about as follows: The blades, after being rolled cold several times, in order to render the grain close and the metal homogeneous, are heated in special furnaces, from which the air is carefully excluded, and when at the proper temperature are plunged in a bath of colza oil; this is done in a dark chamber. The tempering is effected with the aid of machines which cause the blades to pass between cast-iron plates heated to a fixed temperature, according to the nature of the article to be produced. The tooth-cutting, planishing, and grinding are done by machinery, as is also the reducing of joints of ribbon-saws, which is effected longitudinally, instead of across the blade.

Saw-teeth are known, according to shape, rake, interval, set, or other peculiarity, as *peg*, *fleam*, *gullet*, *brier-tooth*, *hawk's-bill*, *skip*, *insertable tooth*, etc.

Fig. 4594 shows varieties of saws and saw-teeth.

Fig. 4594.



Saws.

a d, cross-cut tooth.
b, hand-saw tooth.
c, gullet-tooth.
e, compass-saw.
f, hand-saw.
g, tenon-saw.
h, frame-saw for wood.
i, smith's frame-saw for metal.
j, Boynton's "lightning" saw. See *a a' a''*, Fig. 4642.

The following table shows the dimensions of the generally used varieties of the rectilinear saws, arranged in three groups.

1. Taper Saws, mostly without Frames.

The thickness is that given by the Birmingham wire-gage.

With a Handle at each End.

	Length of Blade.	Width at Wide End.	Width at Narrow End	Form of Tooth (Fig 4641).	Space of Tooth.	Thickness of Metal. Gage No.
	Feet	Inch.	Inch		Inch.	
Cross-cut saw......	4 - 10	6 - 12	3 - 7	*a - d*	¾ - 1	12 - 15
Long, pit, or whip saw..........	6 - 8	9 - 12	3½ - 5	*k l*	½ - 1	12 - 16
Pit-frame saw.....	4 - 6	7 - 11	3 - 4½	......	½ - ¾	15 - 18
Felly or pit-turning saw............	4 - 6	3 - 4	2 - 3	......	½ - ⅝	13 - 15

With Handle at one End.

	Length of Blade.	Width at Wide End.	Width at Narrow End	Form of Tooth (Fig. 4641)	Points per Inch.	Thickness of Metal. Gage No.
	Inch	Inch	Inch.			
Rip-saw...........	28 - 30	7 - 9	3 - 4	*e f*	3½	18
Half-rip saw.......	26 - 28	6 - 8	3 - 3½	......	4	18 - 19
Hand-saw.........	22 - 26	5 - 7½	2½ - 3	......	5	18 - 19
Broken space or fine hand	22 - 26	5 - 7½	2½ - 3	......	6	18 - 19
Panel-saw..........	20 - 24	4½ - 7½	2 - 2½	......	7	19
Fine panel-saw....	20 - 24	4 - 6	2 - 2½	......	8	19 - 20
Chest-saw (for tool-chests)..........	10 - 20	2½ - 3½	1¼ - 2	......	6 - 8	18 - 21
Table-saw.........	18 - 26	1¾ - 2¼	1 - 1½	......	7 - 8	16 - 19
Compass or lock saw	8 - 18	1 - 1½	½ - ¾	......	8 - 9	18 - 19
Keyhole or fret saw	6 - 12	½ - ¾	⅛ - ¼	......	9 - 10	19 - 20
Pruning-saw	10 - 24	2 - 3½	½ - 1¼	*c*	4 - 7	13 - 16

2. Parallel Saws with Backs.

With a Handle at each End.

	Length of Blade	Width of Blade.	Form of Tooth.	Points per Inch.	Thickness of Metal. Gage No
	Inch.	Inch.			
Tenon-saw...............	16 - 20	3½ - 4	*e f*	10	21
Sash-saw	14 - 16	2½ - 3½	......	11	22
Carcass-saw.............	10 - 14	2 - 2½	......	12	23
Dovetail-saw....	6 - 10	1½ - 2	......	14 - 18	24
Smith's screw-head saw...	8 - 8	½ - 1	......	12 - 16	15 - 22

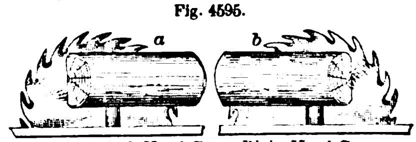
3. Parallel Saws used in Frames.

Stretched Lengthways.

	Length of Blade.	Width of Blade.	Form of Tooth.	Points per Inch.	Thickness of Metal. Gage No.
	Feet.	Inch.		Inch.	
Mill-saw..................	4 - 8	4 - 5	*i l*	½ - 1	10 - 14
Mill-saw web............	4 - 6	3 - 4	....	½ - 1	17 - 20
Veneer-saw	4 - 5	4 - 5	*f*	2 - 4	19 - 21
	Inch.				
Chair-maker's saw........	20 - 30	1½ - 2½	....	3 - 4	19 - 22
Wood-cutter's saw........	24 - 36	2 - 3½	*e*	3 - 4	19 - 22
Continental frame-saw....	15 - 36	1 - 3	*f*	4 - 12	19 - 24
Turning or sweep saw	6 - 22	1/10 - ⅛	....	10 - 20	19 - 24
Ivory-saw	15 - 30	1½ - 3	*e*	4 - 6	22 - 24
Smith's frame-saw........	3 - 12	½ - ¾	*g*	10 - 14	20 - 26
Piercing-saw.............	3 - 5	1/30 - 1/40	*f*	40 - 60	1/100 in.
Inlaying or buhl saw.....	3 - 5	1/25 - 1/30	....	15 - 40	1/70 - 1/100

Fig 4595, *a*, left-hand circular-saw; *i. e.* the direction of rotation is from left to right.

Fig. 4595.



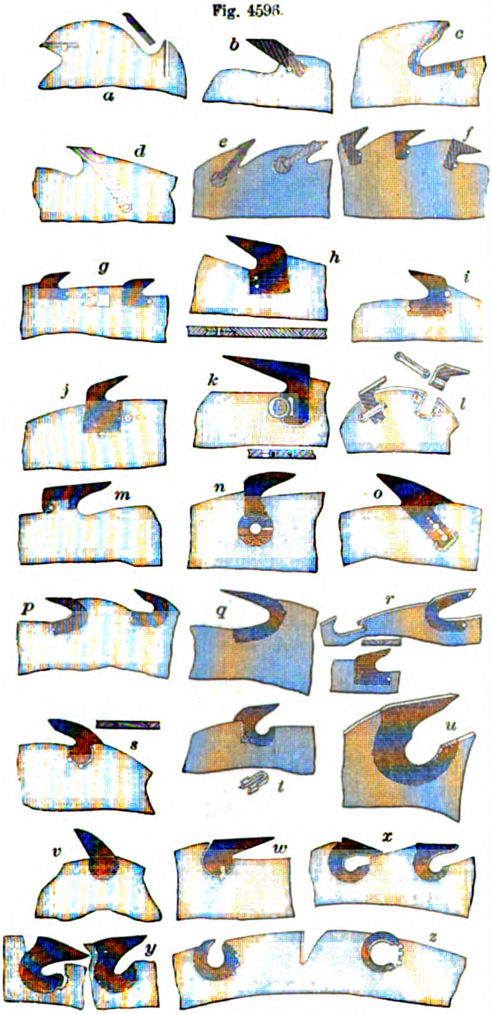
Saws: Left-Hand Saw; Right-Hand Saw.

b, right-hand saw; rotates the other way.

Rail-saws now consist of circular disks about 3 feet in diameter, and driven at the rate of 3,000 revolutions per minute, giving a circumferential velocity of over 5 miles per minute. Steel rails are cut rapidly, giving out abundance of sparks. Such saws are used in America and in England.

Fig. 4596 shows a number of detachable teeth for circular saws. In each case but a portion of the blade is shown. The shape of the teeth and the mode of fastening them in the blades will be understood at a glance.

Fig. 4596.



Insertable Teeth for Circular Saws.

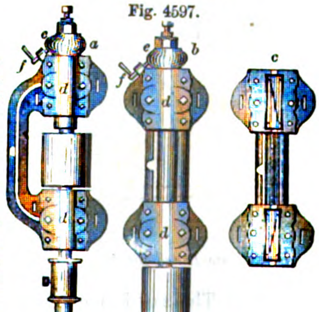
a, Krauser.
b, Colsen.
c, Emerson.
d, Clemson.
e, Lippincott.
f, Spaulding.
g, Emerson.
h, Neale.
i, Emerson.
j, Brown.
k, Clemson.
l, Woodruff.
m, Emerson.
n, Disston.
o, Shoemaker.
p, Emerson.
q, Emerson.
r, Emerson.
s, Disston.
t, Disston.
u, Hoe.
v, Strange.
w, Humphrey.
x, Miller.
y, Disston.
z, Miller.

See under the following heads:—

Amputating-saw.
Annular saw.
Back-saw.
Band-saw.
Barrel-saw.
Belt-saw.
Bench-saw.
Bevel-saw.
Bolt-saw.
Bow-saw.
Brier-tooth saw.
Broken-space saw.
Buck-saw.
Buhl-saw.
Bur-saw.
Burring-saw.
Butting-saw.
Buzz-saw.
Carcass-saw.
Center-saw.
Chain-saw.
Chair-maker's saw.
Chair-web saw.
Chest-saw.
Chuck-saw.
Circular saw.
Comb-cutter's saw.
Comb-sawing machine.
Compass-saw.
Corner-saw.
Cross-cut saw.
Crown-saw.
Cylindrical saw.
Deal-frame.
Double saw.
Dovetail-saw.
Drag-saw.
Drum-saw.
Edging-saw.
Endless saw.
Equalizing-saw.
Exsecting-saw.
Felling-saw.
Felly-saw.
Frame-saw.
Fret-saw.
Fuse-saw.
Gage-saw.
Gang-saw.
Gate-saw.
Gig-saw.
Gin-saw.
Grub-saw.
Gullet-saw.
Gummer.
Hack-saw.
Hand-saw.
Hawks'-bill tooth-saw.
Hey's saw.
Ice-saw.
Indicator for saw-teeth.
Inlaying-saw.
Inserted-teeth saw.
Ivory-saw.
Jig-saw.
Joint-saw.
Keyhole-saw.
Live-gang saw.
Lock-saw.
Marble hand-saw.
Marble-saw.
Meat-saw.
Metacarpal saw.
Metal-saw.
Mill-saw.
Molding-saw.
Muley-saw.
Panel-saw.
Perforated saw.
Piercing-saw.
Pile-saw.
Pit-saw.
Pruning-saw.
Rabbet-saw.
Rachitome.
Rack-saw.
Re-sawing machine.
Ribbon-saw.
Rip-saw.
Router-saw.
Rubber-saw.
Sash-saw.
Saw-arbor.
Saw-bench.
Saw-buck.
Saw-clamp.
Saw-doctor.
Saw-file.
Saw-filing machine.
Saw-frame.
Saw-gage.
Saw-gate.
Saw-grinding machine.
Saw-gummer.
Saw-handle.
Saw-hanging.
Saw-horse.
Sawing-block.
Sawing-machine.
Saw-mandrel.
Saw-mill.
Saw-mill dog.
Saw. Perforated
Saw-sash.
Saw-set.
Saw-sharpening.
Saw-swage.
Saw-tempering.
Saw-tooth.
Saw-tooth indicator.
Saw-toothing machine.
Saw-tooth upsetting.
Saw-vise.
Screw-head saw.
Scroll-saw.
Scroll sawing-machine.
Segment-saw.
Set-saw.
Shingle-mill.
Shingle-saw.
Skip-tooth saw.
Slabbing-gang.
Slabbing-saw.
Spherical saw.
Spindle-saw.
Stadda.
Stave sawing-machine.
Stocker's saw.
Stock-gang.
Stone-saw.
Subcutaneous saw.
Sweep-saw.
Swinging-saw.
Tenon-saw.
Tier-saw.
Timber-frame.
Tin-saw.
Tooth-saw.
Trepan-saw.
Trephine-saw.
Tub-saw.
Turning-saw.
Twining-saw.
Two-handled saw.
Veneer saw.
Washing-tub saw.
Weather-boarding saw.
Web-saw.
Whip-saw.
Wood-saw.
Yankee gang-saw.

Saw-ar′bor. The axis to which a circular saw is secured and by which it is rotated. *a b*, Fig. 4597, are two different forms. In the first, the pulley which drives the saw is placed between the journal-boxes *d d*, and in

Fig. 4597.

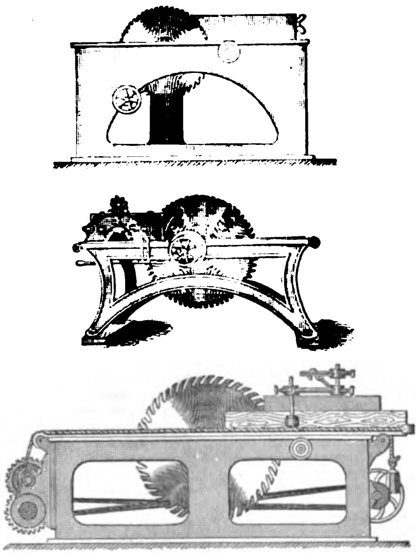


Saw Arbor and Box.

the second outside of them. The device has flanges by which it is bolted to the table. The saw is held between a gland and a nut *e*, and an expanding device operated by a screw at the end adapts the arbor to saws having different-sized holes. A pin-lever *f* prevents the arbor from revolving while removing or replacing a saw. The journal-boxes have a chamber at each end connected by a diagonal recess, in which a piece of cotton-wicking is placed for the purpose of lubrication, as shown at *c*.

Saw-bench. (*Wood-working.*) A table on which stuff is fed to a saw. The examples are several forms

Fig. 4598.

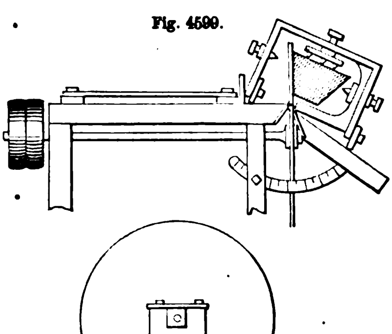


Saw-Benches.

of circular-saw benches, with gages and fences for sawing dimension stuff.

Donkin's saw-bench (English) has a hinged platform in front of the saw, with quadrants by which it may be fixed to any bevel within its range. The parallel rule is available for setting out the widths of

Fig. 4599.



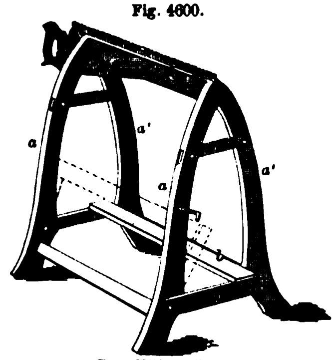
Saw-Bench for Mitered and Beveled Work.

the work. The saw is mounted upon a swing-frame of cast-iron, shown separately in the other figure, and is adjusted by the cam, so as to project the required distance through the slit in the table.

Saw-buck. Another name for the SAW-HORSE (which see).

Saw-clamp. A device, also known as a *horse*, for holding saws while being filed. The standards

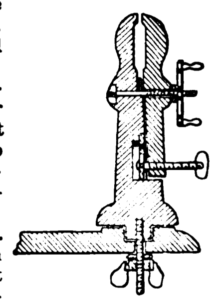
Fig. 4600.



Saw-Filing Clamp.

a a' are hinged together, and are spread apart so as to open the jaws *c* at the upper end, in order to hold the saw. This is pinched tightly by pressing down the treadle *b*, which forces the feet apart and shuts the jaws.

Fig. 4601.



Saw-Filing Clamp.

Fig. 4601 is a form adapted for the bench or table.

Saw-doc'tor. An instrument having an angular punch for cutting pieces out of the edge of a saw-blade, to increase the depth of the interdental spaces. A *saw-gummer.*

Saw'dust-car'ri-er. (*Wood-working.*) A trough or tube by which the sawdust is conducted away from a circular or other saw. See FAN-BLOWER, *A*, Fig. 1918.

Saw-file. A file adapted for saws; triangular in cross-section for hand-saws and *flat* for mill-saws. See FILE, Fig. 1965. The fineness of the file depends upon the character of the work. See list and table, page 840.

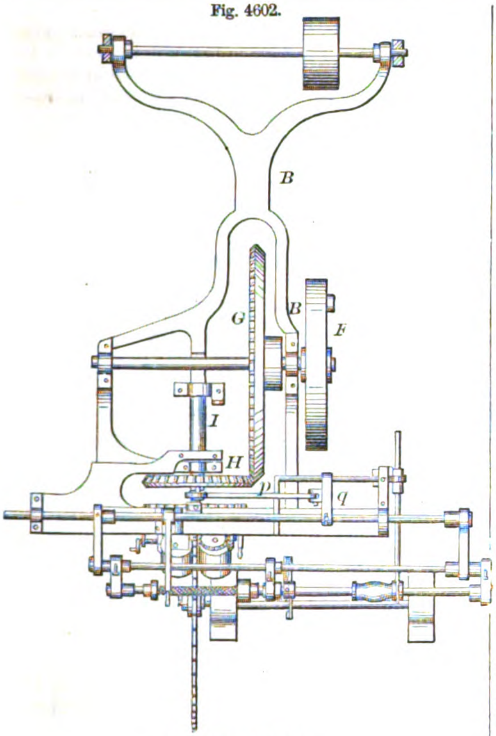
Saw-fil'ing Ma-chine'. One for sharpening the teeth of saws. See also SAW-SHARPENING.

The teeth of saws are usually made by a punching action in a *saw-toothing machine.*

The example (Fig. 4602) has a suspended frame *B* on which the file and operative mechanism are arranged. The axis of suspension is also the arbor of the countershaft pulley, connecting by belt with the driving-pulley *F*. The vertical shaft *I* is rotated by bevel-gearing *G H*, operating the pitman *p* and cross-head *q*, and reciprocating the file-carrier. The saw is temporarily placed on a mandrel on the bench.

Fig. 4603 comprises a standard *a* having a pulley from which a belt passes to a pulley on the movable frame *c*, attached by a ball and socket joint to the main frame *d*. The pulley-shaft carries the grinding-wheel *b*, which, by means of a handle, may be presented to the work at any desired angle. It is driven at the rate of 1,500 to 2,000 revolutions per minute, and is counterpoised by a weighted lever *e*, so as to be manipulated by a slight pressure. See "Art of Saw-Filing" (56 pp.), John Wiley, New York.

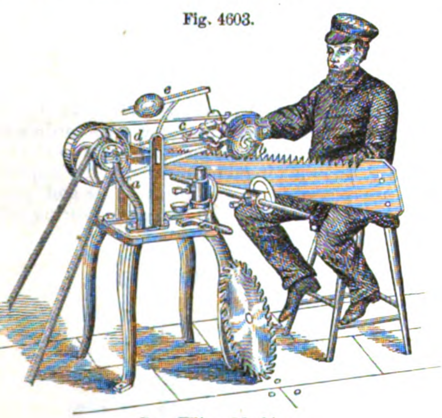
Fig. 4602.



Saw-Filing Machine.

Saw-frame. 1. The frame in which a saw-blade

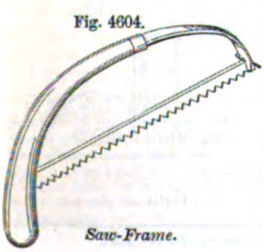
Fig. 4603.



Saw-Filing Machine.

is stretched. In the illustration, this is effected by a stout metallic spring attached to the part which serves for a handle. See FRAME-SAW, page 913.

Fig. 4604.



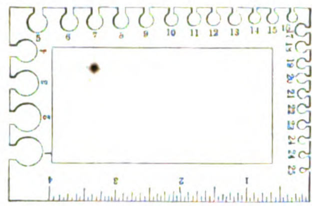
Saw-Frame.

2. The *sash* or *gate* of a mill-saw.

Saw-gage. 1. (*Saw.*) *a.* A test for the thickness of saw-blades or the width of saw-tooth points.

Fig. 4605 is a form of standard saw-gage, also adapted for sheet metals and wire; the central space is open, rendering the gage lighter and affording ready means for hanging up.

Fig. 4605.

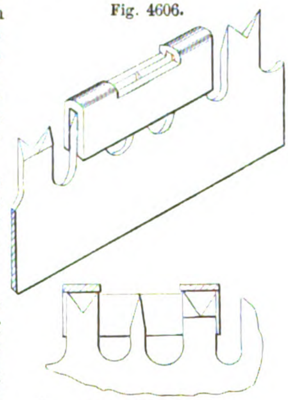


Saw-Gage (drawn to ⅓ Scale, Linear).

b. A test for the straightness of the line of teeth.

Fig. 4606 is a gage to be laid over the line of teeth so as to indicate the exactly proper length of a tooth. In the illustration, the gage lies upon two teeth, and at its notch exposes the middle tooth, which is under treatment.

Fig. 4606.

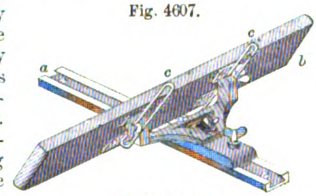


Saw-Filing Gage.

c. A test for the range of teeth-points relatively to their distance from the center of rotation. See Fig. 4643.

2. An adjustable device for governing the width of the scantling or board cut and its angle of presentation to the saw. In Fig. 4607, the former is determined by the position of the gage in the slot *a*. The angle is varied by adjusting the piece *b*, and any desired slope is given by inclining the links *c*. Set-screws are provided for securing each part in the position to which it is adjusted.

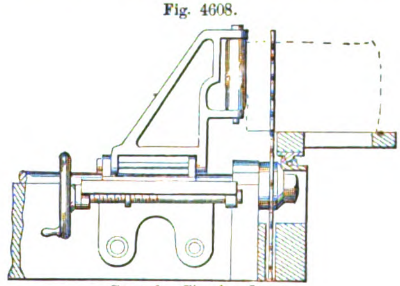
Fig. 4607.



Saw-Gage.

Fig. 4608 is a gage for circular saws. The distance of the rollers from the plane of the saw's motion determines the thickness of the plank.

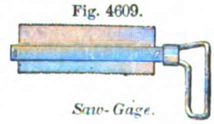
Fig. 4608.



Gage for Circular Saws.

3. A loose back, which is adjusted toward or from the edge of the saw, to limit the depth of the kerf.

Fig. 4609.



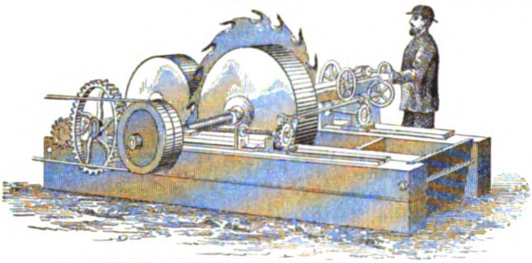
Saw-Gage.

Saw-gate. The rectangular frame in which a mill-saw or gang of mill-saws is stretched. See Fig. 1601. See also SAW-MILL, Plate LIV.

Saw-gin. (*Cotton.*) The original form of cotton-gin, in which the fibers are drawn through the grid by the teeth of a saw. Fig. 1486, page 634, and Fig. 2222, page 969.

Saw-grind'ing Ma-chine'. A machine for dressing the sides of saws, so as to give the blade a

Fig. 4610.



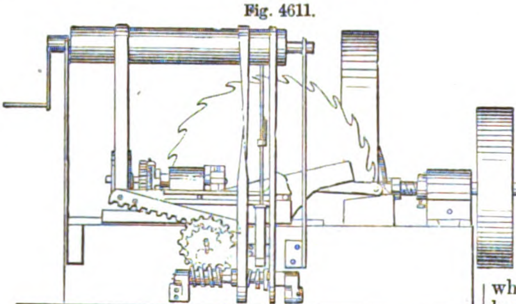
Grinding-Machine for Circular Saws.

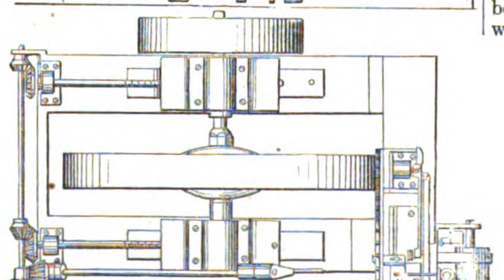
uniform thickness, or impart a uniform taper from center to circumference.

Saw-grinding machines were among those supplied by Sir Samuel Bentham to the British Admiralty, before 1800.

In Fig. 4610, the saw is hung on a spindle, and is caused to rotate between two grindstones in a plane at right angles to their axes. By means of

Fig. 4611.





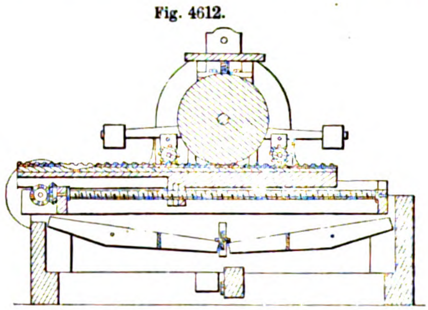
Grinding-Machine for Circular Saws.

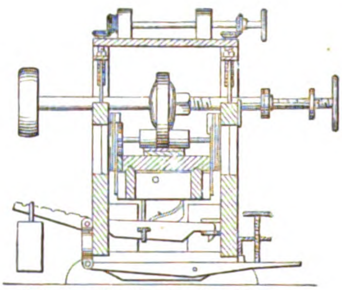
hand-wheels and gearing the grindstones are moved alternately toward and from the center of the saw until it is reduced to the desired thickness.

In Fig. 4611, the saw is on a horizontal mandrel, and receives a motion in two directions, — one upon its axis, and the other by the reciprocation of the carriage that supports the saw. The circular arbor or bearing for the saw is so constructed as to permit the center of the saw to advance to the edge of the grindstone. Thus every portion of the disk is brought in turn to the operation of the grindstone. See also Disston's patent, November, 1874, in which a pair of grindstones grind the face of the saw, and have mandrels so adjustable as to give any required taper, increasing or decreasing from the edge to the eye.

In Fig. 4612, the flat mill-saw blade is placed in position upon the reciprocating bed and beneath the rollers, the force of the levers being then exerted

Fig. 4612.



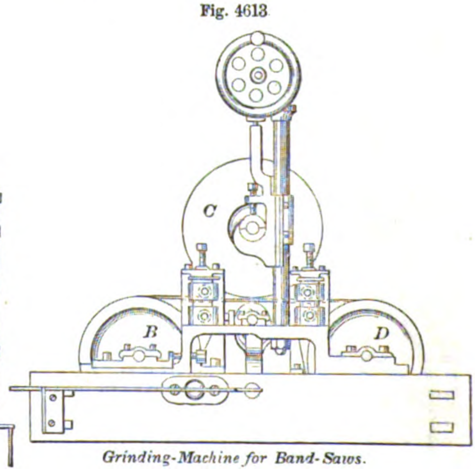


Grinding-Machine for Gate-Saws.

to raise the bed and cause the blade to bear against the rotating grindstone. The rollers confine the blade and its supporting plate to the bed.

Fig. 4613 is for grinding band or ribbon saws, which are placed over the drums *B D* and passed beneath the grindstone *C* above a bearing-roller which supports the blade.

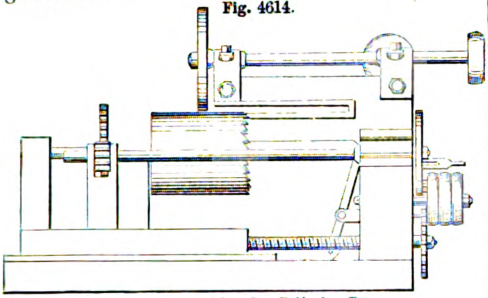
Fig. 4613



Grinding-Machine for Band-Saws.

The machine may also be used for grinding other saw-blades; the metallic apron, in connection with the feed-rollers, moving the saw-blade to the action of the grindstone with a force not greater than the grinding capacity. The flange or collar at the eye of the grindstone may be set in position, or at an inclination corresponding with that of the side of the grindstone.

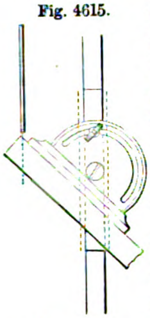
Fig. 4614.



Grinding-Machine for Cylinder Saws.

Fig. 4614 is a machine for grinding cylinder or *tub* saws. The revolving grindstone or wheel is brought in contact with the surface of the cylindrical saw, which slowly revolves and traverses longitudinally from end to end, when its motion is reversed by suitable mechanism. The saw-mandrel has a friction-roller and gage, and the grinding-wheel is adjustable in position.

Fig. 4615.



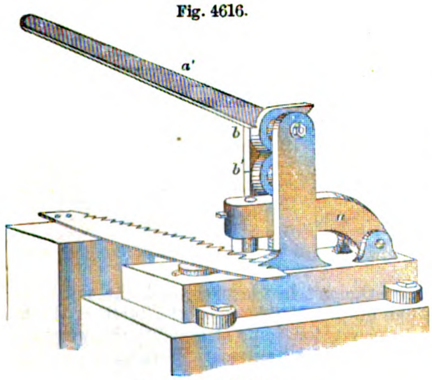
Saw-Guide.

Saw-guide. A piece with an adjustable *fence*, which may direct the saw in cross-cutting strips, against which the piece is laid.

Saw-gum'mer. An apparatus for cutting away the plate of a saw to deepen the interdental spaces. This is sometimes done by punching, sometimes by grinding.

In Fig. 4616, the punch-holder *a* is pivoted and depressed by a lever *a'* operating the cams *b b'*, and thrown upward, after making the cut, by a spiral spring beneath.

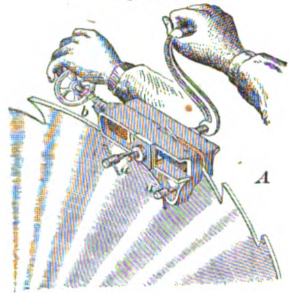
Fig. 4616.

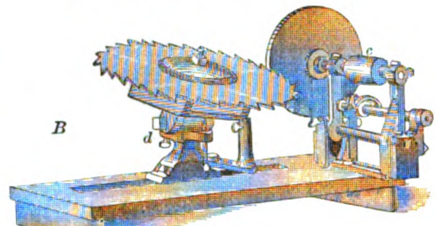


Hoe's Saw-Gummer.

In Fig. 4617, *A*, the saw is clamped between the jaws of the gummer by the screws *a a*; rapid rotation is imparted to the cutter by means of a winch, and it is advanced to deepen the cut by the hand-wheel and screw *b*. In *B*, a lap or emery wheel is turned by belt and pulley *c*; the saw is held on a stand *d*, whose distance from the lap may be varied to suit different-sized saws, and which may be tilted to vary the angle of the cutting edges of the teeth.

Fig. 4617.



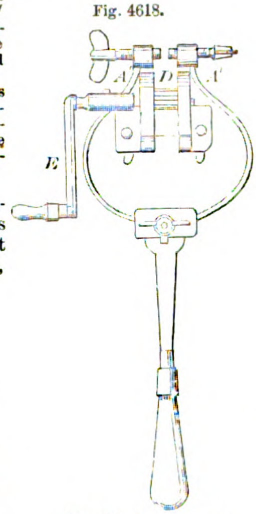


Saw-Gummer.

Fig. 4618 is a view of a portable form which is held by one hand against the blade of a mill-saw, the set-screws *A' A'* resting against opposite surfaces of the blade, while the cutting cylinder *D* is rotated by the crank-handle *E*.

There are many other forms of the tool, some of which employ the emery-wheel, commonly known as *tanite*. See EMERY-WHEEL, and specific index under GRINDING, 1017.

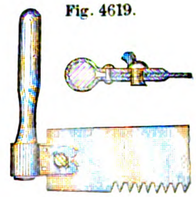
Fig. 4618.



Portable Saw-Gummer.

Saw-han'dle. Various forms of handles are used for the different kinds of saws, — hand, cross-cut, etc.

Fig. 4619.



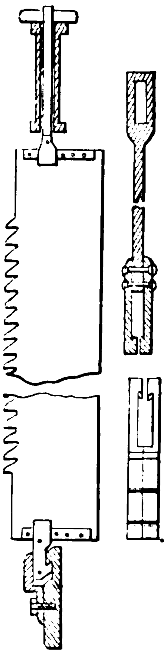
Saw-Handle.

In Fig. 4619, the wings of the handle-socket have elongated slots through which, and through a corresponding slot in the saw-blade, is passed a bolt, cam-shaped in section; this can enter the slot in only one way, and on being turned strains the blade, causing its ends to bear against the rivets, which unite the wings, while a projecting lip draws the wings together, and tends to prevent displacement.

Saw-hang'ing. The devices by which a mill-saw is strained in its gate. In the example, strips of steel are riveted on each side at each end of the saw and their dovetailed edges. Hooks with curved and correspondingly dovetailed lips engage the steel strips, and form a means of adjusting the strain at any part of the saw nearer to or farther from the edge. See also STIRRUP.

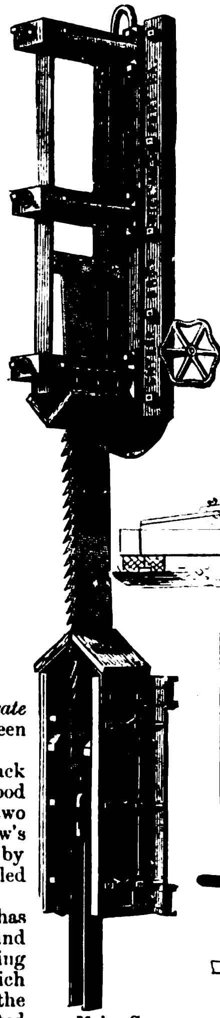
Fig. 4621 shows Snyder's muley-saw hanging.

Fig 4620.



Saw-Hanging.

Fig. 4621.



Muley-Saw.

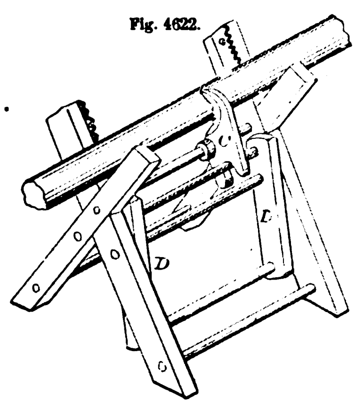
The saw is destitute of a *gate* or *sash*, but plays between guides.

Saw-horse. A kind of rack on which sticks of cord-wood are laid for sawing. Its two ends each form a St. Andrew's cross, and are connected by longitudinal stays. Also called SAW-BUCK.

That shown in Fig. 4622 has a curved clamp *C* pivoted and sliding on the upper connecting round of the frames, and which is held to or released from the log by turning the pivoted frame or lever *D D*.

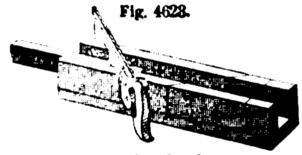
Saw'ing-block. (*Joinery.*) A wooden trough, through the upright sides of which a saw kerf is cut at right angles with the axis, and two others forming opposite angles of 45° therewith. These serve respectively as guides for cutting off square the ends of a piece of wood placed within the box, and for making miter-joints. See MITER-BOX.

Fig. 4622.



Saw-Horse.

Fig. 4623.

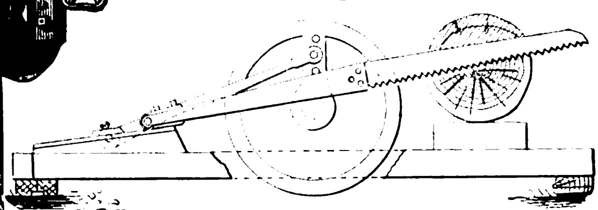


Sawing-Block.

Saw'ing-ma-chine'. A mechanical contrivance by which the power — of the man or an engine — is applied to the work of driving the saw.

The applications of the saw in shops are very numerous, and are considered under their various heads. Among them may be here cited : —

Fig. 4624.



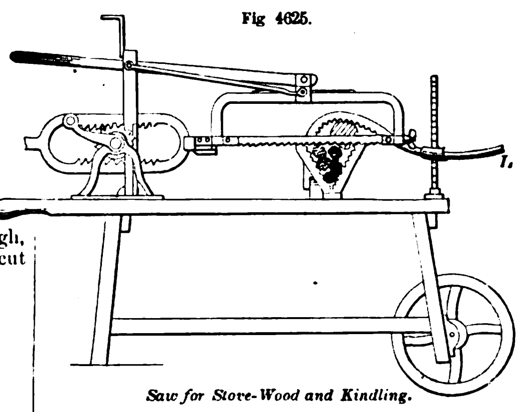
Drag-Saw for Cross-cutting Logs.

Band-saw.	Gate-saw.
Barrel-saw.	Gig-saw.
Buzz-saw.	Resawing-machine.
Circular saw.	Shingle-saw.
Drag-saw.	Stave-saw.
Gang-saw.	Veneer-saw, etc.

See also specific index under SAW, page 2035.

Fig. 4625 is a domestic saw for making short fire-wood ; the pieces are laid in a V-shaped trough,

Fig 4625.



Saw for Stove-Wood and Kindling.

held by the notched lever *L*, and the saw is reciprocated by the double rack, the teeth of the upper and lower portion being alternately thrown into gear with the pinion by automatic devices.

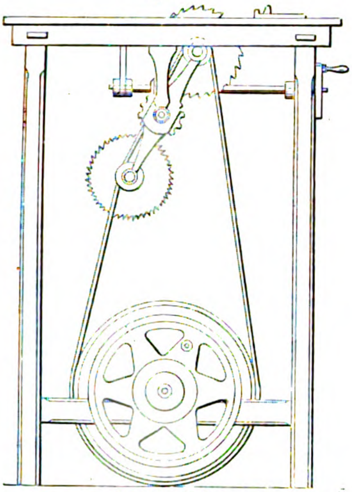
A handy workshop-form of the circular saw. In the form shown (Fig. 4626), either of several saws is brought into cutting position at the slit in the table.

Saw'ing-ma-chine' Gage. See SAW-GAGE.

Saw-man'drel. A hold-fast for a circular saw in a lathe. See SAW-ARBOR.

Saw-mill. Wood-saw mills, driven by water, were erected as early as the fourth century in Germany, on the river Roer. Stone, marble, and grain

Fig. 4626.



Sawing-Table.

mills had been used many centuries previously in Pontus, Caria, and in Rome.

Saw-mills were driven by water at Augsburg in 1322. Indeed, a saw-mill with a complete self-action and driven by a water-wheel is found in a MS. of the thirteenth century, now in Paris.

Saw-mills were erected by the Spaniards in the island of Madeira in 1420. Erected in Breslau, 1427; in Norway, 1520; in Rome, 1556.

Saw-mills driven by water afterward became common in Europe. In the year 1555, the Bishop of Ely, ambassador from Mary Queen of England to the court of Rome, visited a saw-mill in the vicinity of Lyons, which he thus describes: —

"The saw-mill is driven with an upright wheel, and the water that maketh it go is gathered whole into a narrow trough, which delivereth the same water to the wheels. This wheel hath a piece of timber put to the axle-tree end, like the handle of a broch, and fastened to the end of the saw, which, being turned with the force of the water, hoisteth up and down the saw, that it continually eateth in, and the handle of the same is kept in a rigall of wood from swerving. Also the timber lieth, as it were, upon a ladder, which is brought by little and little to the saw with another vice."

In 1575, a mill having a gang of saws, capable of sawing several boards at once, was in operation on the Danube, near Ratisbon. In 1596, the first, it is said, in Holland was erected at Saardam. In England, one erected in 1663 by a Dutchman was abandoned on account of the opposition of the populace; and more than a century later (1767), when James Stansfield established a wind saw-mill at Limehouse, East London, it was destroyed by a mob. A similar mill had previously been in operation for some years at Leith, Scotland.

In 1802, Oliver Evans of Philadelphia constructed a double-acting high-pressure engine for a boat to run between New Orleans and Natchez. On reaching the Mississippi, the boat was high and dry, and could not be floated till the periodical rise of the river occurred. The engine was, therefore, set up in a saw-mill, and sawed at the rate of 3,000 feet of boards per day. This mill, also, was burned by hand-sawyers, who thought their craft was in danger.

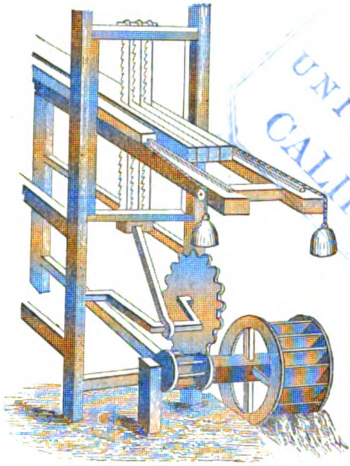
The illustration (Fig. 4627) is taken from a tract published in London in 1650, entitled "Virginia's Discovery of Silk Worms, with their Benefit and the implanting of Mulberry Trees. Also the dressing and keeping of Vines for the rich Trade of making Wines there. Together with the making of the Saw Mill, very useful in Virginia for cutting of Timber and making Clapboards to build withall, and its Conversion to other as profitable Uses."

In Michigan and Wisconsin, Canada, Maine, and Pennsylvania, the lumber business is carried on upon a large scale. An instance may be given.

Perley and Pattee's saw-mill is one of nine situated at the Chaudière Falls of the Ottawa River, just above the city of Ottawa, the capital of the Dominion of Canada. Five of these mills are on the south side of the river and four on the north side. One, Wright and Batson's, is driven by steam.

The united production of the nine mills is about 1,500,000 feet, board measure, in twenty-four hours, running day and

Fig. 4627.



Virginian Saw-Mill (1650).

night for six months in the year. A general idea of the arrangement of one of these mills may be obtained by a description of that belonging to Messrs. Perley and Pattee, above referred to.

It is a composite stone and frame building, the main part of which is 84×112 feet, with an L 48×121 feet, and two wings, 20×122 and 20×40, respectively.

Beneath the main floor is the heavy sub-frame in which the water-wheels and their adjuncts are secured, and arranged upon the floor are two *sets* of machines.

It may be here mentioned that each of these gangs is driven by a reaction water-wheel, known technically as the *Rowe reaction-wheel*, the same being 5 feet in diameter and having an area of discharge of something over 400 square inches. The head of water is 14 feet, and the quantity unlimited. The power upon each wheel is computed to be equal to 70 horses.

The *edgers* and *butters* are driven by a direct-action central-discharge wheel. The volume of water passing to each wheel is graduated by a wicket in the chute.

The logs are obtained in the Ottawa Country at various points as far as 200 miles above the falls. At the various rapids log-slides have been made, toward which the logs are directed. The saw-mill owners have combined to improve this water-way for logs, and have expended $ 130,000 in the slides, booms, piers, and other improvements.

Perley and Pattee employ about 700 men in the *bush* (as the forest is called in Canada) and 300 spans of horses.

The logs are marked, floated down the river to a point about 30 miles above the city, are then sorted for the mills on the north and south sides of the river, respectively, and at a point above the Chaudière Falls are sorted to the separate owners and collected in the ponds, whence they pass by races to the respective mills. The ponds are formed by booms or more permanent structures. The water runs from the icy north, and never slacks except in winter. The amount "running to waste" is immense, but there is no more land around the falls to set mills upon.

About 300 men are employed in the mill-yard and in shipping.

As a precaution against fire, a large "Holley" pump is rigged in a fire-proof building in the vicinity. It is driven by an 80-horse-power water-wheel, called into action should occasion require. It delivers four $1\frac{1}{2}$-inch streams through four hose.

The capacity of the mill is from 250,000 to 300,000 feet, board measure, per 24 hours, running day and night for 6 months of the year. The mill contains two *sets* of machinery. A set consists of a *slabbing-gang*, *stock-gang*, and *Yankee-gang*, succeeded by a *double-edger* and *double-butter*. The *slabbing-gang* and *stock-gang* act consecutively upon logs over 21 inches in diameter. The *Yankee-gang* is similar to the two former, but the respective gangs are in more immediate proximity, for the sake of compactness and convenience.

The logs are drawn from the fore-bay by grapples attached to an endless chain. Being placed on the ways, each is dogged between a head and tail block on an endless chain, which advances it to the slabbing-gang. Thus they pass continuously, there being no *gigging-back*. The saws are arranged to leave a central balk of a width equal to the width of the boards to be sawed therefrom in the succeeding operation (the stock-gang). The sides of the log are ripped into boards by the slab-saws, the result being a central balk and two sets of slab-boards with wany edges. This is delivered behind the gang of saws, and another log advances to the saws.

The balk is then transferred to the *stock-gang*, lying upon one of its flat sides, and is ripped into boards by the gang of saws.

The work on the *Yankee-gang* is similar, but, the logs being lighter, the gangs and ways are placed nearer to each other.

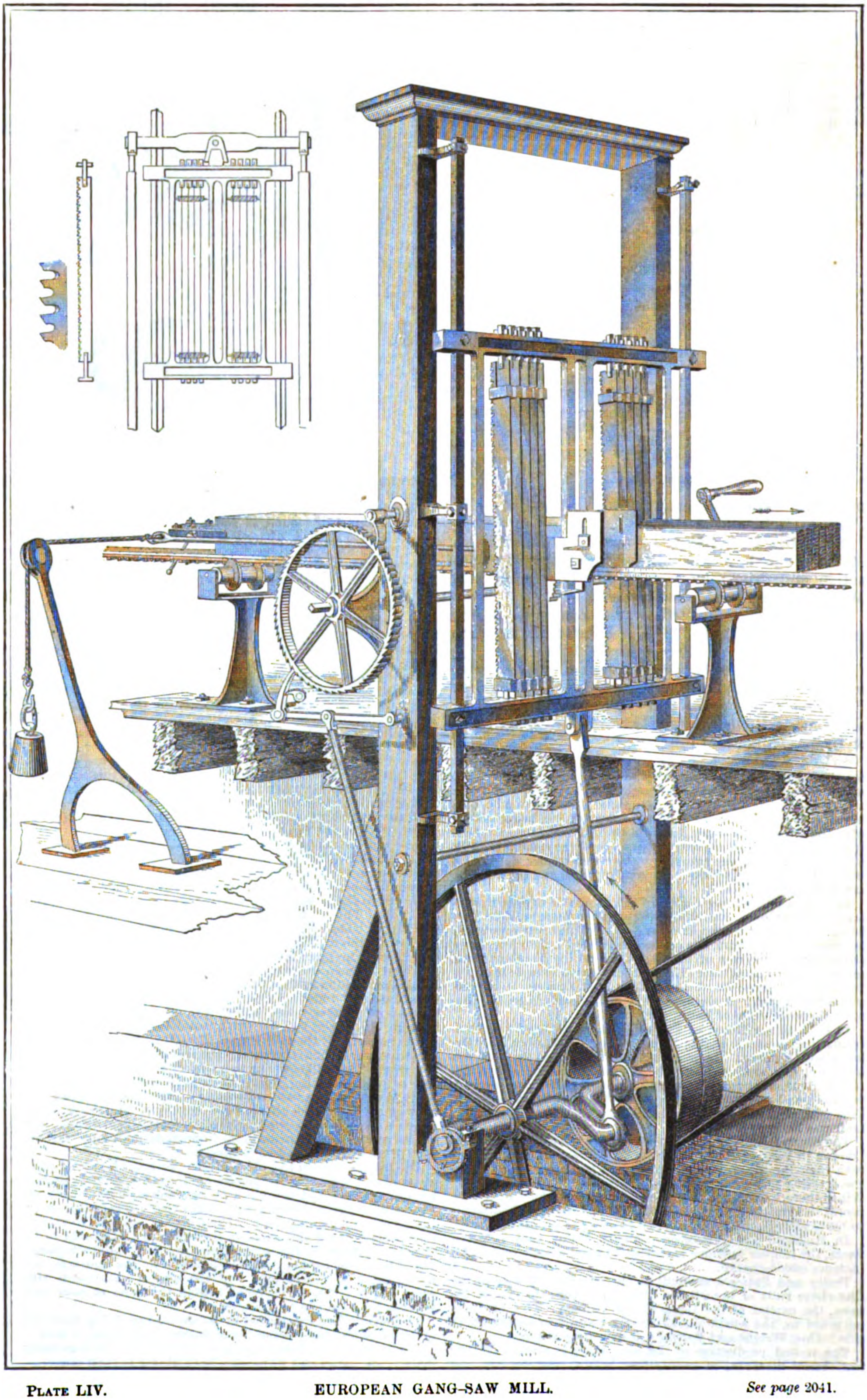


PLATE LIV. EUROPEAN GANG-SAW MILL. *See page* 2041.

The slab boards or wany stuff from the sides of the log are then taken to the double-edging machine, which has two saws, one being permanent and the other adjustable on its mandrel by means of a lever, the saw moving on a spline in the usual manner. This adjustability is for the purpose of edging boards of varying width. The boards are then lifted on to a double-butting machine, which squares the ends and brings them to a uniform length, 12, 14, 16, etc., as the case may be. Logs are cut 13 feet long for 12-feet lumber, and the mill works for a while on 16-feet and then on 12-feet stuff.

The double-butting machine has a pair of endless chains traveling in parallel planes, and having dogs at equal and coincident distances. The board is advanced by them to the two saws, and the ends are butted simultaneously.

The slabbing-saws are of No. 9 gage, and 5, 6½, or 7 feet long.

The stock-saws are No. 11 gage, and 4½ feet long.

The gage is the Stub's wire-gage.

Four hundred saws are used or in reserve, and eight men are employed in gumming, swaging the points, and filing.

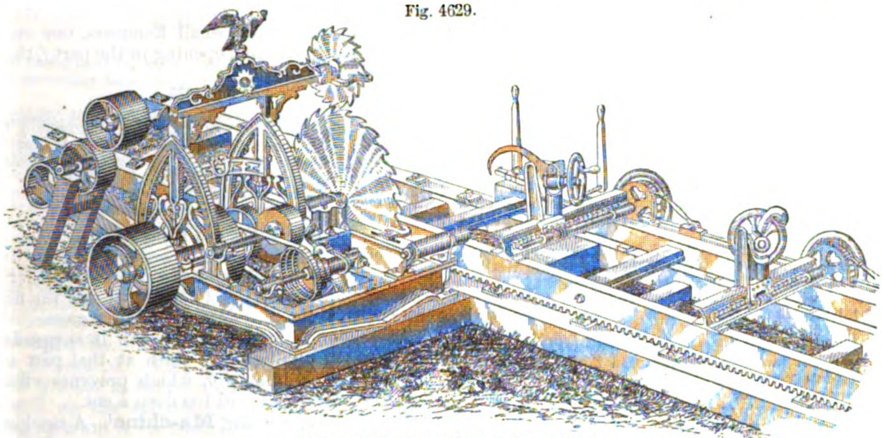
The edges of the slabs are worked into sash, blind, and door stuff, and the refuse ground up in a machine to chips, which are passed with the sawdust into the river. The authorities do not allow larger stuff to be thrown into the river, as it tends to obstruct navigation. In some mills, the pieces obtained by butting the boards are sold to be worked into matches.

The Basin Mill at Orono, Maine, is 440 feet long, 66 feet wide, has 4 gang-saws, 5 single saws, 2 circular saws, 5 lath-machines, 1 shingle and 1 clapboard machine. It saws daily 200,000 feet of long lumber, 200,000 laths, 10,000 shingles, and 4,000 clapboards, and by requirement of law burns up about 120 cords of waste wood each day.

Plate LIV. represents a European gang-saw mill.

For many centuries none but the reciprocating saws were used, and it was only during the latter half of the last century that the circular saw was used for its present purpose. This guarded expression is adopted because circular saws or disks have been used for many centuries in lathes and lapidary work. Miller's English patent of 1777 describes the circular saw, and such were made at the commencement of the century by General Sir Samuel Bentham for the British Admiralty. At present the circular-saw mill is the favorite in the woods, where the location is to be occasionally changed to comport with the supply of logs. Circular saws of very large diameter are also used in some of the great mills on the Mississippi. See also CIRCULAR SAW.

Fig. 4629.



Lane and Bodley's Circular-Saw Mill.

Saw-mill Dog. A device for holding logs on the carriage while being sawed.

Fig. 4629 has a swivel joint to permit the point to be turned in any direction.

Fig. 4629.

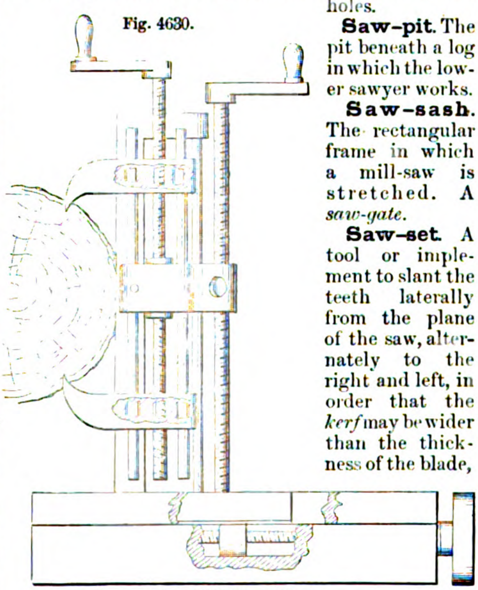
Saw-Mill Dog.

Fig. 4630 has an arrangement of two dogs that hold the log while it is being sawed, and are adjustable by means of a screw passing through the dog-heads. Two parallel rods also pass through the dog-heads to keep them firmly in position, and all turn or swing upon an upright rod passing through a swinging head, and are again adjusted by a screw-rod passing through the swinging head and bearing on the top of the head-block.

Saw-mill Gate. See SAW-GATE.

Saw-pad. A contrivance for conducting the web of a compass-saw or lock-saw in cutting out small holes.

Fig. 4630.



Saw-Mill Head-Block.

Saw-pit. The pit beneath a log in which the lower sawyer works.

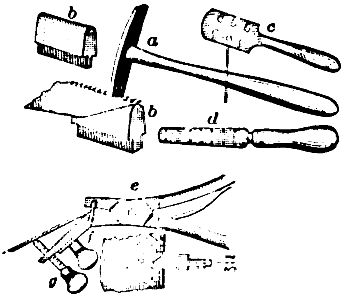
Saw-sash. The rectangular frame in which a mill-saw is stretched. A *saw-gate*.

Saw-set. A tool or implement to slant the teeth laterally from the plane of the saw, alternately to the right and left, in order that the *kerf* may be wider than the thickness of the blade, and friction be reduced. In some cases, the edge of the tooth is spread to widen its cut, instead of bending it laterally.

"Green wood fills the intervals between the teeth of the saw with sawdust, rendering its edge uniform and inert; it is for this reason that the teeth are made to project right and left in turns, so that the sawdust is discharged." — PLINY, A. D. 79.

The saw-maker generally employs a small hammer *a*, the saw being laid nearly flat, with its teeth along the ridge of a rounded edged anvil or stake *b b* held in the tail vise; the angle is in great measure determined by the curve of the stake, which is,

Fig. 4631.



Saw-Sets.

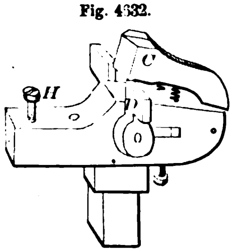
for fine-toothed saws, considerably pointed. Half the teeth having been bent, the saw is turned end for end, and the intermediate teeth similarly treated.

The set *c d* is commonly employed by the users of saws, requiring less skill to give the proper inclination to the teeth. *c* is used for large, and *d* for small saws. It consists of a narrow blade of steel, with notches of various widths, to accommodate different thicknesses of blades. The saw is held between clamps, the alternate teeth inserted a little way into the notch which they most nearly fit, and bent over to the proper angle by pressing the handle of the tool; the operation is then repeated on the intermediate teeth.

Sometimes saw-set pliers *e* are used. These require two adjustments: one for setting the jaws to the thickness of the teeth, which is effected by a stop held by the thumb-screw *f*; and the other for determining the angle to which the teeth shall be bent, which is regulated by the thumb-screw *g*.

Fig. 4632 is a form to be stuck in a hole on the work-bench. The punch *C* is pivoted to the stock, and is struck by a hammer. The gage *D*, against which the points of the teeth rest, graduates the position of the saw in accordance with the length of the teeth and in relation to the hammer. The blade rests on *H*, whose vertical adjustment determines the degree of *set*.

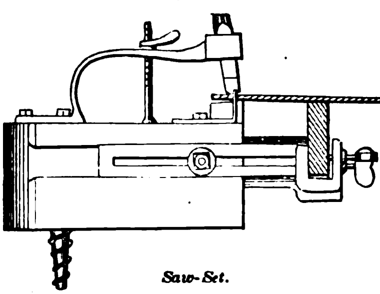
Fig. 4632.



Saw-Set.

Fig 4633 is another form of bench implement, in which the punch is placed in a socket of the adjustable spring. The saw-rest has an inclined lower side, and the brackets vary in elevation to suit, so that the rest can be moved endways to alter its elevation and the set of the saw, such movement not destroying the horizontality of the upper edge of the rest.

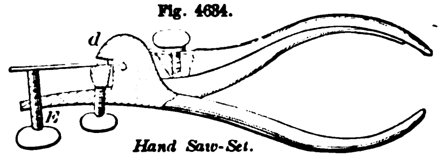
Fig. 4633.



Saw-Set.

Fig. 4634 is a hand-tool for small saws. The blades rest on *E*, and the teeth are driven by the jaw *d* upon the anvil-block.

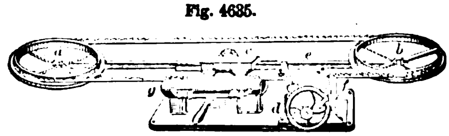
Fig. 4634.



Hand Saw-Set.

Saw Set'ting and Fil'ing Ma-chine'. The machine (Fig. 4635) for setting and filing band-saws has two flanged rotatable disks *a b* pivoted on the ends of adjustable arms passing through a clamp-piece *c*; the saw is slipped over the disks, and kept tense by extending and clamping the arms. Turning the hand-wheel *d* actuates the pawl *e*, advancing the saw the distance of one tooth at a time; the same movement causes two small hammers, one on each side of the longitudinal opening in the part *f*, through

Fig. 4635.



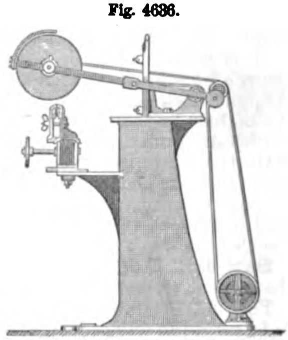
Saw Setting and Filing Machine.

which the saw passes, to strike a tooth on either side, alternately bending one to the right and the next to the left to a distance determined by a gage.

At proper intervals, the motion is suspended for the purpose of filing the teeth at that part of the saw within the clamp *g*, which prevents vibration and also serves to avoid too deep a cut.

Saw-sharp'en-ing Ma-chine'. A machine for grinding, filing, or swaging teeth of saws.

Fig. 4636.



Saw-Sharpening Machine.

In Fig. 4636, a disk of consolidated emery is employed. This is journaled on a counterbalanced arm, so as to be presented to the teeth at any required angle, and rotated by band and pulley. The saw is held by a vise with wooden jaws, clamped to the table. For sharpening circular saws, this is removed and replaced by another of different form. See also SAW-GRINDING MACHINE.

The angles at the points of saw-teeth are in general more acute in proportion to the softness of the material to be operated on, varying from 90° for metals and very hard woods to 60° or less for soft woods. To insure the action of each tooth, their points must be in the same straight line (in rectilinear saws), and for this purpose they are *topped* by laying the file, without its handle, flatwise upon their points, and reducing them to the same level by a few strokes of the tool.

More force is applied to the file in sharpening the teeth near the ends of the saw than at the middle, where they are more worn.

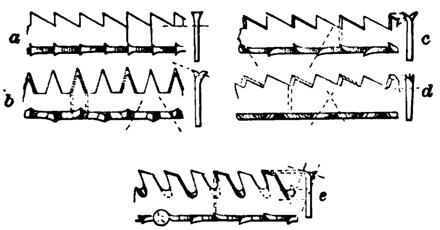
There are five different methods usually employed, depending on the character of the teeth.

The first (Fig. 4637) is applicable to the smith's frame-saw, the teeth of which have no set. The saw being held in a vise, face upward, the teeth are lightly hammered, by which they are slightly spread or upset and reduced to the same general level. The file is then applied, being held so as to form a right angle, both vertically and horizontally, with the saw-blade.

2. Peg, M, and mill-saw teeth in general, are sharpened, as shown at *b*, by applying the file to the faces of the teeth in the

direction indicated by the dotted line; several of the teeth are thus treated, operating from one side of the saw; the workman then operates from the other side, applying the file to the alternate faces, which have been left untouched, in diametrically opposite direction; this process is continued a few teeth

Fig. 4637.



Saw-Teeth.

at a time throughout the entire length of the saw, after which the two remaining faces of each tooth are filed in a similar way.

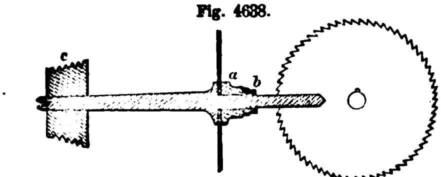
3. Hand-saw and other teeth, having angles of 60°, are sharpened by first filing the oblique faces until they coincide with one dotted line, next the backs of the same, then the other oblique faces and their backs.

4. Wood-pruning saws *d*, which are made thicker on the face than at the back, are sharpened by a triangular file applied very obliquely in a horizontal direction, sometimes at an angle exceeding 45°, as shown by the oblique lines.

5. In sharpening gullet or brier teeth *e*, the gullets are first filed with a round-edged file, somewhat smaller than the gullet, which gives a concave face to the tooth; it is then employed on the back of the preceding tooth; the top being filed last with the flat side of the file. The *setting* (see SAW-SET) is afterward performed.

Saw-spin'dle. The shaft upon which a circular saw is secured. This is ordinarily effected by means of a collar *a*, between which and the flat face of a swell on the spindle the saw is clamped by screwing up a nut *b*. A steady pin, passing through

Fig. 4638.



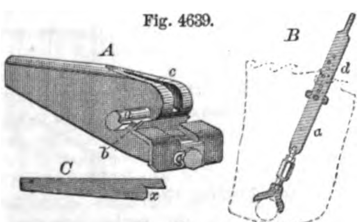
Saw-Spindle.

the saw and into the spindle, prevents slip and vibration. Rotation is imparted by a cone-pulley having a series of grooves for receiving a circular band, enabling it to be run at different velocities. See also SAW-ARBOR.

Saw-swage. A form of punch or striker by which the end of a saw-tooth is flattened to give it width and *set*.

The swage *A* has a movable rod *a* having a tooth *b* by which the points of the saw-teeth are spread

Fig. 4639.



Saw-Swages.

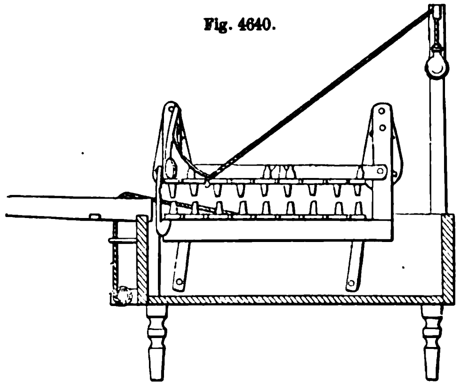
out previous to filing; for swaging and filing they are inserted within the notch *c*.

B. The split end of the adjustable bar *a* is placed on the saw-collar; the ends of the teeth are successively inserted in the notched piece *d* and swaged by a tap with the hammer.

C. The saw-tooth is inserted in the opening *x* and slightly raised by a blow; it is afterward filed to the proper hight.

Saw-tem'per-ing Ma-chine'. One for holding a saw-blade to prevent buckling when plunged into the bath. The studded and perforated plates

Fig. 4640.

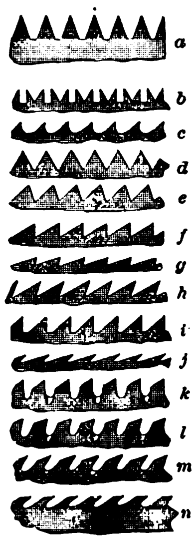


Saw-Plate Tempering-Machine.

are adjustable in distance from each other, and the studs impinge upon the opposite sides of the plate, while the same is lowered into the bath in a horizontal position to insure all parts entering the oil at the same time. See TEMPERING.

Saw-tooth. Saw-teeth are generally cut out by the fly-press. Those of the forms *d* to *h* (Fig. 4641) require but one punch, the sides of which meet at an angle of 60°. Two studs are used to direct the edge of the saw-blade to the punch, the required angle depending on the pitch or inclination of the teeth; and an adjustable stop determines the *space* or interval from tooth to tooth by catching against the side of the last tooth previously made. Gullet-teeth and the other kinds shown require punches corresponding to their peculiar shapes and sizes.

Fig. 4641.



Teeth of Saws.

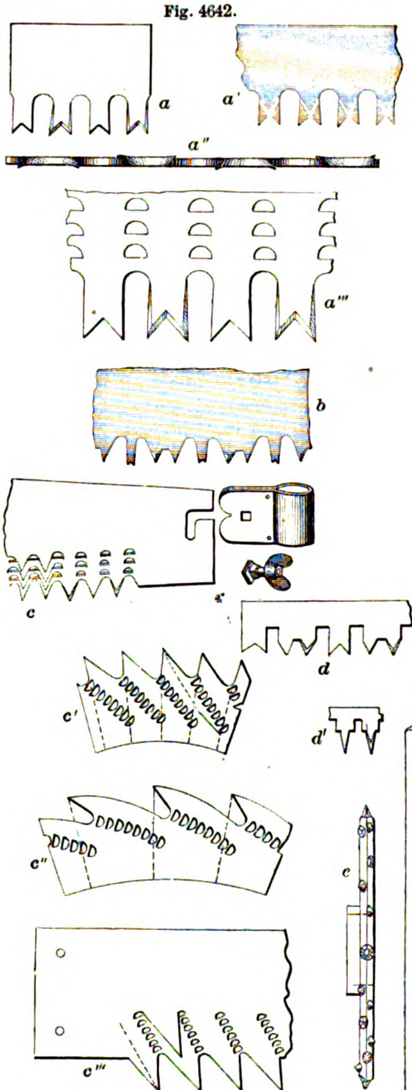
After the formation of the teeth, the blade is ground upon a grindstone of considerable diameter, and (in the case of straight saws) principally cross-ways, so that it may be thicker at front than at back.

When, by means of hammering, the blade has acquired a uniform elasticity, the teeth are sharpened with a file and *set*, that is, bent to the right and left alternately.

The word *pitch* (preferably *rake*) is employed to designate the inclination of the face of the tooth, and not the distance from tooth to tooth, as in gearing. The distance between the teeth is expressed in narrow-spaced saws by the number of *points to the inch;* when the distance between them is ½ inch or more, the saw is said to be of ½-inch, ⅝-inch, etc., *space*.

Fig. 4641 shows various forms of saw-teeth: —
a, peg-tooth or fleam-tooth.
b, M-tooth.
c, half-moon tooth.
d, cross-cutting tooth.
e, *slight pitch* or cross-cutting tooth, generally used in small saws; the pitch exceeds that of the former by about 15°.
f, hand-saw, or *ordinary pitch* tooth
g, tooth having the cutting-face *set forward* at an angle of 15°, used in mill-saws for soft wood.
h, tooth used in some circular saws; also occasionally for pit-saws, cross-cut saws, and saws for cutting soft stone.
i, shouldered tooth, employed in some rectilinear saws.
j, a similar tooth, having greater pitch; used in circular saws.
k l m n, gullet or brier teeth: the first is better adapted for cross-cutting and for hard woods, such as mahogany; the two next for pit and mill saws; and the last for ripping and for soft woods.

Fig. 4642.



Saw-Teeth.

In Boynton's saw (*a a' a''*, Fig. 4642), the teeth are all clearers, as well as cutters; the cutting-edges of the teeth are alternately on each side of the blade, and they are set alternately to the right and left.
a''' is Boynton's perforated saw.
Hoe's cross-cut saw *b* has double cutting-teeth, their cutting-edges alternating, and slender clearing-teeth interposed between each pair of cutters, as shown in the figure.

Emerson's saws (*c c' c'' c'''*, Fig. 4642) have series of semi-circular openings in the blade, back of the gums. These serve to prevent a crack between the teeth from extending farther in case it should occur, and also obviate the necessity of removing much metal with the file in the process of gumming.

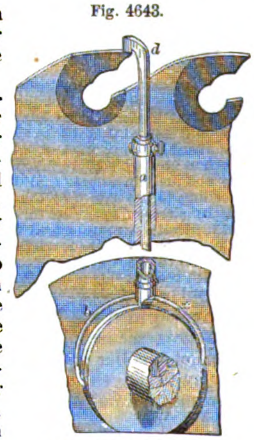
Lippincott's cross-cut saw *d d'* has slots or indentations having parallel sides, and extending into the blade below the root or termination of the inclined side of the teeth, for the purpose of serving as a guide in dressing the saw with a file, so as to preserve the original shape and relative distance apart of the saw-teeth, and enable it to be kept in order without gumming.

Drake's stone-cutting saw *e* has diamond points, constituting or affixed to the teeth. The illustration shows an elevation of a circular saw on this plan. See STONE-SAW.

For insertable-teeth saws, see Fig. 4596; for varieties of teeth, see Fig. 4641.

Saw-tooth In'di-ca'tor. A device for insuring the filing or setting the teeth of circular saws to an equal distance from the center. It consists of a hollow shaft *a*, having a V-shaped point and two curved arms *b c*, which are adjusted to a groove in the saw-collar. The movable branch *d*, whose outer end has a knife-edge, is set to the proper distance from the center, and held in this position by a screw.

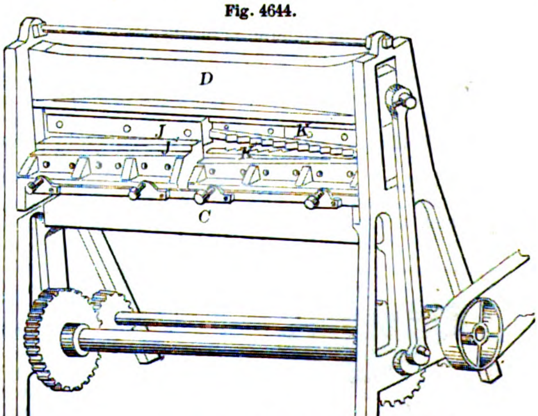
Fig. 4643.


Saw-Tooth Indicator.

The points of the teeth, if projecting beyond this distance, are filed down, or if they are too low and movable, they may be adjusted to proper hight by filing away the shoulder.

Saw-tooth'ing Ma-chine'. The machine (Fig. 4644) has a gate *D* reciprocated by an eccentric and

Fig. 4644.

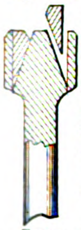


Saw-Toothing Machine.

pitman, and has at one end two plain shearing-blades *J J'*, and at the other two toothing-blades *K K'*, secured to blocks attached to the gate and frame *C*, respectively. Two saws are cut from a sin-

gle sheet at each operation, the projecting teeth of one corresponding to the interspaces of the other. The blades have a slight inclination, so that the cutting action is gradually effected. Adjustable gages are secured to the shearing and toothing ends of the gate, traveling down along with the cut plate or saw, and on the return stroke the work is released and sticking prevented.

Fig. 4645.



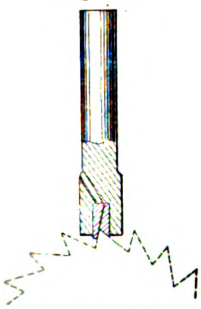
Swage for Saw-Teeth.

Saw-tooth Swage. An anvil block used in connection with a punch or wedge of some kind to flatten the edge of a saw-tooth. See also SAW-SWAGE.

Saw-tooth Up-set'ter. A tool to spread the edge of a saw-tooth. In Fig. 4646, two steel wedges are socketed in a stock, their faces adapted to form the edges of the tooth; the tool is driven upon the tooth, upsetting and displaying it to widen its kerf. See SAW-SWAGE.

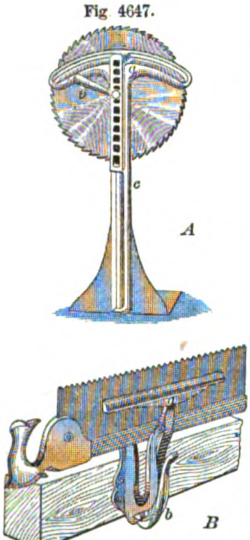
Saw-vise. A species of clamp for holding saws while filing. *A* has two jaws, one of which is seen at *a*; they are of metal lined with wood, and are closed or unclosed by turning the handle *b*. The temporary mandrel of the saw may be placed in either of the holes of

Fig. 4646.



Tool for Upsetting Saw-Teeth.

Fig. 4647.



Saw-Vises.

the perforated standard, according to the diameter of the saw, so that its periphery or edge shall be in the required proximity to the jaws of the vise.

B is secured by screws to any convenient support, and the upper part of one leg carries a fixed jaw. A movable jaw *a* is pivoted in the other leg, the lower end of its shank being in contact with a cam-lever *b*. Depressing the lever closes this jaw, which is thrown outward by a spring when the lever is depressed.

Saw-wrest. A tool to bend saw-teeth to give them a *set*. See SAW-SET.

Saw'yer's-dog. A *timber*-dog, *raft*-dog, *saw-mill* dog. An iron bar with a bent-over end, which is pointed to drive into a log.

Sax. A slate-maker's axe, for trimming slates to shape. It is 16 inches long and 2 broad, and has a point at the back for making nail-holes in the slate.

Sax'horn. (*Music.*) A wind-instrument of metal with keys and valves, and made *en suite*, that is, of various sizes and compass. See HORN, *f f f*.

Sax'o-phone. (*Music.*) A brass musical instrument with a single reed and a clarinet mouthpiece. The body of the instrument is a parabolic cone of brass provided with a set of keys. They are seven in number, the *high*, *soprano*, *alto*, *tenor*, *barytone*, *bass*, and *double-bass*. The compass of each is nearly the same. See HORN, *b*.

Sax'o-trom'ba. (*Music.*) A brass instrument with a mouthpiece and three or four cylinders. It is, like the *saxhorn* and *saxophone*, made *en suite*, but, its tube being a little more contracted, it gives a shriller sound.

Sax-tu'ba. (*Music.*) An instrument with a mouthpiece and a mechanism of three cylinders.

Say. (*Fabric.*) A thin woolen cloth. The name is obsolete, but exists in old authors.

"Thou *say*, thou serge, nay thou buckram [barracan] lord."
SHAKESPEARE.

Commoner goods for each succeeding epithet.

Say-ette'. (*Fabric.*) A mixed fabric of silk and wool. *Sagathy.*

Scab'bard. The sheath of a cutting weapon or bayonet, made of metal, wood, leather, raw hide, or paper. The first mentioned is the poorest material for the purpose. So said Captain Nolan of the English Dragoons, killed in the heroic but wanton cavalry charge at Balaklava in the Crimea.

In early times men had cases for their knives; and, associated with the earliest history, the swords are seen in their scabbards, as in the sculptures of Nimroud.

Scab'bard-plane. An abbreviation of SCALE-BOARD PLANE (which see).

Scab'bled. (*Masonry.*) Stone dressed with a fine axe, in contradistinction to plain-faced. *Scappled.*

Scab'bling-ham'mer. (*Masonry.*) A mason's tool used in reducing stone to a surface. It has two somewhat pointed ends, whereby the stone is picked. The face of the stone is left in lines, and is said to be *nigged* or *nidged*. The roughly dressed block is termed a *nigged ashlar*. It succeeds in weight and order of use the *spalling-hammer* or *kevel*.

Scaf'fold. 1. (*Building.*) A platform temporarily erected during the progress of a structure, for the support of workmen and material.

The ordinary bricklayer's scaffold consists of upright poles called *standards*, supporting the horizontal poles which are lashed thereto and called *ledgers*; these support the outer ends of the *putlogs*, the other ends resting in holes in the wall. The scaffold boards rest on the putlogs.

Square timber-scaffolding with a traveling-crane was introduced into England at the building of Euston Station of the Northwestern Railway, London, and subsequently was used at the raising of the Nelson Column, Trafalgar Square, London, and the new Houses of Parliament, Westminster. See OVERHEAD-CRANE; TRAVELING-CRANE.

The square timber-scaffolding was, however, used on the Cologne Cathedral from the commencement of its building, A. D. 1248, and probably will be for several hundred years to come on the same structure, in the rebuilding and extension which seem to be progressing simultaneously.

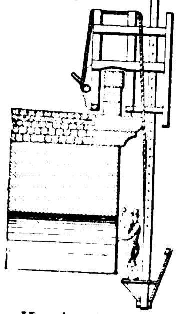
A precedent for the Nelson Column erection is found in the more complex and difficult work of raising the Egyptian Obelisk in the Plaza of St. Peter's at Rome, by Domenic Fontano, A. D. 1586.

The Arc de l'Etoile and the Eglise de la Madeleine are triumphs of the first Napoleon, on which the same style of scaffolding was used.

The tendency in the United States is to the use of the derrick-crane, whose simplicity and efficiency leave little to be desired. The extension of the Treasury Building in Washington, under the conduct of A. B. Mullet, was made by colossal stones; its monolithic character is said to be second only to the Church of St. Isaac's at St. Petersburg, Russia. The derrick-crane was used on this building, and on the Capitol Extension also.

Fig. 4648 represents a hanging scaffold contrived by Perronet for the workmen employed in dressing and pointing the masonry of the arches of the bridge at Orleans. It was suspended from a frame which straddled the parapet, and was rolled from place to

Fig 4648.



Hanging Scaffold.

place as required. The platform could be raised and lowered and held at any desired hight.

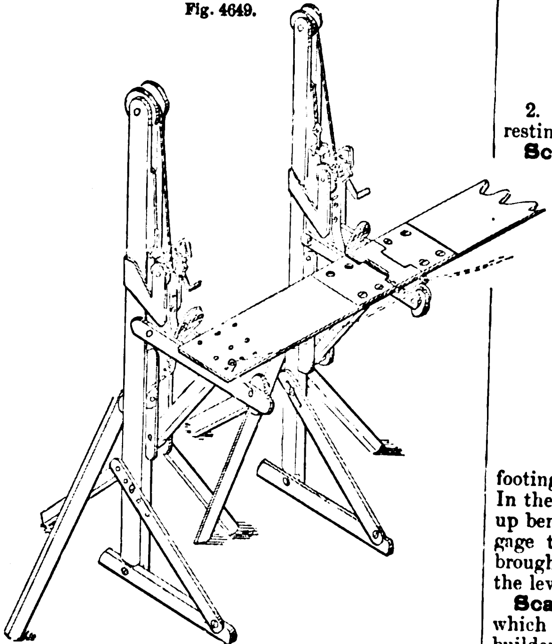
Curious turning scaffolds have been used in domes. See Cresy.

From the numerous varieties, three representative examples may be shown: —

a. Suspended from spars or upright timbers. The uprights have base supports and braces at their lower ends. The platform is connecting to sliding frames which are raised by ropes passing over sheaves at the tops of the uprights and wound by windlasses attached to the frames.

b. Propped against the building. In the example, the platform is sustained against the wall by the

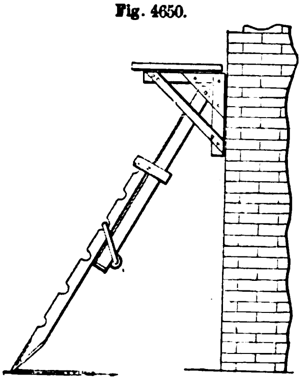
Fig. 4649.



Builders' Suspended Scaffold.

extensible props reaching from the ground to the inner angle between its horizontal and vertical parts.

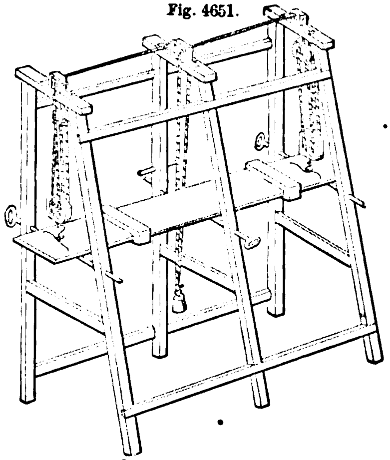
Fig. 4650.



Propped Scaffold.

c. Suspended from *trestles*. The platform is balanced by ropes passing over pulleys secured to the upper cross-pieces of the trestle-frame, the said ropes having a weight attached to one end. The platform is sustained in any fixed position by bars, which are passed through holes in the uprights of the trestle.

Fig. 4651.

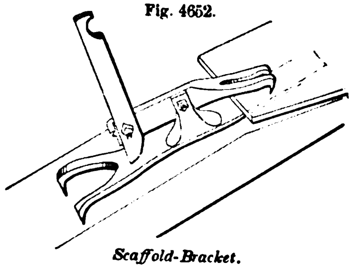


Suspended Scaffold.

2. (*Mining.*) A platform affording a temporary resting-place for an ascending or descending load.

Scaf'fold-brack'et. An implement to form a

Fig. 4652.



Scaffold-Bracket.

footing for a board to support a person in roofing. In the example, the tang of the lower plate is pushed up beneath the course of shingles, and its claws engage the rafter. The upper pivoted claw-plate is brought down upon the shingles by the vibration of the lever.

Scaf'fold-ing-pole. One of the vertical poles which support the putlogs and boards of the usual builder's scaffold.

Scagl-i-o'la. A hard, polished plaster, colored in imitation of marbles.

Scagliola is prepared from powdered gypsum mixed with isinglass, alum, and coloring matter into a paste, which is beaten on a prepared surface with fragments of marble, etc. The surface prepared for it has a rough coating of lime and hair. The colors are laid on and mixed by hand, in the manner of fresco, and in imitation of various kinds of marbles. When hardened, the surface is pumice-stoned and washed; it is polished successively by tripoli and charcoal, tripoli and oil, and oil alone.

Scald'ing. *a.* The last boiling or bucking of cloth with white soap after bleaching.

b. The soap itself.

Scale. 1. A measure divided into equal parts, usually main divisions and subdivisions; as inches and octonary fractions for carpenters' work, decimal divisions and subdivisions for chain-work, duodecimal for plotting carpenters' work which is in feet and inches. The meter and its decimal subdivisions are also sometimes employed.

Used by surveyors, architects, and draftsmen for laying down work on paper.

Among the kinds may be cited the following, but some of the names are synonyms: —

Architect's scale.
Drafting-scale.
Engineer's scale.
Gunter's scale.
Mathematical scale.
Micrometer-scale.
Offset-scale.
Pocket-scale.
Protracting-scale.
Sector-scale.
Slide-rule.
Sliding-scale.
Tailor's scale.

Some of these are considered under these heads. They are made of

Aluminium.
Beech.
Bone.
Box.
Brass.
Ebony.
German-silver.
Glass.
Horn.
Ivory.
Palladium.
Paper.
Silver.
Steel.

Scales are variously graduated, so that certain simple relations between numbers, trigonometrical lines, etc., may be ascertained by inspection. To this class belong the sector (which generally forms part of a case of mathematical instruments); Gunter's scale, and Dr. Wollaston's scale of chemical equivalents.

See list under CALCULATING AND MEASURING INSTRUMENTS.

2. A balance for weighing; in this sense the word is usually employed in the plural.

They frequently receive special names, as —

Coin-weighing machine.
Counter-scales.
Platform-scales.
Spring-balance.
Steelyard.
Weighing-machine.

Some of which are considered under their respective heads. See also BALANCE, page 213.

Weighing-machines and scales, measures, and weights have, in some form, been in use from time immemorial. Pliny states that they were invented by Phidon of Argos, or, according to Gellius, by Palamedes. Many centuries before this time, however, Abraham, 1860 B. C., *weighed* out "400 shekels of silver, current money with the merchant," to Ephron the Hittite, as payment for a piece of land, including the cave and all the standing timber in the field and the fence. This sale was made in the presence of witnesses, and is believed to be the earliest transfer of land of which record survives.

In ancient Egypt the superintendence of weights and measures belonged to the priests until the privilege was removed from them by the Romans. The scales were in the public market, and recourse was had to them by buyers and sellers. The practice still prevails to a great extent in modern Egypt. The same mode was adopted in Greece, as we read: "As the civil magistrate weighs bread in the market-place."

The scales were erected temporarily, and had the ordinary "beam suspended from a stirrup at its mid-length." The weights, like the money, were in the form of rings, as may be seen in a number of places on the Theban tombs. See COINING.

Large scales were flat wooden boards, each attached by four ropes to a ring at its respective end of a beam, which was supported by a middle ring, suspended from the standard post.

The steelyard is a Chinese invention. Wilkinson failed to find it at Thebes or Beni Hassan.

Fig. 4653.

Egyptian Scales.

It was used in Rome under the name of *statera*. See BALANCE; WEIGHING-MACHINE.

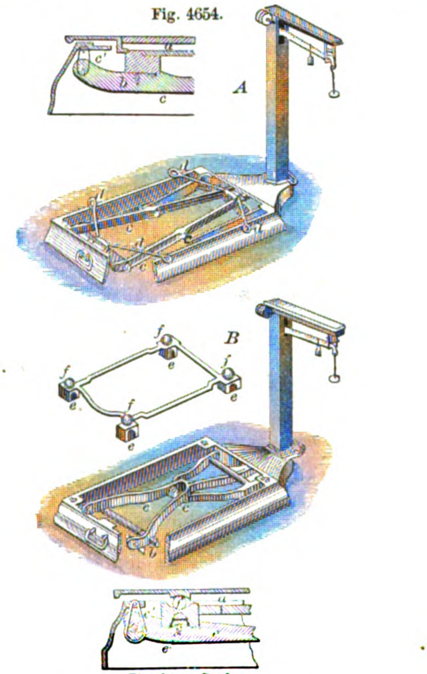
The illustration is from an ancient Egyptian papyrus in the British Museum, representing the "Ritual of the Dead" of Hennefer, superintendent of the cattle for Seti I., about 1350 B. C. The heart of the deceased is being weighed before Osiris in the Hall of Perfect Justice. It will be noticed that the balance-beam is not suspended from the middle with a series of weights, like the modern scale, nor in the manner of the *statera*, or steelyard; but it has a shifting fulcrum, by the adjustment of which the differences of the weights of the articles may be ascertained.

The *lever-scale*, on the principle of the steelyard, has for 40 years been used in the United States, for all purposes, from that of a letter-weigher to that of the weigh-lock scale. The former weighs to half-ounces, and the latter to 1,200,000 pounds. Here this principle is supreme; in England it is yet far otherwise. The ordinary balanced beam, with a number of iron weights, 112 pounds each, in one scale and the hogshead of sugar or what not in the other, was the ordinary means of weighing in the London Docks, a few years since, and may be yet.

Platform-scales were probably in use in England in 1796, one being patented in that year by Salmon.

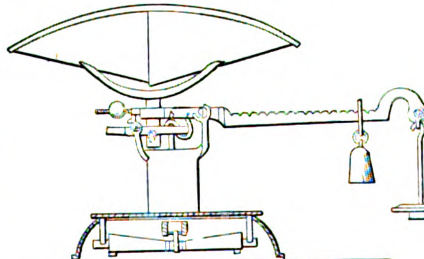
In the ordinary platform-scale (*A*, Fig. 4654), the platform *a* has a downwardly projecting steel-faced plate at each corner, which rests upon the knife-edges *b* of the levers *c*; the downward motion of the free ends of the levers is limited by loops *c'*. The platform is steadied by check-rods *d* connected to it and to the scale.

Fig. 4654.



Platform-Scales.

Fig. 4655.

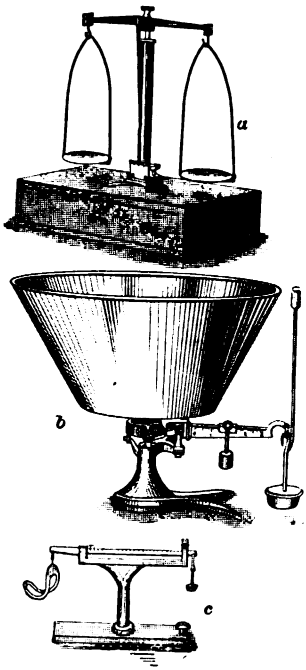


Platform and Scoop Scale.

The Howe scale *B* has adjustable bearings *e* at the corners of a framework resting upon the knife-edges *b*: balls *f* are interposed between this framework and the platform for obviating jar and friction on the knife-edges when a weight is placed on the scale and the check-rods are dispensed with. See WEIGHING-MACHINE, for the larger kinds.

Fig. 4655 is a combination of the platform and scoop scale, in which one graduated beam is connected to both the platform and scoop, so that the weight of articles placed on either is indicated on the beam, without the necessity of adjusting any part of the scale. By the proportioning of the leverages, the weight on the beam will balance much heavier articles on the platform than in the scoop.

Fig. 4656.



Counter-Scales.

Fig. 4656 shows three forms of scale for factory purposes.

a is a *yarn* scale for sizing. One *lea* or *cut* of 120 yards is used.

b is a *lap* scale to weigh quantities of cotton or wool, to be spread on the feed-apron of the carding-machine.

c is a form of scale for weighing yarn, roving, drawing slivers, etc. See also COUNTER-SCALE.

3. (*Cutlery.*) One of the side plates of iron or brass which form the main portion of a pocket-knife handle, and to which the *sides* of ivory, bone, wood, etc., are riveted.

4. A metallic plate worn instead of an epaulet by soldiers.

5. (*Metal-working.*) The film of oxide which forms on the surface of iron or other metal when heated.

6. (*Steam.*) The hard deposit which gathers in steam-boilers. See INCRUSTATION, page 1177.

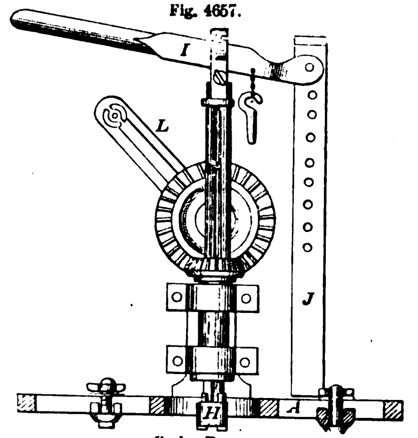
Scale′board. 1. A thin veneer of wood, used for covering the surfaces of wooden articles of furniture; as backing for pictures and looking-glasses, for making wooden boxes, and for very many other purposes.

2. (*Printing.*) A thin slip of wood, used for extending pages of type to the proper length, filling out matter, etc. See REGLET.

Scale′board-plane. (*Joinery.*) One for planing off wide chips, for fruit, hat, and bonnet boxes and other objects. It is a plane the width of a board, is loaded with weights, and dragged or driven over the surface of the board or balk, the degree of protrusion of the plane-iron determining the thickness of the *scale*. A converse arrangement is that in which the plane is fixed and the board is driven past it.

Scale-bor′er. An implement for removing the scale from boiler-tubes. Keener's (Fig. 4657) is arranged to be readily taken apart, so that it may be introduced through the man-hole. The bed-plate *A* is secured to the boiler-sheet by screw-clamps; the cutter-head *H* on the shaft *G* is rotated by bevel-gears through the medium of the crank *L*, and is advanced by the lever *I* adjustably fulcrumed in the standard *J*. Extensions may be fitted to the

Fig. 4657.



Scaler-Borer.

shaft *G*, enabling it to bore through tubes of any length.

Scale-mi-crom′e-ter. A graduated scale in the field of a telescope for measuring distances between objects. A *linear micrometer*.

Scale-pi-pette′. A tubular pipette having a graduated scale on the side, enabling various definite quantities of liquid to be taken up. The *bulb-pipette* has a swelled bulb and but a single mark.

Scal′er. A dental tool for removing salivary calculus (*tartar*) from the teeth. They have various shapes, — as chisels, scrapers, gouges, with straight, oblique, curved edges, to enable them to penetrate to deep-seated parts.

Scal′ing. 1. (*Metal-working.*) A preliminary process in the manufacture of tin plate. The rectangular plates are bent so as to stand when placed on edge, pickled in dilute muriatic acid, heated in a furnace to remove the scale, cooled, flattened on an anvil, and rolled cold. See TIN PLATE.

2. (*Nautical.*) The process of adjusting sights to the guns on shipboard was formerly so termed.

Scal′ing-bar. (*Steam.*) A rod for detaching scale in boilers.

Scal′ing-fur′nace. (*Metal-working.*) A reverberatory furnace in which plates are exposed in the process of scaling.

Scal′ing-ham′mer. (*Steam.*) A hammer with an edge peen, used in loosening scale formed in steam-boilers.

Scal′ing-lad′der. A ladder used in the assault of fortified places.

The parties represented as attacking fortified cities, in the paintings of ancient Egypt, are provided with scaling-ladders. One shown in the Memnonium has 34 steps; it was probably 48 feet long.

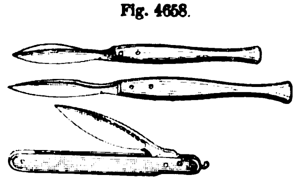
It has played a much less important part in sieges since the introduction of artillery; the use of which is continued when practicable until the rubbish detached and broken up by its fire has formed a slope, over which the storming parties may pass. Its principal modern use is to facilitate the descent into the ditch, as the counterscarp cannot be demolished by the artillery.

Scal′lop-ing-tool. (*Saddlery.*) A tool for giving an ornamental edge to leather straps.

Scal′pel. (*Surgical.*) A knife used in operations and dissections.

Fig. 4568 shows

Fig. 4658.



Scalpels.

two forms in fixed handles, and one in a sheath like a lancet.

Scalp'er. (*Surgical.*) A tool for rasping bones. A *scalping-iron.*

Scalp'ing-ir'on. (*Surgical.*) See SCALPER.

Scalp'rum. (*Surgical.*) A rasping instrument used in trepanning; or removing the roughness from the edges of bones, or the teeth.

Sca-mil'lus. (*Architecture.*) A small plinth below the bases of Ionic and Corinthian columns.

Scam-pa'vi-a. (*Vessel.*) A fast-rowing war-boat of Naples and Sicily; in 1814–15 they ranged to 150 feet, pulled by 40 sweeps or oars, each man having his bunk under his sweep. They were rigged with one huge lateen at one third from the stem; no forward bulwark or stem above deck; a long brass 6-pounder gun worked before the mast; only 2 feet above water; abaft a lateen mizzen with topsail. — ADMIRAL SMYTH.

Scant'ling. 1. (*Carpentry.*) Lumber under 5 inches square, used for studs, braces, ties, etc. It is expressed in terms of its transverse dimensions; as "a timber having a scantling of 12 × 8."

2. (*Masonry.*) The dimensions of ashlar stones.

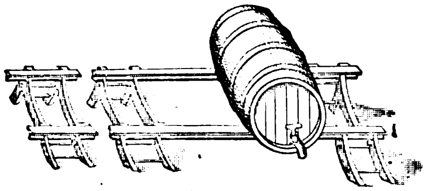
3. (*Shipbuilding.*) The transverse dimension of pieces of timber, etc. The respective sides are known as *molding* and *siding.*

Molding is depth or dimension which lies in the molding-plane.

Siding, the thickness in a direction perpendicular to the molding-plane.

4. A trestle or horse in a cellar for holding casks on tap.

Fig. 4659.



Scantling for Casks.

5. The rough draft of a work or plan.

Scape. (*Architecture.*) *a.* The shaft of a column.

b. The apophygee of a shaft.

Scape'ment. (*Horology.*) See ESCAPEMENT.

Scape-wheel. (*Horology.*) The wheel in an escapement whose teeth escape one at a time from the pallets.

Scap'ple. (*Masonry.*) To reduce a stone to a comparatively level surface by hammer-dressing without smoothing.

Scap'pling-ham'mer. (*Stone-working.*) A hammer for dressing the face of a stone.

Sca'pus. (*Architecture.*) See SCAPE.

Scarce'ment. 1. (*Mining.*) A ledge of a stratum left projecting into a mine-shaft as a footing for a ladder. A support for a pit-cistern, etc. It is so fashioned below as to form a corbel or bracket.

2. (*Building.*) A ledge or footing formed by the setting back of a wall.

Scarf. 1. (*Carpentry.*) A joint uniting two pieces of timber endwise. The ends of each are beveled off, and projections are sometimes made in the one corresponding to concavities in the other, or a corresponding cavity in each receives a joggle; the two are held together by bolts, and sometimes also by straps. Also written *scarph.*

The rods for the pumps of mines are sometimes made in wooden sections joined together by scarfs and bands. *a,* Fig. 4660, is from a pump-rod in a German mine.

It is common, but not universal, to scarf the timbers together without making a bulge at the junction. In some cases the parts are simply laid or driven together, and in others they are forced to their seats by means of a wedge. In all cases the notches of one have counterpart projections on the other face, and the surfaces fit snugly against each other without longitudinal or lateral play.

The mode of scarfing which has the appearance of a regular zigzag, when viewed in elevation, is called by the French, *traits de Jupiter* (*i*), from a fancied resemblance to forked lightning.

The timbers are secured by bolts, straps, side plates, stirrups, or other devices, according to circumstances and the nature of the strain

Fig. 4660 illustrates various modes of scarfing

a, pump-rod scarf

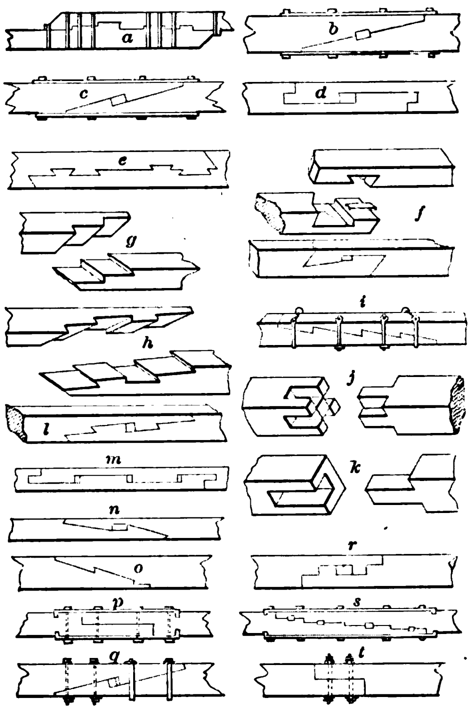
b c, scarfs with wedges and fish-plates.

d, scarf with wedge

e, scarf without wedge.

f, another form showing the two pieces apart and united.

Fig. 4660.



Scarfs.

g h, different ways of making the joint.

i, traits de Jupiter.

j k, end scarfs

l m n, square and bevel scarfs.

o, hook and butt.

p, square scarf with iron fish-plate.

q, bevel scarf with bolts.

r, hook butt scarf

s, scarf joint secured by fish-plates, bolts, and keys.

t, plain rabbeted scarf with bolts.

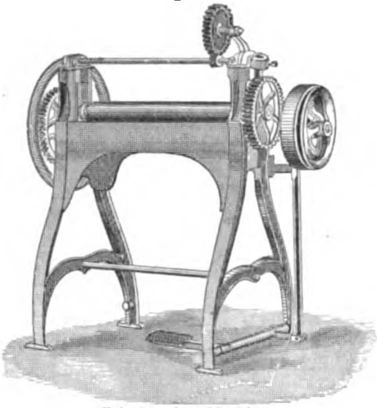
2. (*Metal-working.*) The flattened or *chamfered* edges of iron prepared for welding. The two surfaces being drawn out or cut obliquely, a larger contact is given to them, which fortifies the junction.

Scarf-bolt. (*Shipwrighting.*) One used by shipbuilders for securing the false keel.

Scarf'ing-ma-chine'. A machine for tapering or shaving the ends of leathern belts where they lap to form a joint. It has an upper or "hand-wheel shaft," having right and left screws at its ends, playing in wedges which act upon the vertically sliding

boxes of the upper or gage roller, so that the leather, which is fed with a drawing motion against the

Fig. 4661.



Belt-Scarfing Machine.

knife, may be tapered or scarfed to an edge, — *feather-edged.*

Scarf-joint. See SCARF.

Scarf-loom. A narrow-ware figure-loom of such width and capacity for variety of work as to adapt it for ornamental weaving of fabrics of moderate breadth.

Scar'i-fi-ca'tor. (*Surgery.*) *a.* An instrument used in dental surgery in separating the gum from the teeth.

Fig. 4662.

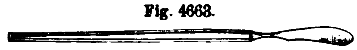
Scarificator.

b. An instrument used in cupping. It has a number of lancets, whose protrusion beyond the face of the case is adjustable. These are set in a retracted position, and simultaneously discharged by a pull on the trigger, so as to protrude through the apertures in the plane face and make a number of incisions through the skin.

c. A lancet for scarifying the skin or an engorged membrane.

Dr. Buttle's uterine scarificator and leech (Fig. 4664) is used for abstracting blood from the engorged

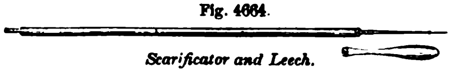
Fig. 4663.



Desmarre's Scarificator.

cervix-uteri. The handle portion, shown detached, acts as a cover for the needle when in the pocket. In use, the elastic-bulb handle is attached to the

Fig. 4664.



Scarificator and Leech.

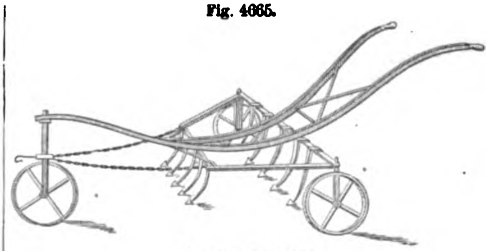
hilt end of the instrument, and, being compressed, affords a means of withdrawing blood through the hollow needle and stock.

Scar'i-fi'er. 1. (*Surgical.*) An instrument for lancing preparatory to cupping. A *scarificator.*

2. (*Agriculture.*) An agricultural implement used in Britain for stirring the soil. It is a wheeled cultivator, but the teeth are long, sharp, and comparatively thin. Its construction will be readily understood from the illustration.

Fig. 4666 has a series of cutting-disks, like colter-wheels, pivoted in standards attached to the inclined

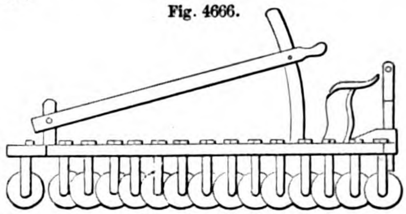
Fig. 4665.



Henry's Scarifier.

bars of a frame which is vertically adjustable upon rollers.

Fig. 4666.



Wheel-Scarificator.

Scarp. (*Fortification.*) The interior slope or wall of the ditch at the foot of the *parapet.* It is hidden from the enemy by the *glacis.* See PARAPET; ESCARP.

The scarp and counterscarp were used by the early Egyptians, and also the parallel wall in the ditch. They were originally contrived against the movable towers of assailants; but favorable banks or recesses in the ground must always have been welcome to those who fought with missiles.

Scatch. (Fr. *escache.*) (*Menage.*) A kind of bridle-bit.

Scav'en-ger-roll. (*Cotton Manufacture.*) A roller in a spinning-machine to collect loose fiber and fluff which may gather on the parts with which it is placed in contact.

Scen'o-graph. (*Drafting.*) The general view of a building, etc.

Ichnograph, the ground plan.

Orthograph, the front elevation.

Sciograph, a section, or a profile showing the interior.

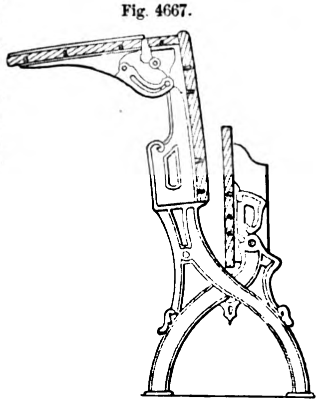
S-chis'el. A well-boring chisel whose cutting-face has a doubly curved form, like the letter "S."

Schmelze. (*Glass.*) A composition of silica, 500; minium, 800; niter, 100; potash, 100.

To 500 parts of which add: —

43 parts prismatic borax; 4 parts oxide tin; 4 parts oxide antimony; and a small portion of solution of gold in aqua regia. Heat for 12 hours in a crucible and anneal. The mixture is used for making a ruby glass for *flashing* colorless articles. See FLASHING.

Fig. 4667.



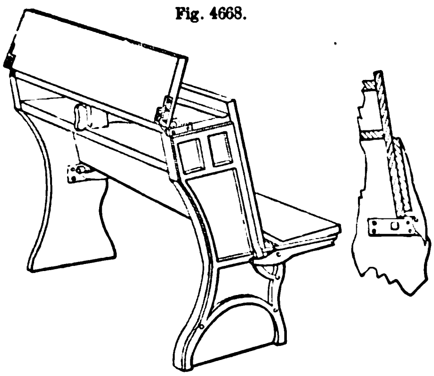
Folding School-Desk.

School-desk. One of compact form, usually having within itself a seat for one row of boys, backed by a desk for the next rear row; as in the illustrations.

In Fig. 4667, both seat and desk are folded, while the room is being swept; a convenient condition for stowage also during transportation.

Fig. 4668 is a form in which a flap of the desk only is folding, covering up the other half, which has

Fig. 4668.



School Desk and Seat.

recesses or drawers. See also DESK, Fig. 1618, page 689.

Schoon'er. (*Nautical.*) A two or three masted vessel whose sails are of the *fore-and-aft* class, *i. e.* extended on booms. The masts have but one splice, the topgallant, if any, forming part of the topmast stick.

When a schooner has none but fore-and-aft sails, she is termed a *fore-and-aft* schooner; if carrying a square foretopsail and fore-top-gallantsail, a *topsail* schooner. This latter rig, formerly common, has now become rare. Square-rigged vessels have also lower fore-and-aft sails, denominated spencers or trysails, but these are small and are brailed up to the gaff when furled, instead of being lowered like those of a schooner.

The first constructed was built by Captain Andrew Robinson in Gloucester, Mass., in 1713, and was so named from her *scooning* or sailing over the water as she was launched.

A Ballahore schooner has a foremast raking forward.

Schwan-pan. The Chinese abacus. It is very extensively employed by that people in their every-day business transactions, and enables computations to be made with great rapidity.

The method of the abacus gives an idea of position value in calculating, as in the Indian system, but was long unfruitful with the Greeks and Romans, because the idea of position was not carried into the recording of values. This first obtained general extension in the Middle Ages, especially after the zero sign had superseded the vacant space. See ABACUS.

The Indian numbers and the value from position must be more modern than the separation of the Indian and Zend, one or both, from the parent Aryan stock, for the Zend nation use the far less convenient Pehlevi numbers.

"The Arabs in Persia and on the Euphrates, as well as in Arabia, received in the ninth century the knowledge of the Indian numerical characters, through channels similar to those which had led to their acquaintance with the Indian algebra. Persians were employed at that period as revenue-collectors on the Indus; and the use of Indian numbers became general among the Arab revenue-officers, and extended to Northern Africa, opposite to the coast of Sicily."

Scim'i-ter. An Oriental form of saber. It is generally made much heavier toward the point than the saber of Western nations. *Cimeter.*

Sci'o-graph. (*Architecture.*) The profile or section of a building, to show the inside. See also SCENOGRAPH or list under 'GRAPH.

Sci-op'ti-con. A magic-lantern adapted for the exhibition of photographed objects. See MAGIC-LANTERN.

Scis'sel. (*Metal-working.*) *a.* Clippings of metallic plates.

b. Remainder of plates after planchets have been punched therefrom for coin.

Scis'sors. A cutting instrument consisting of two portions pivoted together and having blades which cut from opposite sides against an object placed between them. The *shears* is on a larger scale, but the action is similar.

The scissors of Atropos were made like sheep-shears, the bowspring at the junction of the bladed handles. Fosbroke says that "*forfices* were thus made," and were common among the Britons and Anglo-Saxons.

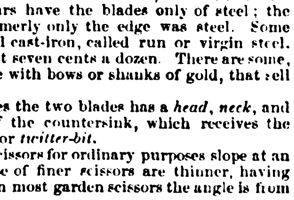
The blades with loops for the fingers and pivoted together by a rivet is of later date. Isidore, in the fifth century, refers to them as the tools of the barber and tailor.

A pair of bronze scissors, lying in a lady's work-basket, were found in an ancient tomb lately opened in Egypt. The handles were formed in the shape of a sphinx. The basket contained many articles of the toilet and work-basket, — needles, pins, combs, false hair, etc.

Scissors (*forfex*, *axicia*) and knives were used by the Roman cutlers.

In order to cut effectually, the blades, instead of being perfectly plain, as shown at *l*, and parallel to each other, are bowed and touch at two points, — the *cutting part*, which moves from hilt to point as the blades close, and the *riding part* *m*, a protuberance behind the screw-pin. The blades have a certain elasticity and touch at the shifting and constant parts as the rivet draws the two portions toward each other with a certain degree of strain.

Fig. 4669.



Scissors.

Wilkinson's patent (English) *n*, instead of a *riding part*, has a spring pin, which bears upon the shank of the blade, near the rivet, with sufficient power to force the edges into cutting contact.

Common scissors are made of shear-steel, with the blades hardened. Tailors' shears have the blades only of steel; the remainder is iron. Formerly only the edge was steel. Some scissors are made of good cast-iron, called run or virgin steel. Of these many are sold at seven cents a dozen. There are some, on the other hand, made with bows or shanks of gold, that sell for fifty dollars a pair.

The screw which unites the two blades has a *head*, *neck*, and *thread*. The bottom of the countersink, which receives the head, is called the shelf or *twitter-bit*.

The cutting-edges of scissors for ordinary purposes slope at an angle of about 40°; those of finer scissors are thinner, having an angle of about 30°; in most garden scissors the angle is from 40° to 50°.

Scissors are made from a bar of flat steel; the end for the bow is flattened, and punched with a small, round hole, which is gradually opened upon the *beak-iron* of the anvil. A shallow groove around the beak-iron serves to round the inside of the bows. The blade and joint of the scissors are made upon the flat of the anvil by means of the hammer, punch, and swages.

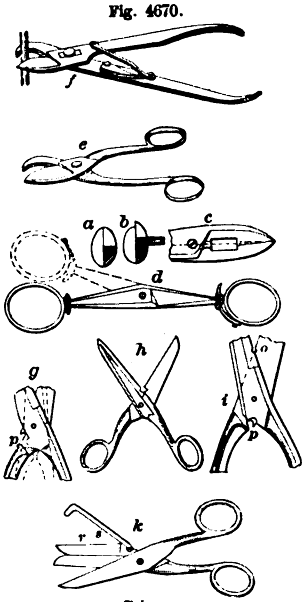
After softening, the shank and bow are improved by filing, the joint is squared, and the hole bored and fitted for the rivet. The blades are then ground, smooth-filed, burnished, matched in pairs, screwed together, and made to *walk* and *talk* well, as it is called. The blades are bound together with wire, the rivet is removed, and the blades are hardened and tempered. The wire is removed, and the blades are ground into shape and fitted together.

The bows and shanks are rubbed with fine emery and oil, the blades and shanks are fine ground, and the instrument is glazed

and polished. The blades are whetted, and certain parts are burnished.

Scissors embrace a number of varieties of construction, specially adapted for cutting fabrics, trimming plants, and for surgical and anatomical purposes.

Fig. 4670.



Scissors.

Flower and grape scissors have one of the blades made in two parts riveted together, so that after the stem is divided, it is held as in a pair of pliers. The edges are also rounded, to prevent injury to the plant. *a* shows a section of the scissors as closed, when not in use, and *b*, closed with the stem of a plant between the blades.

c. Button-hole shears are notched out near the joint-screw to enable the blades to cut at a little distance from the edge of the material.

Lamp-scissors have one blade very broad, and provided with a rim to prevent the snuff of the wick falling on the carpet.

Nail-scissors have short blades, and are made in pairs, one adapted for the left, and the other for the right hand.

d. Pocket-scissors have blades which may be locked by the point of one engaging a spring catch near the bow of the other; it is released by pressure with the nail, and turned into the position shown by the dotted lines for use.

e. The pruning scissors or shears have one broad hooked edge, which is often roughened, to prevent the twig from slipping; or they are made as at *f*, where the cutting-blade is slotted, so as to slide on the joint, moving forward as the blades are opened, and retracting so as to give a draw cut when they close. The handles, being unprovided with bows, are separated by a spring.

In *g h i* the blades have notches *v*, by which a wire or cord may be severed, and one or more (*p*) back of the joint for holding or pulling needles, wires, etc.

The scissors *k* have a knife *r* at the back of the blade, which is covered when not in use by a pivoted guard.

Surgical scissors are used in dividing soft parts which it is difficult to reach with a bistoury; also for renewing the edges of parts to be united by suture, removing excrescences, etc. They are made straight or curved, long or short, heavy or slender, to suit the form of the part to be used upon. They generally have long slender handles, and the blades are frequently curved or twisted.

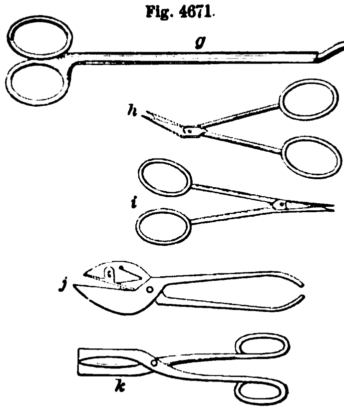
g, Dr. Emmett's double-curved scissors for operations on vesico-vaginal fistula and cleft palate. See also STAPHYLLORAPHY.

h i are dissecting-scissors.

j, flower and fruit scissors.

k, roweling-scissors for veterinary uses.

Fig. 4671.



Surgical Scissors.

Fig. 4672 shows a group of Tiemann's surgical scissors.

a, Maunoir's canalicula scissors.

b, angular strabismus scissors.

c, conjunctiva scissors, curved on the flat.

d, Althof's iridectomy scissors.

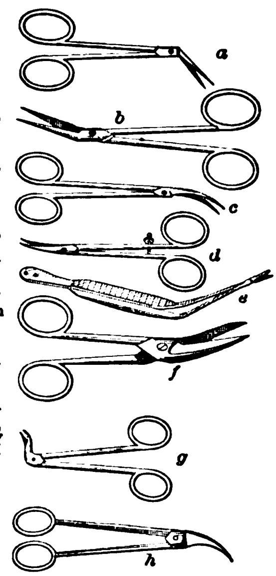
e, Simrock's scissors for operating on the tympanum and bones of the ear.

f, harelip scissors.

g, Chadwick's pterigium scissors.

h, strabismus scissors.

Fig. 4672.



Tiemann's Surgical Scissors.

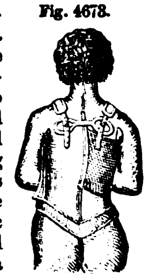
Of the numerous varieties of scissors and shears, some have peculiarities of structure, others merely differ in size and purpose.

Button-hole scissors.
Cutting-out scissors.
Dissecting-scissors.
Draper's scissors.
Flower-scissors.
Garden-scissors.
Grape-scissors.
Hair-scissors.
Horse-trimming scissors.
Lace-scissors.
Lamp-scissors.
Nail-scissors.
Paper-scissors.
Pocket-scissors.
Pruning-scissors.
Stationer's scissors.
Surgical scissors.
Tailor's scissors.

Scobs. Raspings.

Sco-li-o'sis Brace. (*Surgical.*) A brace for treating lateral curvature of the spine. Two elastic crutches are attached to the pelvic belt, and a strong upright bar relieves the spine of the weight of the trunk posteriorly. To the bar are connected two adjustable pads for the scapulæ, and just below these is a leathern band terminating in a number of strong elastic rubber webbings. This is passed around the protuberance obliquely and buckled to the pelvic belt in front, an inch or two beyond the linea alba, so as to exercise a gentle and continuous elastic pressure, at the same time rotating the ribs around their vertebral axes, to restore the spine to its normal position.

Fig. 4673.

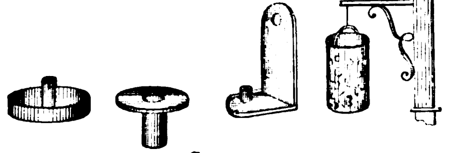


Scoliosis Brace.

Sconce. *a.* A candle-holder fixed to or projecting from a wall.

b. The tube in an ordinary candlestick in which the candle is inserted.

Fig. 4674.



Sconces.

Scoop. 1. *a.* A wooden shovel.

b. A thin metallic shovel with hollowing, capacious sides for handling grain. A grain-shovel.

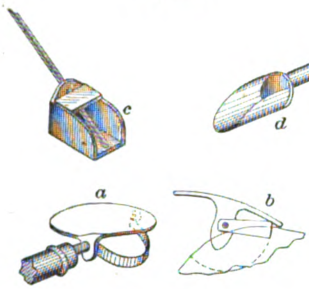
c. A familiar utensil (*d*, Fig. 4676), usually of tin-plate, for handling sugar, flour, etc.

2. A tool (*a b*) for scooping out potato-eyes from the tubers. The object is to save a part of the

Fig. 4675.

Potato-Scoop.

Fig. 4676.

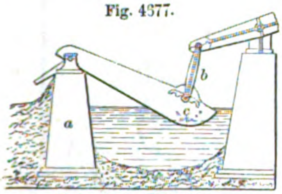


Scoops.

root for food. There are several varieties of it. A bent blade or a sharp-edged spoon will do for the work.

3. A bailing device used where the lift is moderate. Scoops are used for dipping liquors, for baling boats, for wetting sails in racing. *c* is a bailing scoop for use in ditching.

Fig. 4677.

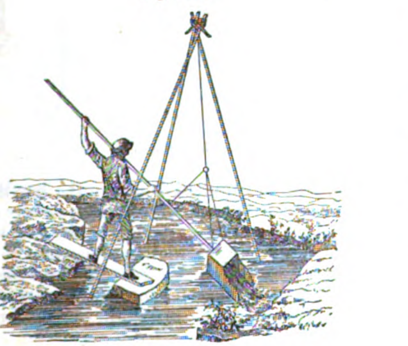


Fairbairn's Bail-Scoop.

Fairbairn's bail-scoop is worked by the single-acting Cornish engine. It is pivoted to a structure *a* on the bank, and adjustably connected by a rod *b* to the beam of the engine, so that the amount of its dip may be regulated. The other end of the engine working-beam is weighted to assist in raising the scoop when filled. Valves *c* in the bottom open when the scoop dips in the water and fall when it begins to rise. It is employed for raising water in draining, etc.

Fig. 4678 is a box shovel suspended from a tripod or pole, and used to dip water over a low bank. For-

Fig. 4678.

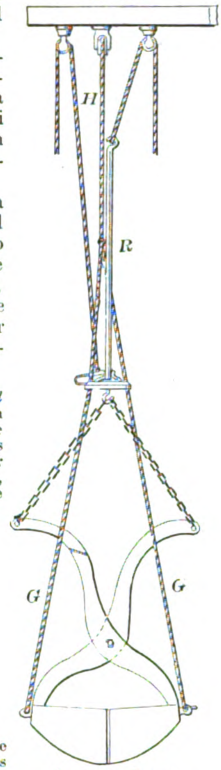


Dutch Scoop.

merly much used in Holland. Now sometimes used in bailing accumulated water from excavations for cellars.

4. (*Hydraulic Engineering.*) The bucket of a dredging-machine. That shown (Fig. 4679) is in two parts, firmly attached to their respective handles, which are pivoted. They are opened to enter the mud by hauling in the bifurcated rope *H G G*, and closed to retain and lift it by means of a rope attached to the rod *R*.

Fig. 4679.



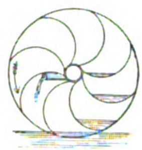
Dredging-Scoop.

5. (*Surgical.*) A spoon-shaped instrument for extracting foreign bodies, as a bullet from a wound, calculi from the bladder, objects from the meatus auditorius externus, nasal fossæ, etc.

Scoop-wheel. A form of the *tympanum* water-wheel in which the buckets are so curved as to scoop up the water into which they dip, raising a portion of the same and conducting it toward or into the axis, where it is discharged. See TYMPANUM.

Another form of the *scoop-wheel* is also adapted to raise water to an elevation equal to about half the diameter of the wheel, but delivers it at the periphery, instead of near the axis. Some of the *scoop-wheels*, used so extensively in draining the

Fig. 4680.



Scoop-Wheel.

fens of Lincolnshire, England, are made of cast-iron with wooden floats which form an angle of 45° with the horizon at the point where they deliver the water. The floats are otherwise like those of an undershot water-wheel, and move in a curved trough of masonry called the "*breasting*," into which they fit exactly, the lower end of the trough being in the drain, and the upper discharging into the chute, which carries off the water on a higher level. It is just the converse of the water-wheel, being *driven* by steam and *lifting* the water. The diameter of the wheel is so proportioned to the lift, that the surface of the water at the outfall is below its axis. The speed of the surface of the wheel is 6 feet per second; a wheel of 35 to 40 feet for a 15-feet lift.

One machine at Deeping Fen has a steam-engine of 80 horse-power, a water-wheel 28 feet in diameter, float-boards 5½ feet in depth, 5 feet wide, moving 6 feet per second, discharging 165 cubic feet of water per second. The float-boards dip 3 feet 4 inches; the average consumption of coal was 10¼ pounds per horse-power per hour. A better *duty* is now attained, probably. This engine of 80 horse-power and another of 60 take the place, but much exceed the former efficiency of 44 windmills.

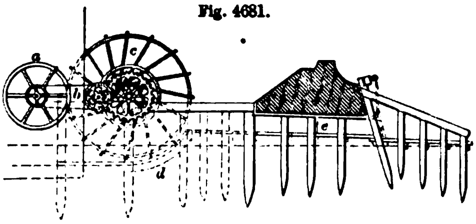
Littleport Fen has 2 steam-engines of 110 horse-power, to drain 28,000 acres; superseding 75 windmills. The *scoop-wheel* is 35 feet in diameter, and weighs 54 tons. The pinion is 4 feet in diameter, weighs 3,696 pounds, and makes 13 revolutions per minute. When the tide is high this pinion works into a cog-wheel 24 feet in diameter, having internal teeth; the float-boards on the *scoop-wheel* then move with a velocity of 212 feet per minute, and discharge in that time 3,519 cubic feet of water. When the tide is low, and so great an elevation of discharge is not required, the pinion is made to work in a cog-wheel 16 feet in diameter, and having external teeth; the float-boards then move at the rate of 318 feet per minute, and deliver 5,278 cubic feet in that time.

In that wet district it is estimated that 7,260,000 cubic feet of water are annually raised and carried off from every 1,000 acres. A 10-horse-power steam-engine can remove this in 232 hours. The rainfall is estimated at 3 inches per month, of which two thirds is to be lifted and removed artificially, which is 7,260 cubic feet to the acre. In the district referred to, this quantity was formerly increased by the natural drainings of 12,000 acres of highlands, amounting to 40,000 cubic feet per minute in a rainy season. By catch-water drains this is now intercepted and carried off by a special channel and outlet.

Glynn, C. E., England, makes the dip of his float-boards 5 feet, the axis 5 feet above the level of the outfall, the rate 6 feet per second at the circumference.

Fig. 4681 shows a *scoop-wheel* employed at Lough Foyle. The

Fig. 4681.



Scoop-Wheel at Lough Foyle (*Section of Wheel and Bank*).

engine fly-wheel *a* carries a pulley connected by a belt to the pulley *b*, whose shaft is provided with a pinion meshing with a spur-wheel on the shaft of the scoop-wheel *c*. *d* is the curved chase up which the water is driven into the chute *e*, passing through the embankment *f*, and conducted into the drain.

'Scope. A common termination for the names of instruments which make visual indications. See under the following heads: —

Æthrioscope.
Altiscope.
Anorthoscope.
Astroscope.
Auto-laryngoscope.
Auto-ophthalmoscope.
Baroscope.
Ceraunoscope.
Chromascope.
Chronoscope.
Dichroiscope.
Dipleidoscope.
Ebullioscope.
Electroscope.
Endoscope.
Engiscope.
Enorthoscope.
Floriscope.
Galvanoscope.
Gasoscope.
Gyroscope.
Helioscope.
Holoscope.
Horoscope.
Hydroscope.
Hygroscope.
Iridioscope.
Iriscope.
Kaleidoscope.
Kinescope.
Lactoscope.
Laryngoscope.
Lychnoscope.
Manoscope.
Megascope.
Meteoroscope.
Metroscope.
Microscope.
Microspectroscope.
Myriascope.
Neomonoscope.
Nepheloscope.
Ophthalmoscope.
Otoscope.
Phantascope.
Phenakistoscope.
Phonoscope.
Phosphoroscope.
Photoscope.
Polariscope.
Polemoscope.
Polyscope.
Pseudoscope.
Pyroscope.
Rheoscope.
Rhinoscope.
Rotascope.
Scotoscope.
Seismoscope.
Sideroscope.
Spectroscope.
Sphygmoscope.
Stereomonoscope.
Stereoscope.
Stethoscope.
Stomatoscope.
Stroboscope.
Teinoscope.
Telescope.
Thaumatrope.
Thermoscope.

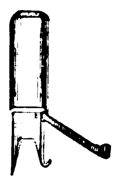
Scorch'ing. (*Metal-working.*) A *roughing out* of tools on the dry grindstone before they are hardened and tempered. So called from the great heat produced.

Score. (*Nautical.*) The groove around a block or a *dead-eye* for the strapping, *shroud*, or *backstay*. The holes in the block are for the *lanyard*.

A *heart* has one large hole with *scores* at the ends for the turns of the lanyard.

Scored Pul'ley. (*Machinery.*) A pulley grooved around its perimeter for a round band.

Fig. 4682.



1234567890

Scorer.

Scor'er. 1. A tool for marking timber. It has two scoop-shaped tools, one for straight lines, and the other adapted to revolve on a pivot for arcs or circles. Of these two forms, readable figures are made to number logs, scribe the gage-marks on barrels, etc.; as shown in the figure. A *race*-knife.

2. (*Joinery.*) An instrument employed to cut transversely the face of a board to enable it to be planed without slivering.

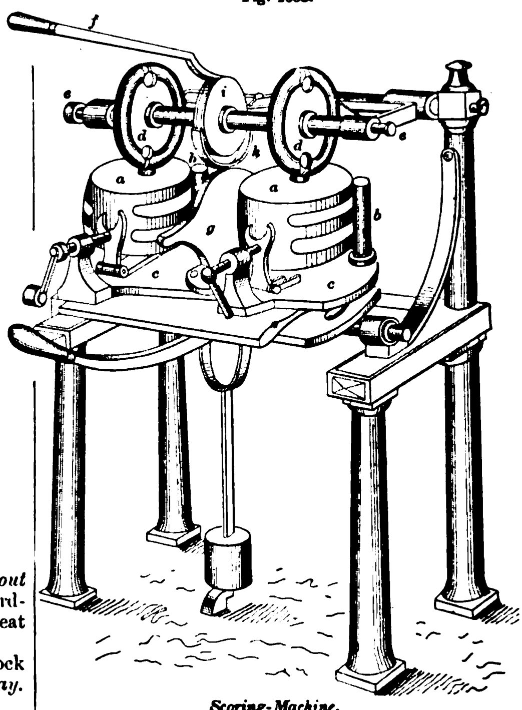
Sco'ri-a. Slaggy lava; dross thrown off from metals in fusion. See SLAG.

Sco'ri-fi'er. (*Assaying.*) A saucer of refractory clay for containing a charge of lead and the metal to be assayed. It is placed in the muffle of an assay-furnace. Also used in burning off inflammable matters from the sweepings of jeweler's shops, or to obtain the metallic portions from gold-lace, etc.

Scor'ing. (*Founding.*) The bursting or splitting of a casting, due to the strain caused by contraction. A term generally applied to cylinders and similar work, in which the core does not give way when the casting cools, and thereby causes its destruction.

Scor'ing-ma-chine'. (*Wood-working.*) A machine for cutting scores or grooves in blocks. It forms the groove around the longest diameters of the blocks for the reception of the ropes or straps by which the blocks are slung. The blocks *a* are clamped between pillars *b* on the table *c*, and exposed to the action of revolving cutters *d* above. These cutters rotate on a spindle pivoted in a swinging frame

Fig. 4683.

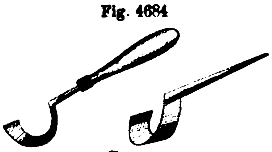


Scoring-Machine.

e, which is moved up and down by the handle *f*, being guided by a curved plate *g*, situate between the blocks. A curved plate attached to the frame *e* rests upon the guide *g*, and incloses but does not touch the pulley *i* by which the spindle is driven. The table itself is poised upon centers *k*, and is tilted up on either side so as to bring the blocks up to the cutters.

Scorp'er. A gouging-tool for working in a depression, as in hollowing bowls, butter-ladles, etc. Also used in removing wood or metal from depressed portions of carvings or chasings.

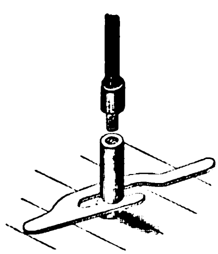
Fig. 4684



Scorper.

Scor'pi-on. A military engine for-

Fig. 4685.



Scotch.

merly used for throwing stones, etc.

Scotch. A prop, shoulder, strut, or support, as of a wheel, or of a log on inclined ground or on skids.

A slotted bar which slips upon a rod or pipe, and forms a bearing for a shoulder or collar thereon, so as to support it while a section above is being attached or detached. Used in boring and tubing wells.

Scotch Car'pet. An *ingrain*, *two* or *three ply* carpet, so named from the country where it is so extensively manufactured. Also called *Kidderminster*, from a town of that name, noted for its production. See TWO-PLY CARPET.

Scotch'man. (*Nautical.*) Stiff canvas wrapping or battening of wood around standing rigging to protect from chafing.

Sco'ti-a. (*Architecture.*) A hollow, curved molding. It occurs in the base of the Ionic column, and also in the projecting angle of the Doric corona.

Synonymous with *cavetto.*

Sco'to-graph. An instrument to assist in writing in the dark or without seeing.

Sco'to-scope. An optical instrument by which objects may be discerned in the dark.

"The scotoscope he [Mr. Reeve] gives me, and is of value; and a curious curiosity it is to discover objects in a dark room with." — PEPYS'S *Diary*, 1664.

Scots'man. (*Nautical.*) See SCOTCHMAN.

Scour'ing. 1. (*Woolen Manufacture.*) The pounding of woven woolen cloth by mallets in a trough provided with a detergent and water, in order to remove the oil and acquired dirt incident to its manufacture up to that point. As a process, scouring comes between *weaving* and *burling*. The process is sometimes termed *braying*, pounding being the action.

2. (*Metal.*) A process in the cleaning of iron-plate for tinning; or of metal in general for plating by electro-deposition or otherwise.

3. (*Hydraulics.*) The cleaning of a channel or sewer by a flush of water. See FLUSHING.

Scour'ing-ba'sin. (*Hydraulic Engineering.*) A reservoir in which tidal water is stored up to a certain level, and let out through sluices in a rapid stream for a few minutes, at low water, to scour a channel and its bar.

Scour'ing-ma-chine'. (*Woolen Manufacture.*) An apparatus consisting of two large rollers placed over a trough, through which cloth is passed after being woven, and is treated with stale urine and hog's dung.

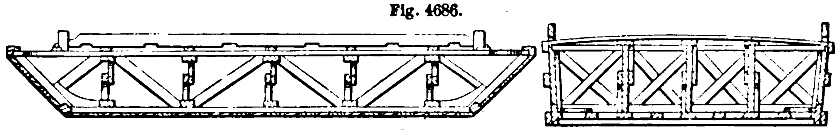
Scour'ing-stock. (*Woolen-manufacture.*) A machine like a fulling-mill, in which woven woolen cloths are pounded by heavy mallets in troughs provided with water and a detergent. The latter consists of urine, hog's dung, soda, or fuller's earth. The mallets are of oak, and oscillate on an axis, being raised by tappet-wheels acting upon their shanks. *Scouring* follows weaving, and is for the purpose of removing the oil added to the wool before *carding*, and also to rid the cloth of dirt or soil acquired in the course of manufacture. *Burling* and *fulling* succeed the scouring.

Sco'vel. (*Baking.*) A mop for cleansing ovens. A *malkin.*

Scow. (*Nautical.*) *a.* A flat-bottomed, square-ended boat, usually propelled by poles, or towed; being very cheaply and easily constructed, scows are employed in still waters for almost all purposes; they are made of all sizes, and often have decks.

b. A form of lighter or barge for carrying a heavy

Fig. 4686.



Scow.

deck-load. The example shows one strongly trussed, to prevent sagging or hogging.

Scrap. 1. The integuments that remain after the rendering of fat.

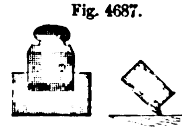
2. Broken iron, cast or wrought, for remelting or reworking.

Scrap-book. A blank-book into which cuttings from paper are pasted, or extracts written.

Scra'per. A tool or implement for removing material by a paring action. The term has many applications.

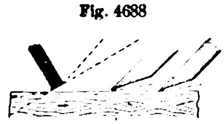
1. (*Wood-working.*) A steel plate, frequently made of a piece of saw-plate, with a square edge made sharp-angled, and burnished to raise a small

Fig. 4687.



Wood-Scrapers.

Fig. 4688

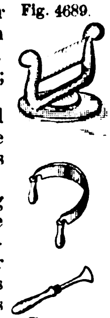


Cabinet-Maker's Scrapers.

bur or wire edge. The edge is used in giving a final dressing to wooden surfaces, veneers, etc. See Fig. 4687. It is held at an angle of 60°.

A piece of window-glass is frequently used where the wood is curly, knotty, or cross-grained, so as to plane with difficulty.

Fig. 4689.



Scrapers.

2. Allied to the former are a number of implements used in cleaning wooden surfaces of tar, paint, ink, and what not.

By the sailor, mast and deck scrapers; triangular tools on the ends of shanks.

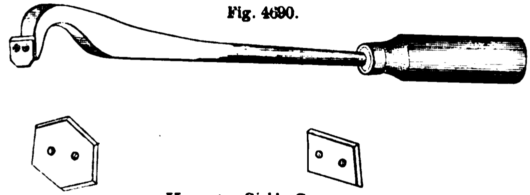
By the warehouseman or porter, bowed and with two handles, or else like the mast-scraper, to remove old directions from boxes and casks for reshipping.

3. A form of cutting-tool for taking shavings from the edge of a blade. The illustration (Fig. 4690) is one for sharpening the edges of sickle-sections for harvesters. The cutters have facets of different angles adapted to the faces of the objects from which shavings are to be cut.

4. (*Engraving.*) A three-sided cutting-tool (Fig. 4691) fluted, to make it more easy to sharpen. It is used in taking off the bur left by the etching-needle or dry-point, in obliterating lines, or working mezzotinto.

5. A large hoe for cleaning roads and streets.

Fig. 4690.



Harvester-Sickle Scraper.

6. An iron plate at a door to remove mud from the boots.

Fig. 4691.

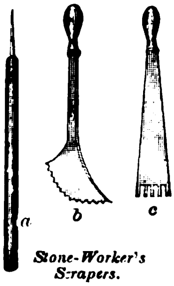
Engraver's Scraper.

7. (*Blasting.*) A spoon by which the detritus is removed from the hole made by the *jumper* or drill. See BLASTING-TOOLS.

8. A thin piece of wood shaped like a knife-blade and provided with a handle, used to scrape the sweat from horses.

9. (*Lithography.*) The board in a lithographic press whose edge is lowered on to the tympan-sheet, to bring the requisite pressure upon the paper, which lies upon the inked stone.

Fig. 4692.



Stone-Worker's Scrapers.

10. (*Stone.*) *a.* A toothed and steeled instrument for sinking flutings in marble, etc.

b. A tool used by stucco-workers.

11. A two-handled scoop (*a*, Fig. 4693), drawn by cattle or horses, and used in making and leveling roads, excavating ditches, canals, and cellars, and generally in raising and removing loosened soil or gravel to a short distance.

The usual mode of using it is to plow up the ground to be moved, and then to remove it by the scraper; if it be road-making, the soil at the sides is plowed, and then moved by the scraper to the middle of the road, where it is dumped by upsetting the scraper, to give the rounded shape to the road. It is leveled by a hoe, or by another scraper, to be described.

The Flemish use a similar implement.

Another form of scraper (*b*) is used in leveling heaps dumped from carts or the scrapers just described; it consists of an iron-shod board drawn with its edge along the ground and presented obliquely to the line of its draft, so as to give the soil a tendency to move toward the rear end. This scraper is drawn along on one side of the middle of the road and returns on the other, keeping the rear portion of the scraper toward the middle of the road, and tending to round it up so as to shed water.

A large machine, consisting of a frame supported near its midlength by an axle and a pair of wheels, and in front by a caster-wheel, was invented by Boase in England about 1830, and used in scraping mud from roads. It had a series of metallic plates, obliquely presented, and acting nearly independently, each being kept to its work by springs. It took a width of an ordinary carriage-track. (LOUDON, page 3749.)

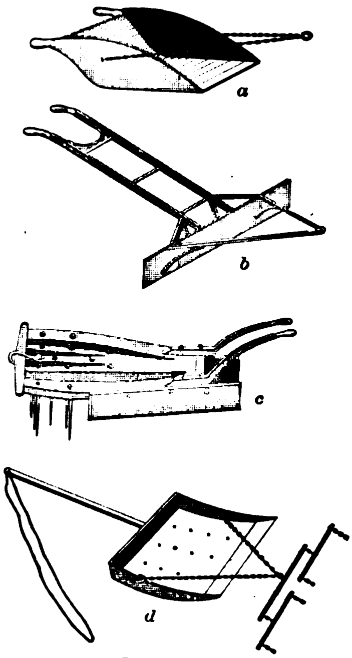
Harriott's road-scraper *c* (English) is designed to fill up the ruts of roads, and consists of a small harrow followed by a pair of converging scraper-boards. The teeth loosen the ridges of earth, gravel, or stones on the sides of the ruts, and the boards drag them into the ruts. It is managed by a man, and drawn by one or two horses.

The scraper is cited by Loudon (Ency. Agri., 1844) as an ingenious Dutch implement (*d*) for leveling soil and removing it short distances. The load, as with our own, is dumped by upsetting, but it has a long handle, recovered by a cord instead of by a pair of handles in continuation rearward of the side-boards.

The road-scraper (Fig. 4694) has an iron bottom fastened at the front, by chains *a*, to the transverse shaft *b*, and hung on a crank-shaft *c* behind.

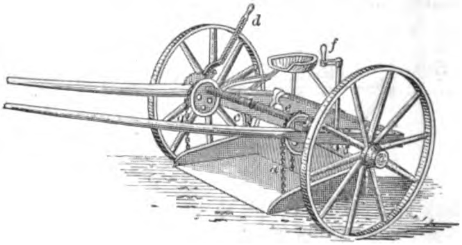
In driving along, the earth is thrown up naturally into the bottom of the scraper, and when full the whole can be raised clear of the surface and carried off to any desired point. The levers *d* and *e* enable the driver to elevate the scraper; the wheels in front, over which the chains pass, are eccentric, so that they lift like arms; and there is a ratchet-wheel and pawl at the end of the shaft the wheels are on, to hold the front edge of the scraper at any angle or desired hight. When the load is to be dumped, a vertical rod *f* is rotated, releasing the rear end of the scraper and allowing it to upset.

Fig. 4693.



Road-Scrapers.

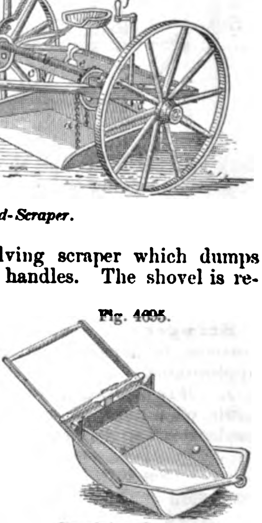
Fig. 4694.



Road-Scraper.

Fig. 4695 is a revolving scraper which dumps without throwing over handles. The shovel is released by a latch.

Fig. 4695.

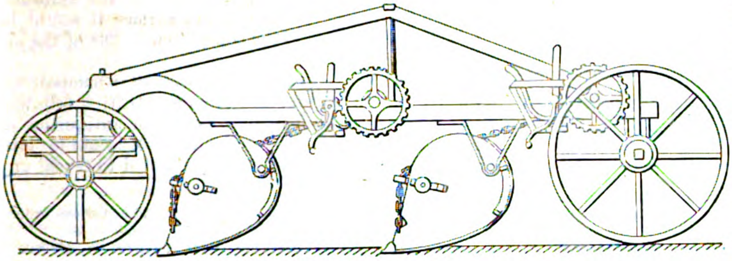


Revolving-Scraper.

In Fig. 4696, the scoops are pivoted by end gudgeons to pedestals beneath the wagon-frame, and are rotated and discharged by chains and winches operated as required by hand-cranks.

Fig. 4697 is an excavator for removing from the sides of railways earth that may have been washed down near or upon the track. The device is carried upon a car. The scoops project below it, and are operated by means of a windlass and lifting apparatus, so that the scoops can be raised and discharged when desired, the power of the locomotive operating them.

Fig. 4696.



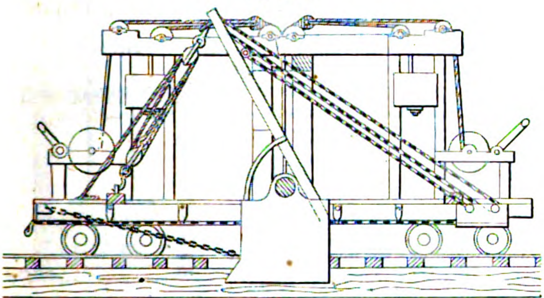
Excavator on Wagon-Frame.

Screed. (*Plastering.*) *a.* A strip of mortar 6 to 8 inches in width, and of the required thickness of the first coat, applied to the angles of a room or edge of a wall. They are laid on in parallel lines at intervals of 3 to 5 feet over the surface to be covered. When these have become sufficiently hard to withstand the pressure of a straight-edge, the interspaces between the screeds should be filled out flush with them, so as to produce a continuous and straight, even surface.

b. A wooden strip similarly placed.

Scra'per-press. (*Lithography.*) The old form of lithographic press, in which the stone and the paper for the impression, with a backing of parchment or paper, was run beneath a gate or straight-edge pressed violently upon the object passing beneath. It is now substituted by the roller-press.

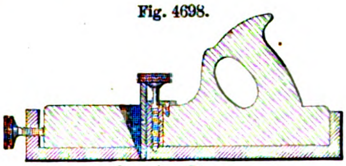
Fig. 4697.



Excavator on Railway-Car.

Scrap'ing-plane. A plane used by workers in iron, steel, brass, ivory, and hard woods. It has a vertical cutter or bit, with an edge ground at an angle of 70° or 80°, adjusted by a vertical screw, and held in place by an end screw and block.

Fig. 4698.



Scraping-Plane.

The scraping-plane for veneers, used in roughing the surface to be glued, has a notched bit, and is called a *toothing*-plane.

Scrap-ir'on. (*Founding.*) Irregular masses of iron spattered about or *run through* in pouring, are known as scraps, and all old metal which has at any time been cast, *wasters*, etc., accumulated for remelting, receives the general name of *scrap-iron*.

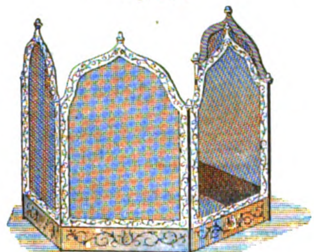
Scrap wrought-iron is piled, heated, and rerolled. It consists of cuttings, clippings, and worn-out small articles, such as horse-shoe nails, etc., which may be balled and worked over; when carefully selected and rewrought, the product possesses superior toughness and malleability.

Scratch-brush. A bundle of wires, whose protruding ends are used to clean files and for other purposes.

Scratch'er-up. A bookbinder's tool.

Screen. 1. A movable framework to keep off an excess of light or heat or cold; a separation; a partition. In ecclesiastical architecture, a screen denotes a partition of stone, wood, or metal.

Fig. 4699.



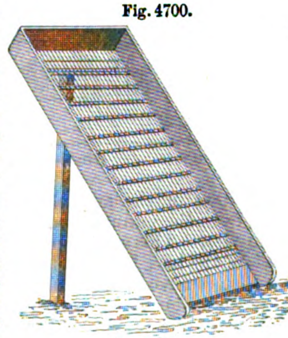
Fire-Screen.

The screen (Fig. 4699) is hinged so that it may be opened out more or less as required, or be folded up to occupy less space.

2. A sifter for coal, sand, grain, etc. The *screen*, *sifter*, *sieve*, *riddle*, vary in size, mode of application, and purpose.

a. Fig. 4700 shows the inclined screen, used in sifting sand and lime for mortar or plastering. The material is thrown a shovelful at a time on the upper part of the grating; the finer parts pass through the meshes, while those which are too large roll down the incline, the side of the screen being occasionally tapped to dislodge any which may stick.

Fig. 4700.

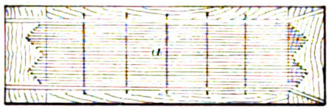


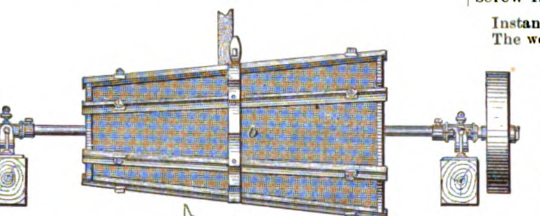
Sand-Screen.

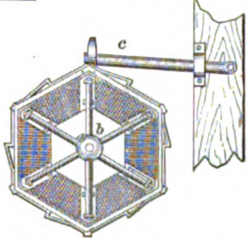
b. A wire-grated screen is employed for sorting crushed ores. In some cases it is made flat, and operated by a reciprocatory shaking movement, as in *a*, Fig. 4701; in others, the wire grating is stretched around the periphery of a drum *b*, which is caused to rotate, and is tapped by a knocker *c*, after the manner of a flour-bolter.

c. The grain is fed in at the higher end of the inclined cylinder *C* (Fig. 4702); the small grain and

Fig. 4701.







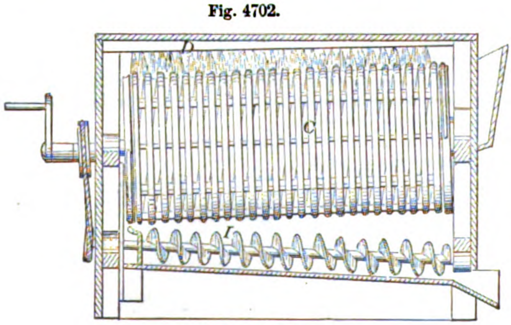
Screen for Comminuted Ores.

offal fall through and are removed by the conveyor *I* below, while the plump grain is discharged at the end into a separate spout.

Brushes *D* are employed to keep the interspaces clear.

3. (*Photography.*) That part of a camera-obscura upon which the visible image falls. It consists of a piece of plate-glass, one surface of which is finely ground, set in a wooden frame. The picture is rendered visible by

Fig. 4702.



Grain-Screen.

the reflection of the rays of light which form the picture, from the minute asperities upon the ground-glass surface. This screen, placed at right angles to the axis of the lens, is used while focusing the image, and is then removed to give place to the plate-holder.

4. (*Nautical.*) *a.* A partition made of canvas, used in place of a wooden bulkhead, where the latter would require to be frequently removed.

b. A kind of curtain, having an opening covered by a flap, placed in front of a magazine in time of action, or when the magazine is open. The cartridges in their passing-boxes are handed through the opening for distribution to the guns.

Screen Bulk'head. (*Shipwrighting.*) A bulkhead under the round-house.

Screen'ing-ma-chine'. (*Mining.*) An apparatus for sifting stamped ores, coals, etc.

Screw. 1. (*Machinery.*) A cylinder surrounded by a spiral ridge or groove, every part of which forms an equal angle with the axis of the cylinder, so that if developed on a plane surface it would be an inclined plane. It is considered as one of the six mechanical powers.

A careful examination in Lepsius, Champollion, Rosellini, Wilkinson, and other authorities, followed by a critical search among Egyptian antiquities in Dr. Abbott's and other collections (Museum of Historical Society, New York), has failed to reveal any screw in ancient Egypt.

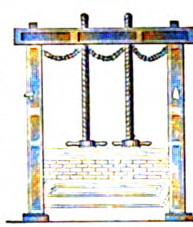
Instances of the screw in nature are found in various orders. The weapon of the *narwhal* is spiral, though it may not be immediately apparent what purpose is subserved thereby.

Some of the smaller animals are furnished with screws or gimlets, by which they penetrate the hardest woods, and even stone.

The vegetable world has its screw-like or spiral tendrils, which are mostly *right-handed*. The hop, however, is an exception, as it takes the *left-handed* whirl, *against the sun*, as it is called.

Screw-presses for clothes, wine, and oil were known to the Romans of the Empire.

Fig. 4703



Pompeian Clothes-Press.

A clothes-press, shown in the accompanying cut, was represented in a mural painting of the Chalcidium of Eumachia, at Pompeii. It has two upright screws with levers.

Vitruvius and Palladius mention the fruit-presses for wine and oil (*cochlea*).

The Archimedean water-elevator is mentioned by Diodorus Siculus, Strabo, and Vitruvius. See ARCHIMEDEAN SCREW.

The *helix* of the Greeks was a spiral for drawing ships on shore or launching them. Apparently a screw, and ascribed to Archimedes.

"And when there was great enquiry as to the best method of launching the great ship of Hiero of Syracuse into the sea, Archimedes the mechanician launched it by himself with the aid of a few persons. For having prepared a *helix* [screw], he drew this vessel, enormous as it was, down into the sea. And Archimedes was the first person who ever invented the helix — MOSCHION, *quoted in the* "*Deipnosophists*" *by* ATHENÆUS, A. D. 220.

The *differential screw* was invented by John Hunter, the celebrated surgeon. It is a combination of screws, so arranged that the motion of the object to which the device is applied is equal to the difference between the pitches of the screws. See DIFFERENTIAL SCREW.

The *endless* or *perpetual screw* is a screw without longitudinal motion, acting upon the cogs of a wheel. See WORM-WHEEL; PERPETUAL SCREW.

The parts of a screw are the *head*, *barrel*, or *stem*, *thread*, and *point*. The head has a *slit*, *nick*, or *square*.

The threads are *convex* or *external*, *concave* or *internal*.

In number they vary, as *single*, *double*, *triple*; the numbers representing the individual threads, and those above single being known as *multiplex-threaded*.

In pitch; as *coarse*, *fine*.

In shape; as *square*, *angular*, *round*.

In material; as *wooden*, *iron*, *brass*, etc.

In direction; as *left hand*, *right hand*.

In purpose; as *binding*, *set*, *wood*, *adjusting*, *attachment*, *regulating*, *feed*, *micrometer*, *propeller*, *water* (Archimedean), *endless*, *differential*.

Known by attachments; as *winged* or *thumb* screw.

Screws are *cast*, *turned*, *chased*, *swaged*, *spun*, as may suit the purpose or material.

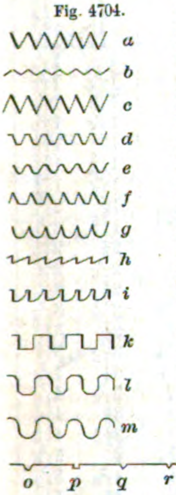
The word also gives names to devices or machines; as *screw-bolt*, *screw-jack*, *screw-plug*, *screw-press*, *screw-propeller*, *screw-tap*, etc. See *infra*.

Pappus Alexandrinus, a Greek mathematician of the fourth century, describes a method of forming screws by means of a templet of thin brass in the shape of a right-angled triangle, to be wound around the cylinder which was to be cut, tracing the spiral line of thread along the edge of this templet, and subsequently removing the metal between the threads. Directions are also given for setting off and forming the teeth of the corresponding worm-wheel.

One of the earliest attempts to obtain extreme accuracy in originating screw-threads was by Ramsden, in his dividing-engine, 1766. See DIVIDING-ENGINE.

Great attention was subsequently devoted to the subject by Maudslay, who, on entering upon his distinguished career as a mechanician, found the screws, which perform so many important functions in mill and machine work, in a very imperfect state. In his efforts to produce screws with perfectly uniform threads, he employed various modifications of the chain or band of steel; the inclined knife, the inclined plane, and all other known methods. He gave the preference to the inclined knife, applied against a cylinder revolving in the lathe, by means of a slide running upon the bar of the lathe, — a process which, besides being very rapid, reduced the mechanism to its utmost simplicity. The knife was adjusted by set-screws, and the correctness of the thread cut by it was tested first upon rods of wood, and afterward upon cylinders of the softer metals, until a screw was produced which was considered sufficiently accurate to serve as a guide-screw, in an apparatus similar in principle to the more modern screw-cutting lathe.

Fig. 4704.



Screw-Threads.

During the course of Maudslay's experiments, his friend, Mr., afterward Sir J. Barton, succeeded in originating screws of equal correctness, by employing a chain or flexible band for traversing the tool. Maudslay made many improvements in the system of taps and dies, and, in the opinion of Holtzapffel, between the years 1800 - 1810, effected nearly the whole change from the old and imperfect method to the modern, systematic, and exact method now generally practiced. He pursued the subject with more or less ardor and at great expense until his death, in 1835.

Fig. 4704 represents sections of various screw-threads. *a* has angles of about 60°, and is used for most screws made of wood, and in many made of metal and employed for uniting metals.

b, a shallow-threaded screw, having angles of nearly 90°, used for the thin tubes of telescopes.

c, a deep-threaded screw, having angles of 45°, used in mathematical and some other instruments.

d, the threads are truncated, the better to enable the bolt to resist withdrawal.

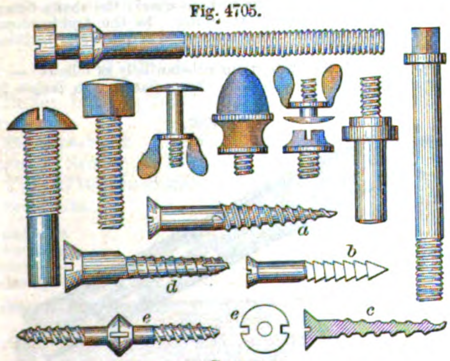
e, angular thread with rounded top and bottom, sometimes called round thread; much used in engineering.

f, angular thread, truncated at the bottom; used for joinery work.

g, rounded thread; used for the same purposes.

h, the lower sides of the threads are beveled at a comparatively small angle to the axis; the upper side is perpendicular thereto, giving a firmer hold: this is used in joinery work.

Fig. 4705.



Screws.

i, German screw, for wood; the lower side of the thread is hollowed out, leaving more of the wood to support the screw.

k, square-threaded screw; the space and thread are usually of equal width, and the depth is either equal to the width or a trifle more.

l is derived from the preceding by the truncation of its angles.

m, the angles of the former are entirely obliterated, forming a rounded thread.

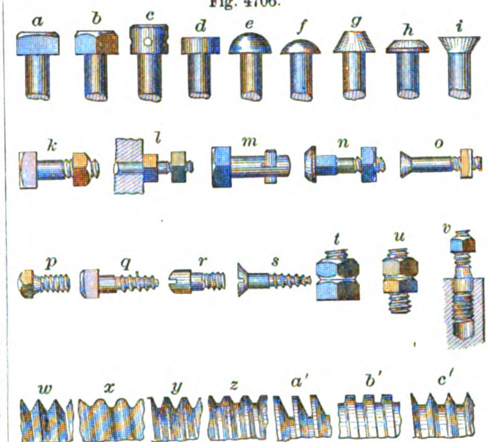
A steep-threaded screw is used for rapid turning; it has a single shallow groove, which may be of angular, square, or circular section, leaving much of the original cylinder remaining.

o to *r* are screws specially adapted to various specific purposes.

Fig. 4705 shows a cluster of screws of various forms and sizes for carriage-makers and carpenters. Of the screws at the lower part of the cut, *a b c d* have peculiar threads to lead in readily or oppose endways retraction. *e* is a dowel-screw, having a head at midlength, and right and left screws which draw two pieces together.

Fig. 4706 illustrates various forms of screw bolt-heads, technically known as, —

Fig. 4706.



Screws and Screw-Bolts.

a, square.	*f*, oval.
b, hexagon.	*g*, conical.
c, capstan.	*h*, pan.
d, cheese.	*i*, countersunk.
e, snap.	

Screw-bolts are designated as, —

k, machine.	*q*, coach-screw.
l, collar.	*r*, machine-screw.
m, cotter-bolt.	*s*, wood-screw.
n, carriage.	*t*, double-nut.
o, tire.	*u*, check-nut.
p, set-screw.	*v*, stud.

The more usual forms of screw-thread are known as, —

w, V-thread.	*a′*, ratchet.
x, English standard.	*b′*, square.
y, United States standard.	*c′*, wood-screw thread.
z, bastard.	

A watch contains forty-four screws. Little automatic machines convert steel wire into minute screws, pare down and nick their heads. They are polished, and then brought to "spring temper" by heating, which leaves them of a blue color.

Machines in a watch-factory will cut screws with 500 threads to the inch; the finest used in the watch have 250. These threads are invisible to the naked eye, and it takes 144,000 of the screws to weigh a pound. A pound of them is worth six pounds of pure gold. Lay one upon a piece of white paper, and it looks like a tiny steel filing.

Screws for the best compensation-balances are of gold. A ten-dollar piece will furnish material for 650 of them. The compensation-balance comes from the punching-room a solid piece of steel as large and heavy as a new penny, and inclosed in a rim of brass.

It is ground down, crossed out, and polished till it becomes a slender wheel, — the outer rim brass, the inner wheel and cross-bar steel. Through the double rim twenty-two holes are drilled for the screws. A chuck whirls the wheel around 4,800 times a minute, while a lad makes each hole by applying three tiny drills, one after the other. Screws of gold or brass are then put in, and the balance is completed.

In France, as long ago as 1844, soles were secured to shoes by screws.

SELLERS'S PROPORTIONS FOR

SCREW-THREADS.				NUTS.						BOLT-HEADS.					
Diameter of Screw.	Threads per Inch.	Diameter at Root of Thread.	Width of Flat.	Short Diameter Rough.	Short Diameter Finish.	Long Diameter Rough.	Long Diameter Rough.	Thickness Rough.	Thickness Finish.	Short Diameter Rough.	Short Diameter Finish.	Long Diameter Rough.	Long Diameter Rough.	Thickness Rough.	Thickness Finish.
1/4	20	.185	.0062	1/2	7/16	37/64	7/10	1/4	3/16	1/2	7/16	37/64	7/10	1/4	3/16
5/16	18	.240	.0074	19/32	17/32	11/16	27/32	5/16	1/4	19/32	17/32	11/16	27/32	19/64	1/4
3/8	16	.294	.0078	11/16	5/8	51/64	63/64	3/8	5/16	11/16	5/8	51/64	63/64	11/32	5/16
7/16	14	.344	.0089	25/32	23/32	9/10	1 7/64	7/16	3/8	25/32	23/32	9/10	1 7/64	25/64	3/8
1/2	13	.400	.0096	7/8	13/16	1	1 15/64	1/2	7/16	7/8	13/16	1	1 15/64	7/16	7/16
9/16	12	.454	.0104	31/32	29/32	1 1/8	1 23/64	9/16	1/2	31/32	29/32	1 1/8	1 23/64	31/64	1/2
5/8	11	.507	.0113	1 1/16	1	1 7/32	1 1/2	5/8	9/16	1 1/16	1	1 7/32	1 1/2	17/32	9/16
3/4	10	.620	.0125	1 1/4	1 3/16	1 7/16	1 49/64	3/4	11/16	1 1/4	1 3/16	1 7/16	1 49/64	5/8	11/16
7/8	9	.731	.0138	1 7/16	1 3/8	1 21/32	2 1/32	7/8	13/16	1 7/16	1 3/8	1 21/32	2 1/32	23/32	13/16
1	8	.837	.0156	1 5/8	1 9/16	1 7/8	2 19/64	1	15/16	1 5/8	1 9/16	1 7/8	2 19/64	13/16	15/16
1 1/8	7	.940	.0178	1 13/16	1 3/4	2 3/32	2 9/16	1 1/8	1 1/16	1 13/16	1 3/4	2 3/32	2 9/16	29/32	1 1/16
1 1/4	7	1.065	.0178	2	1 15/16	2 5/16	2 53/64	1 1/4	1 3/16	2	1 15/16	2 5/16	2 53/64	1	1 3/16
1 3/8	6	1.160	.0208	2 3/16	2 1/8	2 17/32	3 3/32	1 3/8	1 5/16	2 3/16	2 1/8	2 17/32	3 3/32	1 3/32	1 5/16
1 1/2	6	1.284	.0208	2 3/8	2 5/16	2 3/4	3 23/64	1 1/2	1 7/16	2 3/8	2 5/16	2 3/4	3 23/64	1 3/16	1 7/16
1 5/8	5 1/2	1.389	.0227	2 9/16	2 1/2	2 31/32	3 5/8	1 5/8	1 9/16	2 9/16	2 1/2	2 31/32	3 5/8	1 9/32	1 9/16
1 3/4	5	1.491	.0250	2 3/4	2 11/16	3 3/16	3 57/64	1 3/4	1 11/16	2 3/4	2 11/16	3 3/16	3 57/64	1 3/8	1 11/16
1 7/8	5	1.616	.0250	2 15/16	2 7/8	3 13/32	4 5/32	1 7/8	1 13/16	2 15/16	2 7/8	3 13/32	4 5/32	1 15/32	1 13/16
2	4 1/2	1.712	.0277	3 1/8	3 1/16	3 5/8	4 27/64	2	1 15/16	3 1/8	3 1/16	3 5/8	4 27/64	1 9/16	1 15/16
2 1/4	4 1/2	1.962	.0277	3 1/2	3 7/16	4 1/16	4 61/64	2 1/4	2 3/16	3 1/2	3 7/16	4 1/16	4 61/64	1 3/4	2 3/16
2 1/2	4	2.176	.0312	3 7/8	3 13/16	4 1/2	5 31/64	2 1/2	2 7/16	3 7/8	3 13/16	4 1/2	5 31/64	1 15/16	2 7/16
2 3/4	4	2.426	.0312	4 1/4	4 3/16	4 29/32	6	2 3/4	2 11/16	4 1/4	4 3/16	4 29/32	6	2 1/8	2 11/16
3	3 1/2	2.629	.0357	4 5/8	4 9/16	5 3/8	6 17/32	3	2 15/16	4 5/8	4 9/16	5 3/8	6 17/32	2 5/16	2 15/16
3 1/4	3 1/2	2.879	.0357	5	4 15/16	5 13/16	7 1/16	3 1/4	3 3/16	5	4 15/16	5 13/16	7 1/16	2 1/2	8 3/16
3 1/2	3 1/4	3.100	.0384	5 3/8	5 5/16	6 7/64	7 39/64	3 1/2	3 7/16	5 3/8	5 5/16	6 7/64	7 39/64	2 11/16	3 7/16
3 3/4	3	3.317	.0413	5 3/4	5 11/16	6 21/32	8 1/8	3 3/4	3 11/16	5 3/4	5 11/16	6 21/32	8 1/8	2 7/8	3 11/16
4	3	3.567	.0413	6 1/8	6 1/16	7 3/32	8 41/64	4	3 15/16	6 1/8	6 1/16	7 3/32	8 41/64	3 1/16	3 15/16
4 1/4	2 7/8	3.798	.0435	6 1/2	6 7/16	7 9/16	9 3/16	4 1/4	4 3/16	6 1/2	6 7/16	7 9/16	9 3/16	3 1/4	4 3/16
4 1/2	2 3/4	4.028	.0454	6 7/8	6 13/16	7 31/32	9 3/4	4 1/2	4 7/16	6 7/8	6 13/16	7 31/32	9 3/4	3 7/16	4 7/16
4 3/4	2 5/8	4.256	.0476	7 1/4	7 3/16	8 13/32	10 1/4	4 3/4	4 11/16	7 1/4	7 3/16	8 13/32	10 1/4	3 5/8	4 11/16
5	2 1/2	4.480	.0500	7 5/8	7 9/16	8 27/32	10 49/64	5	4 15/16	7 5/8	7 9/16	8 27/32	10 49/64	3 13/16	4 15/16
5 1/4	2 1/2	4.730	.0500	8	7 15/16	9 9/32	11 23/64	5 1/4	5 3/16	8	7 15/16	9 9/32	11 23/64	4	5 3/16
5 1/2	2 3/8	4.953	.0526	8 3/8	8 5/16	9 23/32	11 7/8	5 1/2	5 7/16	8 3/8	8 5/16	9 23/32	11 7/8	4 3/16	5 7/16
5 3/4	2 3/8	5.203	.0526	8 3/4	8 11/16	10 5/32	12 3/8	5 3/4	5 11/16	8 3/4	8 11/16	10 5/32	12 3/8	4 3/8	5 11/16
6	2 1/4	5.423	.0555	9 1/8	9 1/16	10 19/32	12 15/16	6	5 15/16	9 1/8	9 1/16	10 19/32	12 15/16	4 9/16	5 15/16

Rough nut = one and one-half diameter of bolt + 1/8.
Finished nut = one and one-half diameter of bolt + 1/16.
Rough nut = diameter of bolt.
Finished nut = diameter of bolt — 1/16.

Rough head = one and one-half diameter of bolt + 1/8.
Finished head = one and one-half diameter of bolt + 1/16.
Rough head = one-half distance between parallel sides of head.
Finished head = diameter of bolt — 1/16.

2. (*Hydraulics.*) The first screw may have been the water-screw of Archimedes, about 236 B. C.

"The Egyptians have an easy way to water the land by means of a certain engine invented by Archimedes, the Syracusan, which, from its form, is called *cochlea*." — DIODORUS SICULUS (60 B. C.).

It is believed that Archimedes designed the wheel to be moved by the current of the Nile, and it is certainly capable of being moved by a current of sufficient speed, or one deflected by wing dams to act upon the floats of the wheel.

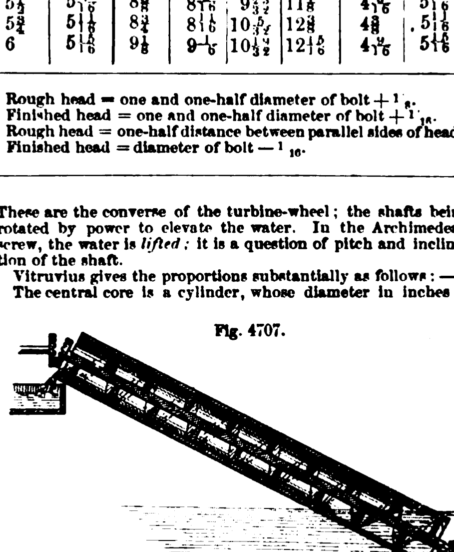
Extending through the inclined shaft is a spiral passage, which may be compared to a large tube wound around an axis. The lower end of the shaft is submerged, and the end of the spiral tube thus dips up the water as the shaft is revolved by the wheel.

If the spirally flanged shaft be revolved with sufficient speed, the pitch may be very steep, and yet raise the water, as shown under the head PUMPS, CENTRIFUGAL; but this is not the primary idea of the Archimedean water-screw, the pitch of which is slight, and the water flows naturally along the spiral canal as the shaft revolves, flowing with a rapidity proportionate to the speed, pitch, and capacity, or sectional area. It is not *forced*, as in the centrifugal pumps of Gynne, Guerick, and others. These are the converse of the turbine-wheel; the shafts being rotated by power to elevate the water. In the Archimedean screw, the water is *lifted*; it is a question of pitch and inclination of the shaft.

Vitruvius gives the proportions substantially as follows: —

The central core is a cylinder, whose diameter in inches is

Fig. 4707.



Archimedean Screw.

equal to its length in feet. Eight spiral flanges are carried around this core of such a width that the diameter of the screw is equal to $\frac{1}{4}$ of the length. The pitch is equal to the diameter. The barrel is inclined, and has pivots at the ends, which turn in gudgeons.

These proportions and forms have been variously modified. For instance, —

1 A pipe has been twisted around an axle and suitably supported in bearings, at a proper inclination.

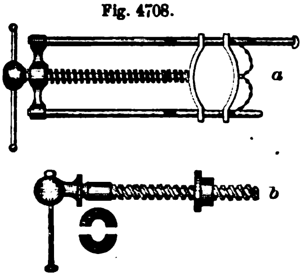
2. The number of channels has been multiplied, several distinct parallel passages winding around the central core.

3. Instead of building passages between the newel and the cylinder, a screw with one or more threads has been made to revolve in a semi-cylindrical, inclined trough

The steeper the pitch of the screw, the greater must be the inclination, as the channels must decline from the plane of the horizon, that the water may, as the screw turns, continually descend in its course.

3. (*Steam Navigation.*) A propeller with spiral wings, and having an axis parallel with the *level line* of the vessel. See SCREW-PROPELLER.

Fig. 4708.



a. Rigging-Screw; b. Bench-Screw.

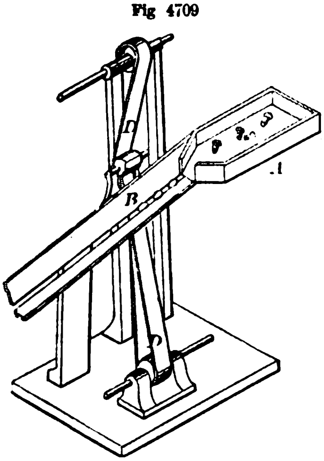
Transverse screws have been suggested or used for maneuvering.

4. A tool working by means of a screw. See SCREW-CLAMP, etc.

Screw-alley. (*Shipwrighting.*) A passage-way along the shaft of a screw-propeller, allowing access for the men who examine and attend to the bearings.

Screw-blank Feed'er. In the screw-blank feeding-apparatus (Fig. 4709), the blanks are placed in the hopper *A*. By means of an angular roller rotated by the belt *D D*, a shaking motion is imparted to the hopper and trough *B*, down which the blanks pass one by one on their way to the thread-cutting dies.

Fig 4709



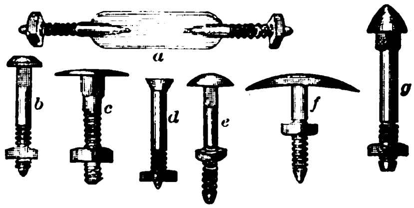
Screw-Blank Feeder.

Screw-blast Ma-chine'. (*Blower.*) A form of blowing-engine, in which the blast is driven through the cylinder by a spiral vane rotating rapidly on its axis.

Screw-bolt. One having a screw-thread on its shank. See BOLT, Fig. 768.

Fig. 4710 illustrates various carriage screw-bolts.

Fig. 4710.



Screw-Bolts.

a, axle-clip.
b, carriage.
c, step.
d, pointed tire.
e, elliptic head.
f, T-headed, or shaft.
g, cone-headed bolt.

See Fig. 768, page 822.

Screw-Threads, Bolt-Heads, and Nuts, as determined and recommended by Committee of Franklin Institute of Philadelphia, 1864.

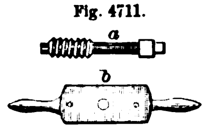
Number of Threads per inch. Angle 60°.

Diameter of Bolt.	Threads.	Diameter of Bolt.	Threads.	Diameter of Bolt.	Threads.	Diameter of Bolt.	Threads.	Diameter of Bolt.	Threads.
Ins.	No.	Ins	No.	Ins.	No.	Ins.	No.	Ins.	No
$\frac{1}{4}$	20	$\frac{3}{4}$	10	$1\frac{5}{8}$	$5\frac{1}{2}$	3	$3\frac{1}{2}$	$4\frac{3}{4}$	$2\frac{5}{8}$
$\frac{5}{16}$	18	$\frac{7}{8}$	9	$1\frac{3}{4}$	5	$3\frac{1}{4}$	$3\frac{1}{2}$	5	$2\frac{1}{2}$
$\frac{3}{8}$	16	1	8	$1\frac{7}{8}$	5	$3\frac{1}{2}$	$3\frac{1}{4}$	$5\frac{1}{4}$	$2\frac{1}{2}$
$\frac{7}{16}$	14	$1\frac{1}{8}$	7	2	$4\frac{1}{2}$	$3\frac{3}{4}$	8	$5\frac{1}{2}$	$2\frac{3}{8}$
$\frac{1}{2}$	13	$1\frac{1}{4}$	7	$2\frac{1}{4}$	$4\frac{1}{2}$	4	3	$5\frac{3}{4}$	$2\frac{3}{8}$
$\frac{9}{16}$	12	$1\frac{3}{8}$	6	$2\frac{1}{2}$	4	$4\frac{1}{4}$	$2\frac{7}{8}$	6	$2\frac{1}{4}$
$\frac{5}{8}$	11	$1\frac{1}{2}$	6	$2\frac{3}{4}$	4	$4\frac{1}{2}$	$2\frac{3}{4}$		

Screw-box. (*Wood-Working.*) A device for cutting the threads on wooden screws. It is similar in construction and operation to the screw-plate used for metallic screws, as is also the tap for cutting interior screw-threads in wood. *a* is the tap, *b* the *box*.

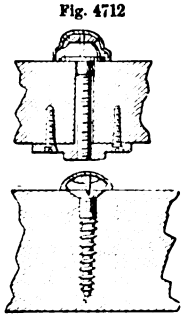
Screw-cap. 1. A cover to protect or conceal the head of a screw.

Fig. 4711.



Screw-Box.

Fig. 4712



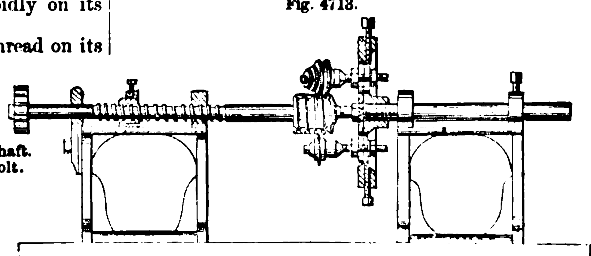
Screw-Cap.

In Fig. 4712, the cap has a small screw-stem in its center, which is screwed into the head of the main screw after the latter has been driven into the wood.

2. A cover for a fruit-jar. See FRUIT-JAR, Fig. 2131, page 920.

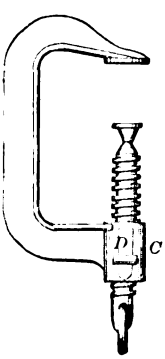
Fig. 4713 is a machine for threading screw-caps of sheet-metal. The sheet-metal cap is placed upon a threaded head upon the screw-threaded mandrel. Rotary and advancing motion being communicated to the mandrel, the cap is brought under

Fig. 4713.



Machine for Threading Screw-Caps.

Fig 4714.



Screw-Clamp.

the action of the screw-threaded roll-dies surrounding it and a thread formed thereon.

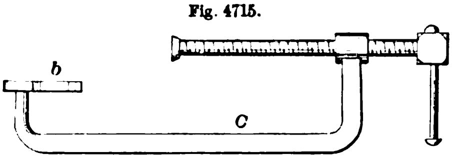
Screw-clamp. A clamp which acts by means of a screw. Different varieties are used by shipwrights for holding planking to the knees while driving the treenails, by house-carpenters, harness-makers, and other artisans.. That shown (Fig. 4714) has an expanding nut *C* having pivoted levers *D* by which it is opened out to allow the screw to be placed nearly to its position before commencing to turn it.

In Fig. 4715, the arm *C* has a serrated foot *b*, which holds firmly against the knee while the plank is pressed home by the screw.

In Fig. 4716, the fulcral screw has a free nut and the clamping screw a jam nut.

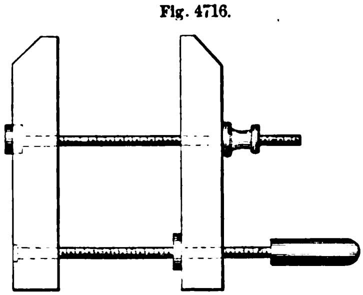
Screw-col'lar. (*Optics.*) The means of adjustment for relative distance between the front and the posterior pairs of an achromatic objective, designed to secure perfect definition with differing thickness of covering glass.

Fig. 4715.



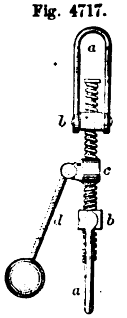
Planking-Screw.

Fig. 4716.



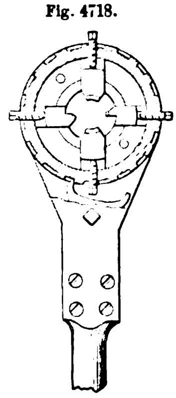
Hand-Screw Clamp.

Fig. 4717.



Screw-Coupling.

Fig. 4718.



Screw-Cutter.

Screw-coup'ling. *a.* A device for joining the ends of two vertical rods or chains and giving them any desired degree of tension. The ends are secured to the loops *a a* swiveled to the nuts *b b*. The cylindrical coupling-nut *c* has a pivoted, weighted arm *d*, which insures its verticality and serves as a spanner.

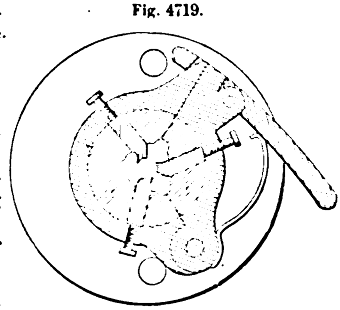
b. A screw-socket for uniting pipes or rods.

Screw-cut'ter. An implement for cutting screws. As a hand-tool it is known as a die, and the complete device as *stock and die*.

In Fig. 4718, the revolvable head has radial bearing-blocks or cutters, which are adjustable from the outside. See also SCREW-PLATE. Machines for the purpose are known as *screw-cutting lathes, screw-cutting machines, turret-lathes*, etc.

Screw-cut'ting Chuck. A lathe-chuck adapted to cut threads on rods or screw-blanks. In the example, the chuck is made in two parts, one hinged to the other. They are held together by a handle and a spring pawl.

Fig. 4719.



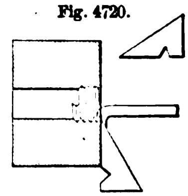
Screw-Cutting Chuck.

Screw-cut'ting Die. The cutting device in a SCREW-PLATE, SCREW-STOCK, or SCREW-CUTTING MACHINE (which see).

Screw-cut'ting En'gine. See SCREW-CUTTING MACHINE.

Screw-cut'ting Gage. A device having angles by which is determined the inclination of the point of the cutting-tool, and also the inclination of the tool when arranged in the post for cutting the thread.

Fig. 4720.



Screw-Cutting Gage.

Screw-cut'ting Lathe. A machine of this kind was invented by Besson in France as early as 1569. It embraced a guide-screw, which was caused to advance the cutting-tool at the same time that the work was rotated by means of a series of cords, pulleys, and weights. Screws of any pitch might be cut by using pulleys of different diameters, and right or left hand threads by crossing or uncrossing the belts.

It was farther improved by Hindley, a watchmaker of York, England, about 1741. It was a watchmaker's and bench instrument for many years before it had any place in the machine-shop.

Fig. 4721 illustrates Varley's screw-cutting apparatus, applicable to the hand-lathe. The mandrel *a* is surrounded by a tube on which four threads of different pitch are cut. The bar *b* carries at one end a piece *c* filed to correspond with the thread to be used as a guide, and has at the other a socket, in which is inserted a screw tool *e* corresponding to the thread to be cut. The bar *b* is held to the mandrel and the work by hand, the piece *c* being supported on the horizontal plate *d* parallel with the mandrel, and the tool *e* upon the lathe-rest *f*.

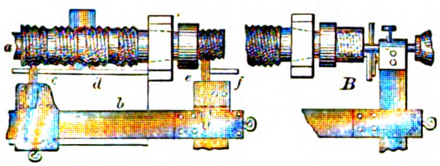
The guide *c* and screw-tool are traversed simultaneously to the left by the screw-guide, and when the tool meets the shoulder of the work, the bar is withdrawn and shifted to the right for a repetition of the cut, and so on until the screw is complete.

Beneath the tool is a screw which rubs against the lathe-rest and acts as a stop, serving to make the screw either cylindrical or conical, as the rest is placed parallel or obliquely.

For the internal screw the tool is placed parallel with the bar, as at *B*, and the cheek-screw is applied on the side toward the center, against a short bar parallel with the axis of the lathe.

Devices of this kind are not adapted for cutting accurate

Fig. 4721.

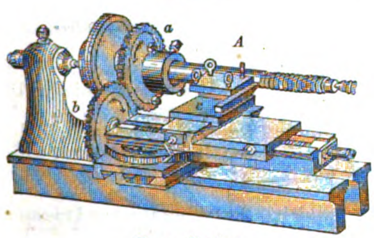


Screw-Cutting.

screws of considerable length or great diameter. For these a lathe is employed, in which the traverse of the tool is effected by a long guide-screw connected with the mandrel, which carries the work by a system of change-wheels

The most simple application of these is shown at *A*, Fig. 4722. The work is attached to the lathe-mandrel by a chuck, to which is secured a wheel *a* gearing with a wheel on the guide-screw, which moves the slide-rest *c* that carries the screw-cutting tool. The wheels *a b*, being equal, will rotate with equal velocity in opposite directions, so that the screw-thread cut will be precisely similar to that of the guide-screw, but reversed; consequently, to produce a right-handed screw, a left-handed guide-screw must be employed. To enable the screw which moves the slide-rest to produce either right or left hand screws, and to cut

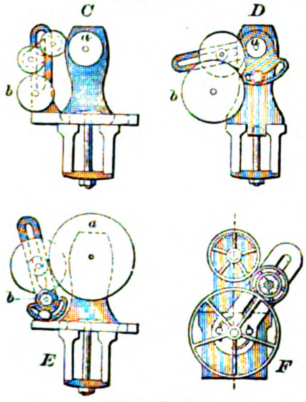
Fig. 4722.



Screw-Cutting.

threads of varying pitch, intermediate wheels, called *change-wheels*, are introduced between *a* and *b*. Thus one intermediate wheel between the two causes them to move in the same direction, cutting a thread corresponding in direction to that of the guide-screw, while the introduction of a second, causing them to move in opposite directions, makes the tool cut a reverse thread. The diameter and number of teeth in the intermediate wheels also being varied, causes a difference of velocity in the rotation of the guide-screw and mandrel, so that they do not advance with equal rapidity, and the thread cut may have a pitch of any determinate proportion, either greater or less than that of the guide-screw. For this purpose, with the better class of lathes, a large variety of change-wheels is employed, enabling threads of any size usually occurring in practice to be cut. The depth and form of the teeth are, of course, regulated by the shape of the cutting-tool

Fig. 4723.



Screw-Cutting

In order to support the axes on which the change-wheels revolve, a pedestal, supported by the bearers or a bracket at the lathe-head, is employed; these are susceptible of many modifications, three of which are illustrated at *C D E*, Fig 4723.

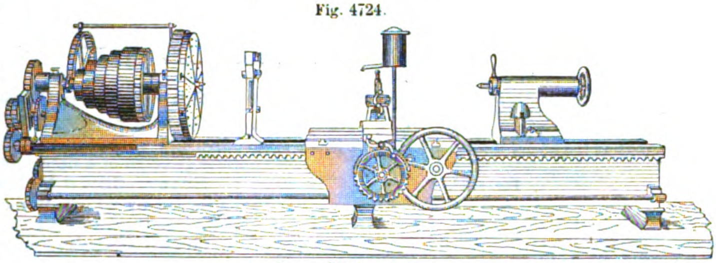
a a a represent the wheels upon the mandrel, and *b b b* those upon the slide-rest.

The rectangular bracket at *C* has two straight mortises, by one of which it is bolted to the bearers of the lathe, and in the other it carries a pair of wheels pivoted in a short piece, which may be fixed at any angle or hight in the mortise, so that either or both may be employed.

In *D* the intermediate wheel or wheels are carried by a radial arm, which has partial rotation around the mándrel, and is fixed to the lathe-head by a bolt passed through the curved mortise.

In *E* a similar radial arm is adjustable around the axis of the slide-rest screw in the fixed bracket Sometimes the wheel *b* is carried by the pedestal or arm fixed to the bed or headstock of the lathe, in order that a shaft or spindle may proceed from

Fig. 4724.



Screw-Cutting Lathe.

this wheel, and be coupled to the slide-rest screw by a socket, enabling the rest to be placed at any point of the bearer for cutting a screw on the end of a long rod, or for cutting a screw which exceeds in length the traverse of the rest, which may then be performed at two operations.

In the larger and more improved class of lathes, specially designed for cutting screws, nearly the entire length of the bed is used as a slide-rest, the tool-carriage traversing directly upon the bed. A change-wheel arrangement, similar to *F*, Fig 4723, is frequently adopted. The guide-screw extends through the middle of the bed, projecting at one end. The slide-rest is attached to the screw by a clasp nut, so as to be detached therefrom and moved independently when required. The train of wheels is placed at the left extremity of the lathe, and the intermediate wheels are journaled upon a radial arm which has one or two straight mortises which receive their journals, and two circularly curved arms which permit its partial rotation around the screw, and enable it to be fixed at any required angle by means of set-screws.

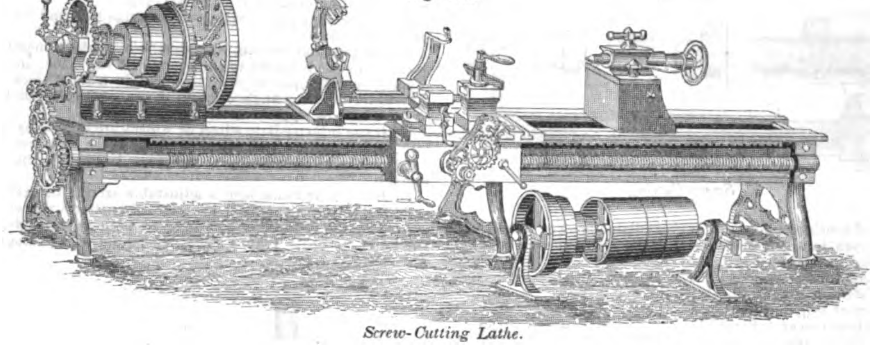
The lathe (Fig. 4724) has screw-cutting and turning feeds, so arranged that one may be instantly exchanged for the other, when both are in gear with the spindle. The turning feed is adjustable to any speed between the fastest and slowest. The slide-rest is compound; the puppet-head has an improved hold-down, insuring its center being in line with the axis of the live spindle, and is provided with a concentric hold-fast.

The lathe (Fig 4725) is adapted for cutting screws, and also for boring cylinders, turning and cutting shafting, and for miscellaneous work. The system of change-wheels is more complicated than those described, admitting a great variety of relative graduations of speed between the guide-screw and the mandrel. Such lathes are made of lengths up to 22 feet, or 18 feet between centers, enabling threads of nearly that length to be cut.

Screw-cut'ting Ma-chine'. A machine on the principle of the lathe, the rod to be threaded being suspended between the head and tail centers, and being dogged to a face-plate on the mandrel of the former.

The motion is derived from a bevel-pinion which engages one or the other of the bevel-wheels to rotate the feed-screws in one or the other direction; for feeding or returning the slide-rest to the commencing point; for for cutting right or left handed screws The feed-screws are shown a little within the ways of the machine, and are turned by pinions into which meshes the spur-wheel on the mandrel of the lathe-head. By the intervention of suitable gearing, such a proportion is established between the rotation of the rod on which the screw is to be cut, and the feed-screws themselves, as to obtain any required pitch of thread on the rod The rate of rotation of the rod being assumed as permanent, an equal rate of the feed-screws will cut a thread of a pitch equal to that of the feed-screws. If the latter are rotated at a slower rate, the pitch of the screw will be less; if the feed-screws are rotated faster than the rod under treatment, the pitch of the screw on the lathe will be proportionately increased. See Bolt-cutter; Bolt-threading Machine; Turret-lathe; Screw-cutting Lathe.

Fig 4725.

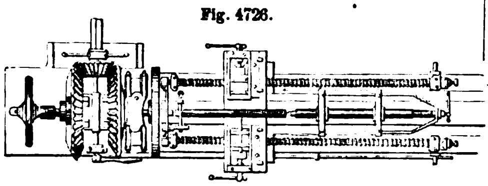


Screw-Cutting Lathe.

General Sir Samuel Bentham made machines for cutting wood-screws by means of rotary cutters.

In Royon's machine (Fig. 4727), the die-chuck *E* is hollow, and is turned by the hollow shaft *B*, rotated by a pinion mesh-

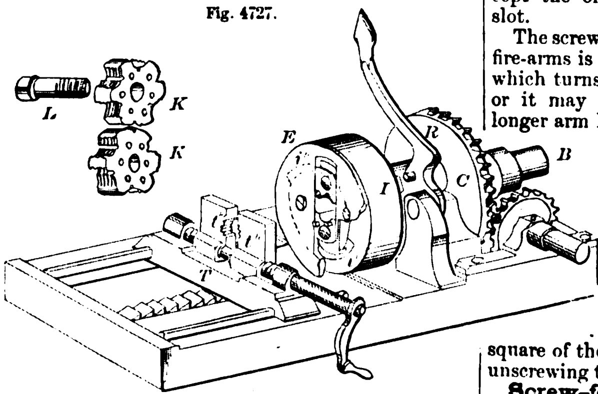
Fig. 4726.



Screw-Cutting Machine.

ing with the bevel-wheel *C*. The dies *K K* are rotatable, have several sets of threads adapted to screws of different sizes and pitch, are secured within the chuck by screws *L*, are caused to approach or recede from each other by moving in the eccentric slots *i′ i″* upon turning the ring *I*, and are fixed at the proper distance apart by a movement of the lever *R*. *T* is the carriage on which the screws or bolts are held between the jaws *t″ t‴*, approached by a right and left hand screw. In tapping nuts, the nuts are held by a hollow-ended mandrel inserted through

Fig. 4727.



Screw-Cutting Machine.

an opening in the chuck *E*, into the hollow shaft, while the tap is grasped by the jaws *t″ t‴* of the carriage.

Screw-dock. (*Hydraulic Engineering.*) A contrivance for lifting a vessel out of the water, in order that the bottom may be examined and cleaned.

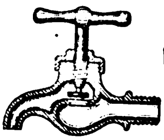
The vessel to be raised by this apparatus is floated over a platform of wood, sunk to the depth of about 10 feet below the surface of the water, and suspended from a strongly built wooden framework by iron screws from 4½ to 5 inches in diameter. This platform has several *shores* on its surface, which are brought to bear equally on the vessel's bottom, to prevent her from heeling over on being raised out of the water. The platform is gradually raised to the surface of the water, carrying the vessel high and dry, suspended between the wooden frames.

Screw-down Cock. A cock provided with a valve which is screwed down to its seat to prevent the flow of liquid, and raised more or less to permit the passage of a determinate quantity.

Screw-down Valve. A valve whose stem has a thread by which it may be screwed down to its seat.

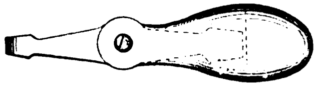
Screw-driv′er. A tool for turning screws in or out of their places. It has an end like a blunt chisel, which enters the *nick* in the screw-head.

Fig. 4728.



Screw-Down Cock.

Fig 4729.

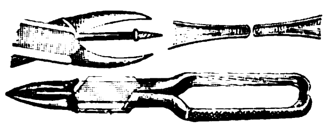


Screw-Driver.

In that shown (Fig. 4729), the handle is slotted to receive pivoted blades of different sizes, which, except the one in use, are turned back within the slot.

The screw-driver for taking apart and re-assembling fire-arms is composed of two blades of steel, one of which turns on a pivot, passing through the other, or it may have an additional pivoted arm. The longer arm has a perforation at one end fitting the square of the "cone" or nipple, for the purpose of unscrewing the nipple from its seat.

Fig. 4730.



Hulliken's Screw-Forceps.

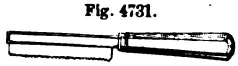
Screw-for′ceps. (*Surgical.*) A dentist's instrument. Between the jaws is a screw which is protruded into the nerve-canal, so as to fill it and prevent the crushing of the tooth when the pressure of the jaws comes upon it.

Screw-gear. (*Machinery.*) The *worm* and *worm-wheel*, or endless screw and pinion.

Screw-head File. A feather-edged file for nicking screw-heads.

Screw-head Saw. The saw for cutting nicks in screw-heads is strengthened by a back-plate like a tenon-saw.

Fig. 4731.



Screw-Head Saw.

In machine-made screws for carpenter's use,

and known as *wood-screws*, the nick is made by a circular saw of small diameter.

Screw-hook. (*Surgical.*) An instrument for withdrawing foreign bodies from the ear or nostrils. It has a shank with little S-shaped prongs at the end. It is introduced into the opening and laid alongside the object; being then slightly rotated, the hooks become engaged with the object, which is then withdrawn.

Screw'ing-ma-chine'. A machine-tool for cutting screws. See SCREW-MACHINE; SCREW-CUTTING LATHE, etc.

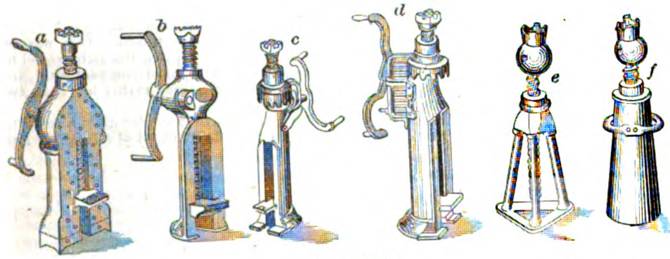
Screw'ing-ta'ble. A kind of screw-stock, used for forming the threads of screw-bolts or wooden screws.

Screw-jack. A *lifting-jack*, in which the power consists of a screw rotating in a nut in the body of the tool. See JACK-SCREW.

a, screw-jack, with wooden case.
b, screw-jack, with malleable iron case.
c, windlass screw-jack, single purchase.
d, windlass screw-jack, double purchase.
In these, additional power is obtained by multiplying gears interposed between the lever and the nut which turns the screw.
e, tripod-jack.
f, bottle-jack.
So termed from the form of the case. They are operated by a removable lever inserted in the head.

It is by no means an uncommon thing for a house to be lifted bodily from its site and removed by machinery to a new one, without disturbing the inmates, but in Chicago the operation was extended to almost the whole city, in 1867-68. The early buildings were generally erected without any regard to the laws of drainage, and eventually, as the city increased in size, the evil became intolerable. By means of screws acting under balks of timber, one of the largest hotels, known as the Briggs House, was raised in 27 days to a hight of 4 feet 2 inches above its previous level. The building had a frontage of 180 feet, a depth of 80 feet, weighed 22,000 tons, and was 5 stories high, presenting accommodation for 450 guests, none of whom were disturbed during the operation. Tremont House, another hotel of a similar size, was also raised without accident. The screws employed were about 2 feet long, $2\frac{1}{4}$ inches in diameter, with a pitch of half an inch. They worked in cast-iron sockets, and were moved by handspikes; 1,450 such screws and 600,000 cubic feet of timber were used in raising the Briggs House. A similar plan was adopted in July, 1868, at Boston, when whole streets of houses were raised in blocks of 6 houses together.

Fig. 4732.



Screw-Jacks.

Screw-key. A spanner for the articles which socket upon the mandrel-screw.

The lever of a screw-press. A form of key used with lock-faucets.

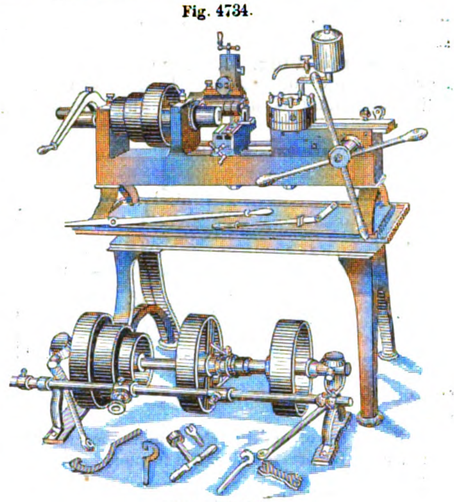
Fig. 4733.

Screw-Lock.

Screw-lock. (*Locksmithing.*) This lock has various forms, and is used for *hand-cuffs*, *fetters*, *manacles*, and also as a padlock. The essential feature is an opening bar, which is detained by a screw when in a locked position.

Screw-ma-chine'. (*Machinery.*) A machine for making from bar-iron screws and studs such as are used in a machine-shop. It is of the nature of a bolt-machine. The various sizes of dies are stocked in the circular head, and such one is presented to the blank, which rotates with the mandrel of the head-stock, as may be of the size required. It has also a rest with a transversely sliding tool-post, whereby a screw may be cut off or dressed. The rest also affords a bearing for a chasing-tool. The countershaft is shown dismounted and placed upside down upon the floor, resting upon the plates of the hangers.

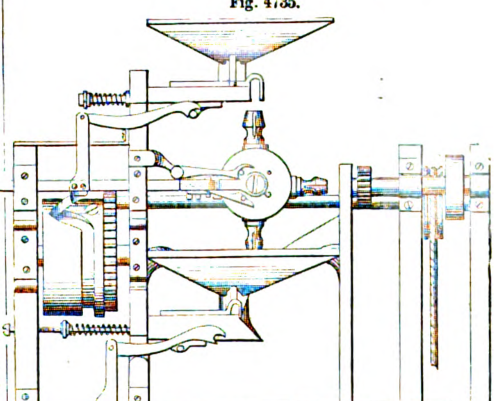
Fig. 4734.



Screw-Machine.

2. (*Wood-Screws.*) A machine or series of machines for shaving, nicking, and threading screw-blanks. The blanks are placed promiscuously in a hopper and sorted and fed therefrom to the first of the series of machines. The blank falling into a socket or being seized by a forceps, according to the mode of feed adopted, is presented to the shaving-tool, and then dropped, to be again selected and fed to the nicking-tool, the process being repeated to the thread-

Fig. 4735.

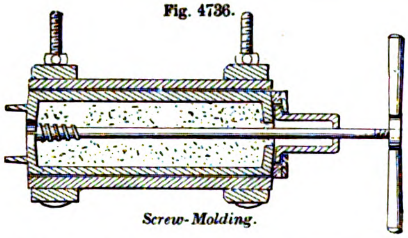


Screw-Making Machine.

er; or it is conducted through the consecutive operations.

Screw-mold'ing. 1. A process of molding screws in sand for casting. In Fig. 4736, a plain cylindrical mold is first made, and afterward the

Fig. 4736.



Screw-Molding.

thread is formed by screwing a pattern-screw through the mold.

2. A process of making sheet-metal screws for collars or caps by pressure upon a former. See Screw-cap.

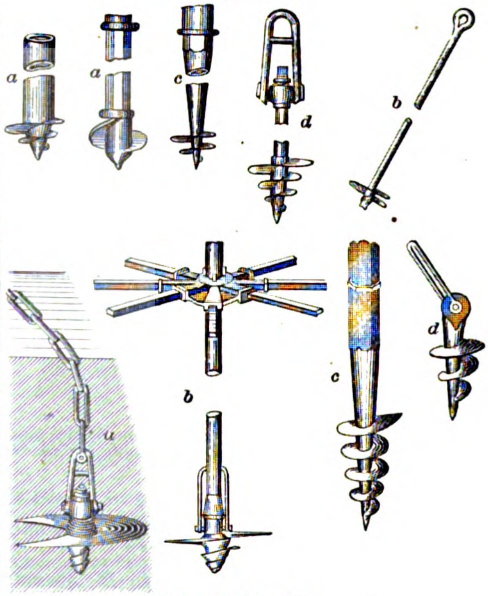
Screw-pile. A pile having a screw-thread at its lower end to enable it more readily to penetrate hard ground and to hold it firmly in position.

Screw-piles of small diameter are usually made of wrought-iron and solid; those of larger size are frequently hollow and made of cast-iron.

They were invented by Mitchell, in England, and are principally employed as foundations for light-houses, for beacons, and for mooring buoys.

They were used in the foundations of the Maplin Sand Lighthouse at the mouth of the Thames, and the Fleetwood Lighthouse, at Fleetwood, in Lancashire, both erected A. D. 1840.

Fig. 4737.



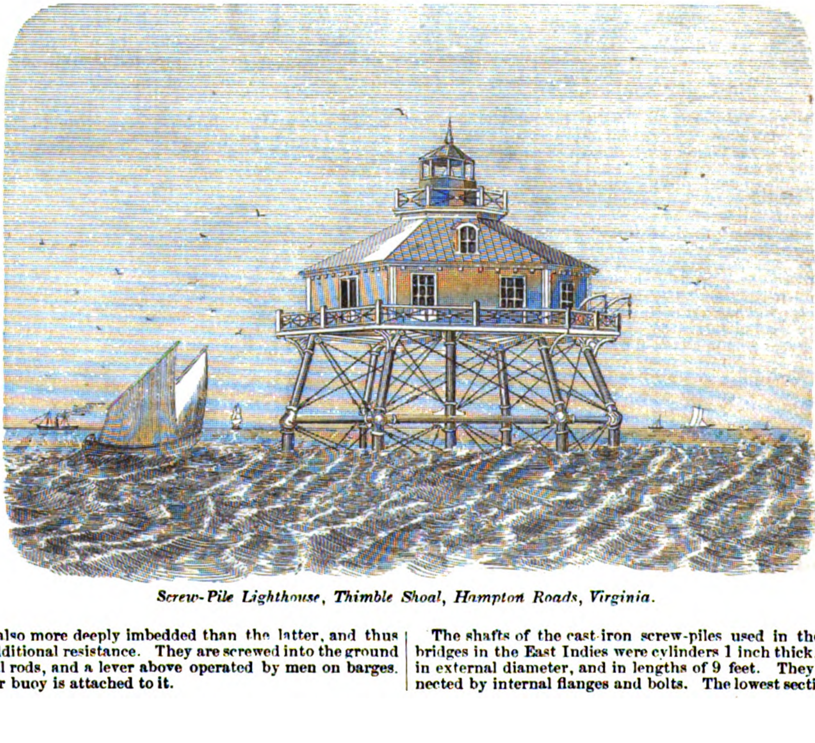
Mitchell's Screw-Pile.

a a a, mooring-pile.
b b, mode of sinking the piles into position.
c c, piles for signal, mile, or telegraph posts.
d d, piles for tethering animals, or, on a larger scale, for attaching guys or *crab* moorings.

Fig. 4738 is a view of the screw-pile lighthouse on Thimble Shoal, near the entrance to Hampton Roads. This was designed by Major Peter C. Hains, to replace the light-vessel on Willoughby Spit The shoal is of firm, hard, compact sand, and the time employed in fixing the piles was rather less than two months. The light is of the fourth order.

A mooring-pile 3 feet 6 inches in diameter gives a resisting surface equal to 10 square feet, double that of a large anchor.

Fig. 4738.



Screw-Pile Lighthouse, Thimble Shoal, Hampton Roads, Virginia.

They are also more deeply imbedded than the latter, and thus acquire additional resistance. They are screwed into the ground by vertical rods, and a lever above operated by men on barges. A chain or buoy is attached to it.

The shafts of the cast-iron screw-piles used in the piers of bridges in the East Indies were cylinders 1 inch thick, 30 inches in external diameter, and in lengths of 9 feet. They were connected by internal flanges and bolts. The lowest section formed

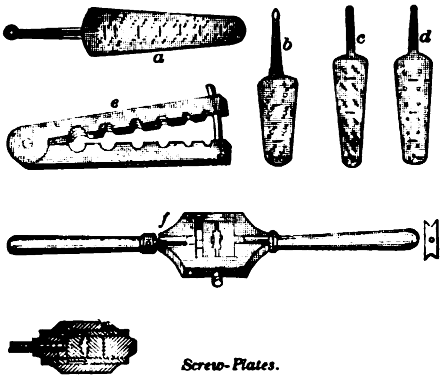
the screw of the pile, having a thread 54 inches in diameter. The cylinders were eventually filled with concrete.

These piles were screwed into the ground by means of 4 levers, each 40 feet long, and having 8 bullocks yoked to it. They penetrated from 20 to 45 feet.

Screw-plate. A steel plate having a series of holes of varying sizes, with worms and notches for cutting threads.

It is usual to bore a smaller hole on each side of that in which the screw is cut, and connect them with the latter by a slit, forming angular cutting-edges, which remove the metal, as shown at *a b c*, Fig. 4739. The wire is commonly held by a hand-vise in the left hand, and the plate operated with the right hand, several holes, of gradually diminishing diameter,

Fig. 4739.



Screw-Plates.

being employed to produce the desired thread. In some cases, for very short and small threads the holes are merely threaded, and not notched, as shown at *d*. *e* is a folding device formerly employed for cutting screw-threads; the larger holes are near the joint, so to allow greater holding power.

For screws exceeding $\frac{1}{16}$ inch diameter, it is customary to use a die-stock with movable dies; several arrangements have been adopted in these for holding and adjusting the dies; in *f* the edges of the dies have triangular notches sliding on corresponding ribs in the opening of the stock, and are held by one of the handles when screwed in. The lower figure has a pin on each side, which in one position fits a semi-cylindrical groove in the die, so as to hold it; when rotated half round, it presents a plain side to the die, permitting its removal.

Screw-post. (*Ship-wrighting.*) The inner *stern-post*, or that through which the shaft of the screw-propeller passes.

Screw-press. A press whose platen is operated by a screw, in contradistinction to one which is worked by a toggle, as in the Stanhope printing-press; by a wedge, as in some forms of oil-presses; by hydraulic pressure, as in the flaxseed-press; by a lever, as in the primitive form of cheese-press. See Fig. 1263.

The screw-press was used for coining in the reign of Henry II. of France, being introduced by Brucher. It was finally established in the French mint, 1645.

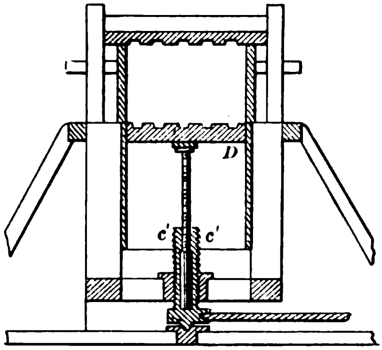
1. Screw-presses are vertical or horizontal; the screw above or beneath the platen, which is usually called a follower in this class of machinery. An understanding of the matter will be as readily attained by a few examples as by a labored description.

a. The old screw-press of the plantation or farm had a vertical screw in the upper cross member of the frame, and a follower which rose or fell, according to the direction of motion of the sweep which rotated it.

b. In another form, the screw came up from below and left the top of the box more clear for charging. In the illustration shown, the screws *C C* are in duplicate and are actuated by the same gearing.

In Fig 4740, the follower *D* is attached to the smaller screw, which works axially in the socket-thread of the larger screw. The latter passes through the nut in the sliding-frame, and is stepped in a metallic block. The revolution of the lever causes the hollow screw *c′ c′* to rotate in the lower bar of the frame, and thus lower or raise the box, according to the direction in

Fig. 4740.

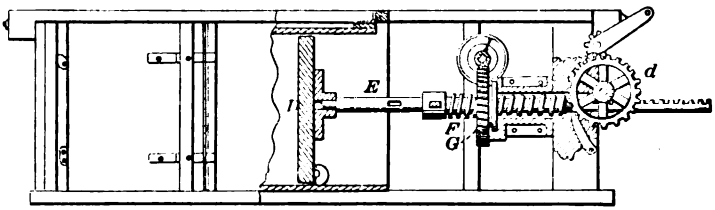


Screw-Press.

which the lever is moved. The threaded stem *c* at the same time rotates in the sleeve-screw *c′*, and raises or lowers the follower *D*. Thus the follow-block and the press-box move simultaneously and in opposite directions. See BALING-PRESS; COINING-PRESS, etc.

***c. Horizontal screw.* In the example, the follower can be operated by a slow or by a quick motion. The slow motion arises from a hollow screw-spindle *F* which screws into a worm-wheel *G* gearing with a worm. A rod *E* passing through said screw-spindle and connected with it by a key unites it with the follower. The extreme end of the rod forms a toothed rack which gears in a pinion *d*; and if the key which unites said rod with the screw-spindle is withdrawn, the pinion and rack form the quick motion for the follower, which can be used independently of the slow motion.**

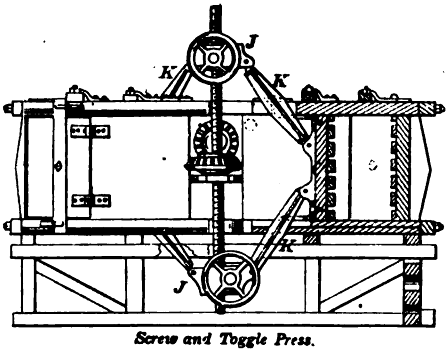
Fig. 4741.



Horizontal Screw-Press.

The press has a slow, powerful motion when compacting the bale: a quick retraction to free the bale and to open the chamber for another charge.

Fig. 4742.

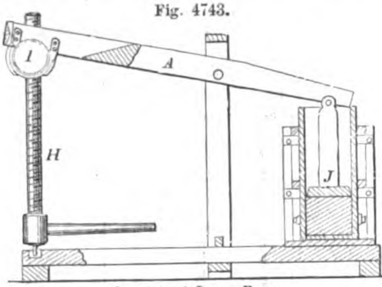


Screw and Toggle Press.

d. Screw and toggle. The revolution of the right and left hand screw draws together the heads *J* and expands the toggles *K*, forcing the followers toward the platens of the press.

e. Screw and lever. The lever is connected to the follower at one end, and has a cylindrical nut at the other, which rocks in bearings at the other end of the lever, and is engaged by a screw

Fig. 4743.

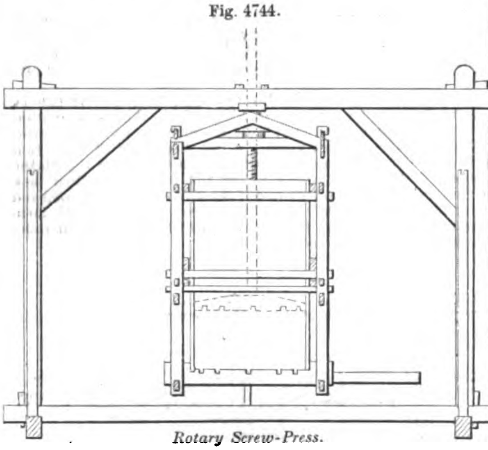


Screw and Lever Press.

which is stepped in the frame. The mule is hitched to the end of the sweep, and as he walks around, the nut *I* climbs (or sinks) on the screw *H*, tipping the lever *A* and depressing or raising the follower *J* in the box.

f. The *rotating press.* As the box rotates, the vertical screw feeds through its nut and depresses the follower. Rotation in the other direction raises the follower.

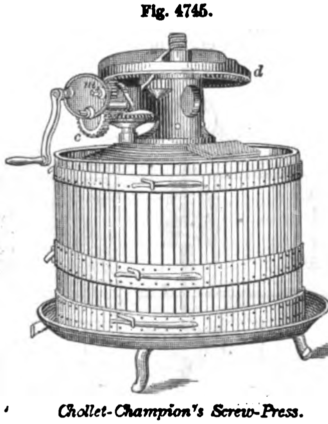
Fig. 4744.



Rotary Screw-Press.

Chollet-Champion's screw-press (French) has three arbors to which the crank can be applied, each producing a different velocity of movement in the platen. The upper two of these are the axles of pinions which can be thrown into gear with a

Fig. 4745.



Chollet-Champion's Screw-Press.

larger wheel *c* below them; the third is the axle of this larger and lower wheel itself. Upon the same arbor with this wheel is a bevel-pinion which engages a large horizontal wheel *f* correspondingly geared. The vertical arbor of this horizontal wheel carries a pinion which acts on an internal gearing in the last wheel *d* of the series, which is the nut applying the power to the platen. The base of the construction carrying this system of gearing is firmly secured to the platen, and the whole apparatus rises and falls with the movements of the press.

The smallest of the pinions to which the crank can be directly applied has 9 teeth, and the larger one 15. The wheel *c* into which these pinions gear has 45 teeth. The bevel-pinion has 10 teeth, and the bevel-wheel which it actuates 42 teeth. The pinion on the vertical axis of this wheel has again 10 teeth, and the internal gearing 65 teeth. The length of the crank is 13 inches, the diameter of the screw 4 inches, and the distance between the threads about an inch.

The force is applied first directly to the large upper wheel *d*; then by placing the crank on the axis of the lower vertical wheel *c*, which, by the conical gearing and the gearing of the internal pinion and the wheel *d*, gives one turn to the nut of the press for 27 turns of the crank. For a greater power, the crank is placed, as seen in the cut, on the axis of the 15-tooth pinion, which gives one turn of the nut to 81 of the crank. As the last resort, the crank is transferred to the axis *m* of the 9-tooth pinion, which gives one turn of the nut to 136½ of the crank. A pressure of 32 pounds on the 9-tooth pinion is equal to 50 tons on the surface of the body compressed.

Fig. 4746.

Bookbinder's Screw-Press.

2. A small stitching-press employed in attaching the head-bands, etc., to books. It consists of two plain jaws, through which guide-pins pass near each end; their distance apart is adjusted by means of a central screw. See also FLY-PRESS; COINING, etc.

Screw-pro-pel'ler. A spiral blade on an axis parallel with the keel of the vessel, and revolving beneath the surface of the water, usually at the stern of the vessel.

Screws have been used at bow and stern; at mid-ships, over the keel, or alongside; twin screws at each side of the dead-wood at the stern.

In the early applications of the screw as a propeller it consisted of a spiral blade, which made one convolution around its stem. Then two half-convolutions of a double-threaded screw were used. Since that time the tendency has been to reduce the length of the spiral.

We find notices of the suggested or experimental use of the screw-propeller by Hooke, 1680; Duquet, 1727; Pancton, 1768; Watt, 1780; Seguin, 1792; Fulton, 1794; Cartwright, 1798; Shorter, 1802.

The idea of propelling vessels by a screw in lieu of oars is mentioned in the "Machines et Inventions approuvées par l'Académie Royale des Sciences depuis 1727 jusqu'à 1731."

Franklin suggested the same thing.

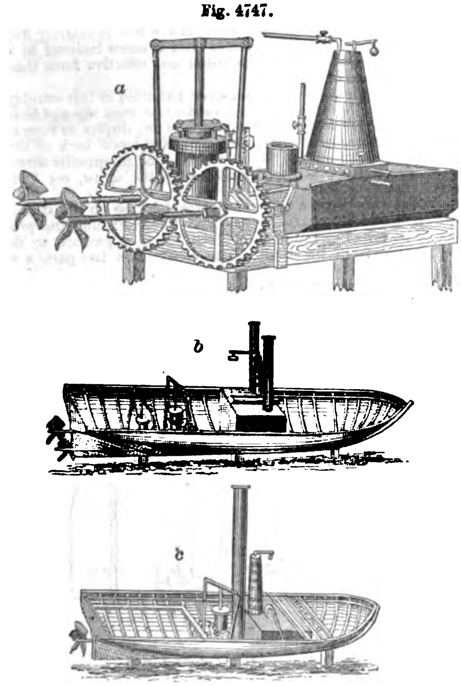
Lyttleton's English patent, in 1794, for an "aquatic propeller" consisted of a screw of one, two, or more threads wrapped around a cylinder, and revolving in a frame placed at the head, stern, or side of a vessel.

The credit of the first application of the screw-propeller for marine propulsion is undoubtedly due to Colonel John Stevens, of Hoboken, N. J. In 1804, he constructed a boat with twin screws, which "attained a very considerable speed." The machinery of this boat (*a*, Fig. 4747), which was 50 feet in length, is still preserved in the Stevens Institute of Technology at Hoboken. The boat itself is shown at *b*.

In 1844, this machinery was placed in a vessel modeled on the lines of the first boat, which, in the presence of a committee of the American Institute, it propelled at the rate of 8 miles an hour.

In 1806, he built a second and larger boat called the "Phœnix," with which he made a successful trip

Fig. 4747.



Stevens's Propeller, 1804.

to Albany in August, 1807, but a few days after that of Fulton, in the "Clermont." This, in which a single screw was employed, is shown at *c*.

Stevens navigated his propeller by sea to the Delaware, as Chancellor Livingston had obtained a patent for the navigation of the Hudson by steam. See Propeller.

F. P. Smith, a farmer, of Romney, England, made a model boat in 1834, in which was a stern screw-propeller driven by a spring. Smith's patent was granted May 31, 1836. Though his claims were more extensive, the actual novelty of his invention seems to have been placing the screw in an open space in the dead-wood (see Fig. 3973). He constructed a boat of 10 tons burden, with an engine of 6 horse-power, which was tried on the Paddington Canal, the river Thames, and, the next year, along the coast.

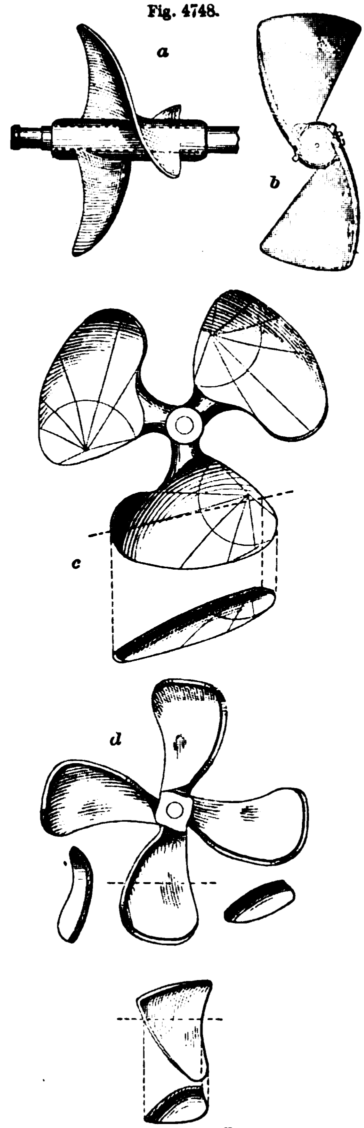
The "Archimedes" was constructed by the help of the Messrs. Rennie, in 1838. She was 155 feet long, 237 tons burden, 90 horse-power. The screws were 5 and 7 feet in diameter, the lengths 7½ and 8 feet.

In 1842, the "Rattler" was built, to determine the best proportions of the screw, and the "Alecto" was built on the same lines, and with paddle-wheels, to compare the modes of propulsion. The propeller was preferred, and soon had an important place in the British navy.

Captain John Ericsson's English patent is dated July 13, 1836, for a propeller containing several blades or segments of a screw, the twist of which was determined in accordance with the principle now usually adopted. His propeller, the "Francis B. Ogden," was tried in April, 1837, and in May of that year was used in towing an American packet, the ship "Toronto," of 700 tons burden, to sea; 4½ knots an hour against wind and tide.

Ericsson's second vessel, the "Robert F. Stockton," was built by the Lairds of Birkenhead, and launched July 7, 1838. This vessel was built for Captain Stockton, of the United States Navy. She crossed to the United States in 1839, and was purchased by the Delaware and Raritan Canal Company. Captain Ericsson subsequently built the propeller "Enterprize." He was the first to couple

Fig. 4748.



Screw-Propellers.

the engine directly to the propeller-shaft. "It will thus be seen that Captain Ericsson accomplished for the screw-propeller in America and in England what Fulton did for the paddle-wheel in the former and Bell in the latter country, namely, its practical introduction." — Woodcroft.

Several years before screw-propulsion had assumed any commercial importance in England, the carrying-trade on our lakes was, to a great extent, conducted by screw-vessels. Already, in 1843, the Ericsson

line of screw-steamers was in full operation between Philadelphia and Baltimore, running through the Delaware and Chesapeake Canal.

Rennie proposed to make the screw spiral instead of helical; the form being generated by winding an inclined plane around a cone or spire. This propeller had two blades on a cylindrical hub, and strikingly resembled a shark's tail (*a*, Fig. 4748).

b shows Hancock's two-bladed screw. The blades are removable.

Bourne prefers three-bladed screws, and gives the following data: —

The area of the circle described by the extremities of the blades should have one square foot for every $2\frac{1}{4}$ square feet in the area of the immersed midship-section. The pitch of the screw should be equal to or a little exceeding the diameter, and should have about $\frac{1}{6}$ of a convolution. The pitch should increase gradually toward the leading end of the screw, and the pitch of the center be 10 per cent less than the circumference. The blades should be inclined backward a little instead of being perpendicular to the shaft, so as to produce a tendency in the water which they drive backward to converge to a point. It is assumed that this convergent tendency may balance the divergent tendency due to the centrifugal force attending the revolution; so that the two forces being in equilibrium will cause the water to be projected backward from the screw in a cylindrical column.

As the screw revolves and thrusts backward against the water, the forward end of the screw-shaft impinges forcibly against a bearing, and thereby impels the vessel. This pressure is very severe, as may be readily imagined, when it is considered that the forward pressure is driving the vessel through the water. One device for receiving this forward thrust is a number of collars or disks placed at the end of the shaft and resting in a cistern of oil, which is firmly supported in the bed-plate of the engine, or some other place sufficiently strong. Between the end of the cistern and the shaft the disks are interposed, and are free to revolve by the frictional pressure of the screw-shaft. If the end of the shaft press with such violence against the disk as to become hot in revolving against it, and engender such friction as to carry the disk along with it, then the first disk revolves against the second, and the surfaces previously engaged, no longer rubbing against each other, have time to cool, and resume their efficiency.

The screw is sometimes suspended on a short shaft, carried by a metallic frame having a rack on one side, which is engaged by endless screws for the purpose of lifting the screw for examination or repairs. See also Fig. 4751.

Maudslay's feathering-screw is so arranged that the blades, whenever the vessel is put under canvas and the screw not required, should be placed in a direction parallel with the line of the keel, and form, as it were, a portion of the dead-wood, as they cause considerable obstruction, if they are allowed to remain fixed in their position, even though they be disconnected from the engine and allowed to revolve. In auxiliary sailing-vessels not fitted with a trunk or screw-well for raising the screw out of the water, this is particularly valuable.

c and *d* are modern forms of screw-propellers, having respectively three and four blades.

The number of blades of a screw should depend on the area of propelling surface in proportion to the length of screw on the line of the keel. The width of blades is reduced in proportion to their number.

The *pitch* of a screw is the distance it should advance in an axial line by one complete revolution, provided no force be lost, as would be the case in an unyielding medium. The *rate* is the *actual* advance, and the difference or loss is called the *slip*.

The slip varies with the angle of the propeller, its velocity, and depth of immersion. The coarser the pitch, the greater the slip.

The *friction* of a screw depends on its velocity and the smoothness of finish of the material of which it is composed.

The *vibration* depends on the form and uniformity of resistance

The *thrust* of the screw is the force exerted on its shaft to propel the vessel. This thrust is generally taken up by friction-collars on the screw-shaft.

The pitch of a two-bladed screw should in general equal $1\frac{1}{2}$ diameters; a three-bladed screw, $1\frac{1}{4}$ diameters; a four-bladed screw, 1 diameter.

The actual force exerted by a screw depends, to some extent, on its depth of immersion. The *inclination* of the screw should be such as to overcome the tendency of the body of water acted upon to rise to the surface.

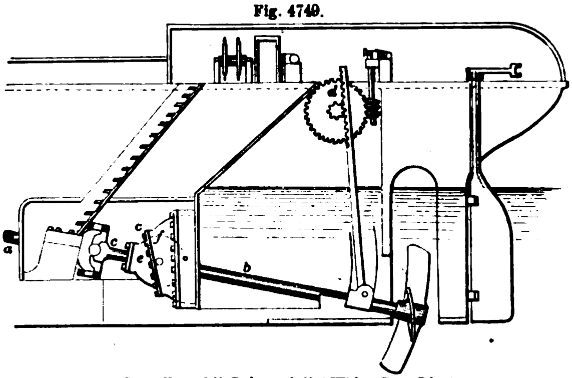
Experiments have indicated that paddle-wheels give the best result when the vessel is lightly immersed, and the screw when deeply immersed

Experiments made by the British navy tend to prove that the best results are obtained when the screw is entirely free from *back-flow* or *dead-water*; also that a screw inclosed in a pipe or box open at the ends has much less effective force than when it is not so inclosed.

Many and various devices have been patented in this country and in Europe, intended to overcome the loss from *slip* and from friction. Among these may be mentioned the duplex or reverse screw, having an inside shaft and auxiliary screw back of the one on the main shaft, the two screws moving in opposite directions. For some other modifications of the screw, see PROPELLER.

Fig. 4749 illustrates a new arrangement in use on the steamship "Britannic," of the White Star line, enabling the propeller to be raised or lowered, and still be in a position to receive motion from the shaft. The shaft is in two parts *a b*,

Fig. 4749.



Propeller of "Britannic" (White Star Line).

coupled at *c* by a universal joint; and the upward or downward movement of the propeller is effected by a pinion gearing in the rack *d* jointed to the rear part of the shaft. Water is prevented from entering the ship by a device consisting of a disk *e* through which the shaft passes pivoted within a second disk *f*, which in turn is pivoted within a casing forming part of the shaft-well, the joints being suitably packed. When the rear portion of the shaft is raised or lowered, it and the disk *e* turn on the universal joint as a center, causing the disk *f* to rotate on its axis and around the disk *e* until the propeller assumes the desired position.

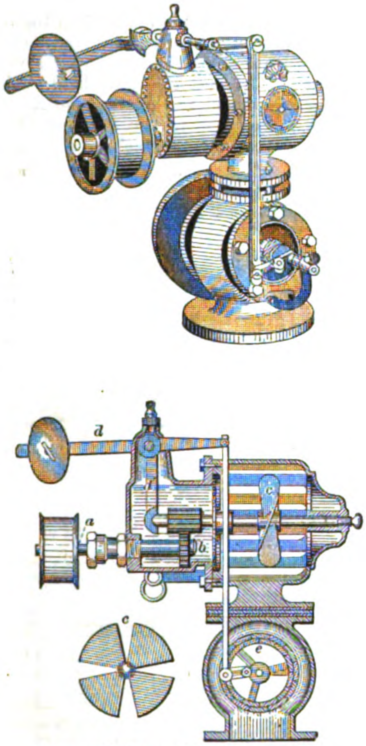
Mr R. Griffiths, of London, well known in connection with propellers, has recently proposed to employ a screw placed within a tunnel both at the bow and stern; from trials with models he concludes that an increase of nearly 50 per cent in speed can be gained with the same power.

A small boat employed at Burlington, Iowa, for crossing the Mississippi, 60 feet long, 7 feet beam, drawing 30 inches aft and 1 foot forward, and propelled by a 4-foot propeller, attains a speed of 10 to 12 miles up stream, and 15 miles down stream. She has a locomotive boiler 11 feet long, with fire-box $2\frac{1}{2} \times 3\frac{1}{2}$ feet, and 27 2-inch flues, 7 feet long The two engine-cylinders are direct-acting and vertical, of 5 inches bore and 10 inches stroke, and are fitted with circular slide-valves. The usual amount of steam carried is 80 pounds; number of revolutions, 133 per minute.

Screw-pro-pel'ler Gov'ern-or. (*Steam-engine.*) One in which the action of a screw-propeller device, working in a resisting fluid, is employed to regulate the throttle-valve. In Huntoon's (Fig. 4750), the pulley-shaft *a*, driven by belt connection with the engine, carries a gear-wheel *b* meshing with a long pinion on the shaft of a screw *c*, inclosed in a tight box filled with oil or water, and causing its rotation. The apparatus is so adjusted that when the engine is working at its normal speed, the lever *d* just balances the tendency of the propeller-shaft to move forward under the influence of the screw, and no movement of the valve *e* takes place; should the speed diminish, the weight overcomes the resistance of the screw, and the valve is opened; if the speed exceeds the regulated amount, the forward movement of the propeller-shaft, acting against the arm *d'*, causes the weight to rise, partially closing the throttle.

Screw-pro-pel'ler Steam-en'gine. A direct-action steam-engine, specifically adapted for the ro-

Fig. 4750.



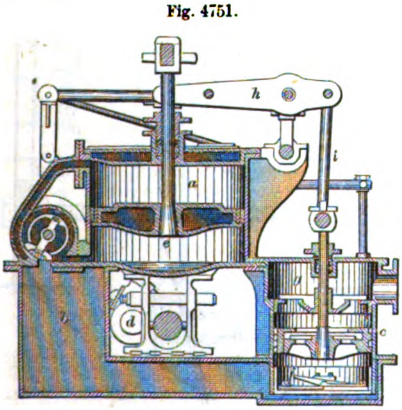
Huntoon's Screw-Propeller Governor.

tation of the screw-propeller shaft. The form of engine most commonly used for this purpose is the OSCILLATING-CYLINDER ENGINE (which see).

Maudslay's direct-action screw-propeller steam-engine was especially designed for dispensing with the multiplying-wheels, or chains and drums, between the engine-crank and the shaft of the screw-propeller, in order to give the latter sufficient speed.

The engines are ranged side by side in a line coincident with the line of the propeller-shaft, and immediately over the engine-shaft, which is concentric with the propeller-shaft, and is connected thereto by a coupling, by which the machinery and screw-shaft may be disconnected when the vessel is to be driven by sails alone.

Fig. 4751.



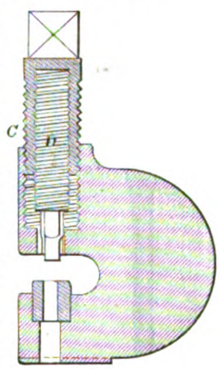
Maudslay's Screw-Propeller Steam-Engine.

The engines have a short stroke. *a* is the cylinder, supported on the upper part of the condenser *b* and on a projecting flange on the air-pump *c*. The engine-crank is beneath the cylinder, and to it is connected one of the cranks *d* of the shaft. The crank is driven by a connecting-rod from the cross-head above the piston-rod and piston *e*. The slide-valve is cylindrical, and has an oscillating motion, the peripheral depression forming a port by which the ends of the cylinder are alternately connected to the condenser *b*, while the internal ports of the valve form the induction steam-passage leading the live steam of the boiler to the alternate ends of the cylinder.

The foot of the air-pump is inserted in a flat prolongation of the condenser; and the foot-valve *f* is at the bottom of the pump. The delivery-valves in the pump are composed of annular plates, which rise and fall vertically between guides, and admit of the escape of air and water around the periphery and at the central aperture. The upper portion *g* of the air-pump forms the hot-well from which the supply for the boilers is drawn by the feed-pump, and the surplus passes off by the waste-water pipe. The air-pump is worked from the parallel motion, consisting of the working-beam *h*, connecting-rod *i*, and other associated parts, as seen in the figure.

Screw-punch. A punching device operated by a screw. In that shown, two screws *C D* are used for forcing the punch, one screwing into the first with a finer thread, so that when the larger or outer screw is turned, the inner one, being held from turning by a square shank passing through a square hole in the stock, screws into it, and therefore exerts a slow and powerful downward movement. See also PUNCHING-BEAR.

Fig. 4752.



Screw-Punch.

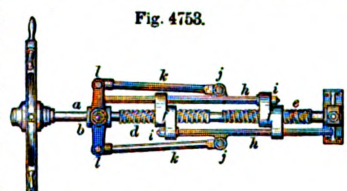
Screw-rud′der. An application of the screw to purposes of steering, instead of a rudder. The direction of its axis is changed, to give the required direction to the vessel, and its efficiency does not depend upon the motion of the vessel, as with a rudder, and the vessel may be turned on itself even when not under way.

Screw-spike. A round spike having a shallow screw-thread cut on a portion of its stem. It is driven partly home and screwed the remaining distance. See SPIKE.

Screw-steam′er. One propelled by a screw, in contradistinction to a *paddle-wheel* steamer.

Screw-steer′ing Gear. A screw on the axis of the steering-wheel may be made to act upon the rudder-head through the intervention of nuts, or nuts and rods. M'Williams's gear (English) operates by means of a right and a left hand screw *d e* on the axis *a* of the steering-wheel. *f f* are two traversing-nuts, and *h h* two traversing-rods, parallel to the spindle, and fixed respectively to the two traversing-nuts at *i i*, and each passing through a guide-eye in the other nut. *k k* are two links jointed respectively at *j j*, to eyes on the traversing-rods, and at *l l* to the two arms of the yoke. *b* is the rudder-head.

Fig. 4753.



Screw-Steering Gear.

A modified form of screw-steering gear was introduced by Reed (English). It has a similar right and left screw operating nut-blocks, which slide on parallel guide-bars. Each nut-block has a pin which engages in a slotted lug on the cap of the

rudder-head, and thus turns the rudder when the screw-axis is rotated. See STEERING.

Screw-tap. An instrument for cutting the interior thread on a hollow screw. For cutting the corresponding thread on the screw rod or bolt, a screw plate or dies are employed.

These are held in a *die-stock*, an improved form of which is shown at *a*. This is adapted to receive dies having different-sized threads, which are held by a screw; the sides of the opening being plain at one end for the ready introduction of the dies, and having ribs at the other, which fit grooves in the dies and prevent their falling out when fixed. *c d* illustrate the action of the common two-part die on the rod placed centrally between its parts. In the first the die has the same curvature as the finished screw; in the latter that of the uncut rod. In either case but a part of the cutting surface acts, and the tendency is to cut an imperfect thread.

This is partially remedied by cutting the dies of a curvature intermediate between the two.

To obviate this defect as far as possible, Sir J. Whitworth introduced the arrangement shown at *e*.

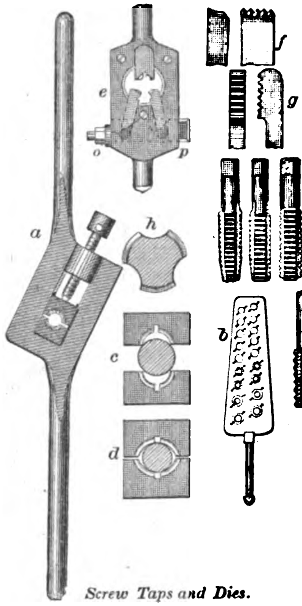
The two narrow dies act as cutters, and are advanced toward the center of the rod on which the thread is being cut by turning the thumb-nut *o*, which advances the slide-piece *p*: the broader die opposite serves principally as a guide for the thread.

f are tools for chasing exterior threads, and *g* for interior threads on work held in a lathe.

h is a section, and *i k* elevations of taps: these have a square shank fitting in an appropriate holder like the die-stock, or sometimes the die-stock itself is adapted for this purpose.

b is the screw-plate; this is principally used for small work, and has a series of screw-threaded apertures of various sizes adapted for different-sized wire.

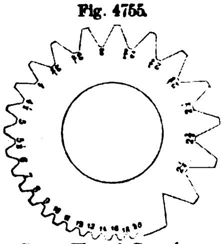
Fig. 4754.



Screw Taps and Dies.

Screw-thread Gage. A gage for giving the proper bevel to the edges of screw-cutting tools. That illustrated is adapted to the system recommended by the Franklin Institute and adopted in government establishments. The angles are of 60°, and the flat surfaces at the top and bottom of threads are equal to one eighth of the pitch.

Fig. 4755.

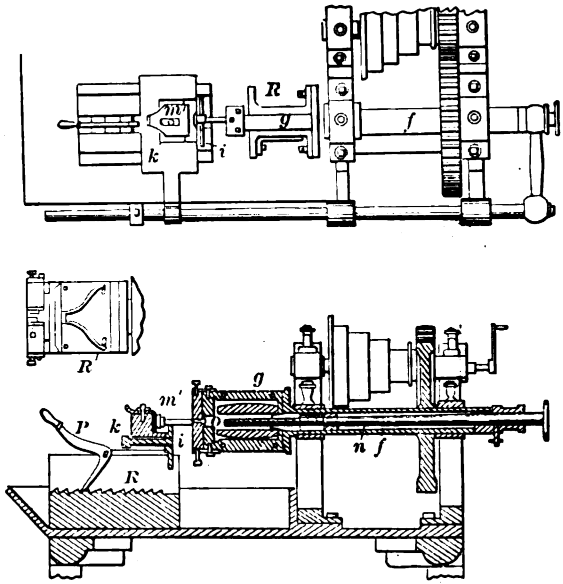


Screw-Thread Gage (one-half Size, Linear).

Screw-thread'ing Ma-chine'. A machine for cutting or chasing threads on bolts or rods. See also SCREW-MACHINE; SCREW-LATHE; TURRET-LATHE, etc.

In Fig. 4756, the screw is received in the holder *i* of the feed-head *k*, and clamped by a gage *m'*. The feed-head is advanced by the bent lever *P* engaging the ratchet-bar *R* to meet the dies which are held by die-holders *g* secured in the cutter-head *R'*. When the thread has been cut to the determined length, the end of the screw strikes the end *o* of the rod *n* within the hollow shaft *f* which rotates the cutter-head, forcing the rod back and permitting the dies to open and release the screw.

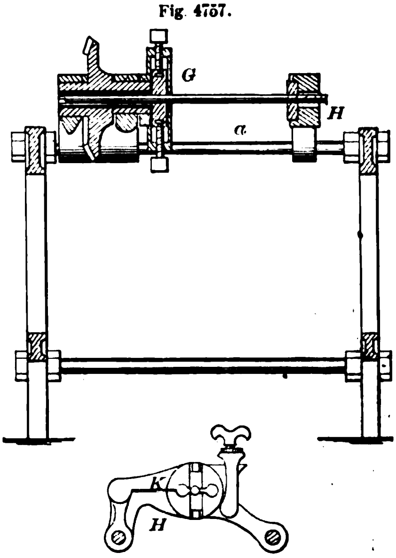
Fig. 4756.



Screw-Threading-Machine.

In Fig. 4757, the screw blank or bolt is clasped

Fig. 4757.

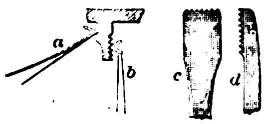


Screw-Threading Machine.

between two jaws held in the stationary head G by set-screws, and rotation is imparted by bevels, gears, and a winch. The dies are held between the pivoted jaw K and movable head H, which slides on the rod a and advances as the thread is cut.

Screw-tool. For wood-turning.

Fig. 4758.



Screw-Tools.

For soft wood: —

a, outside screw-tool.

b, inside screw-tool.

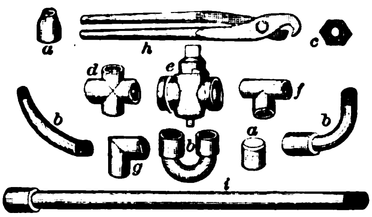
For hard wood or ivory: —

c, outside tool.

d, inside tool.

Screw-tube Fit'ting Fig. 4759 illustrates fittings for gas, water, and steam pipes of wrought-iron.

Fig. 4759.



Screw-Tube Fitting.

a a, sockets.
b b b, bends.
c, nut.
d, cross.
e, main cock.
f, T.
g, elbow.
h, pipe-tongs.
i, pipe.

Screw-valve. A faucet or stop-cock whose valve is actuated by a screw. See STOP-VALVE.

Screw-ven'ti-la'tor. A ventilating apparatus in the form of a screw, which is rotated by the passing current of heated air. It can hardly be said to be a mechanical ventilator, as it is only operated by the air in the discharge-aperture and does not drive the air through. It may be so arranged as only to rotate in one direction, and thus to impede the back passage of air while it yields to its discharge.

Screw-well. (*Shipbuilding.*) A hollow in the stern of a vessel into which a propeller is lifted, — after being first detached from the shaft, — when the vessel is to go under canvas alone.

Screw-wheel. The same as WORM-WHEEL (which see).

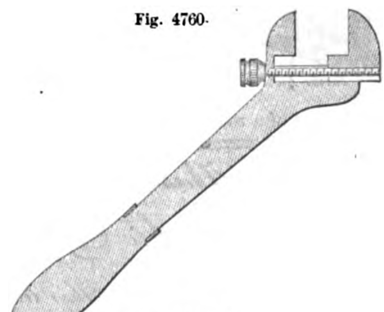
Screw-wire Fas'ten-ing. (*Shoemaking.*) Also known as *cable-screw wire.* A twisted wire for fastening soles and uppers together; a substitute for pegs or stitches. Boots and shoes made by this process have their soles fastened by a flexible wire, twisted into the form of a screw, which an ingenious machine cuts off in proper lengths and drives in without the preliminary punching which has always been considered necessary. The machine is capable of putting on five hundred pairs of soles in a day. See NAILING-MACHINE, page 1507; WIRE; WIRE-PEGGER, etc.

Screw-wrench. 1. A spanner fitting the square head of a bedstead-screw. A *turn-screw.*

2. A wrench whose movable jaw is opened and closed by a screw.

Fig. 4760 has a sliding jaw adjusted by a screw.

Fig. 4760.



Angle-Wrench.

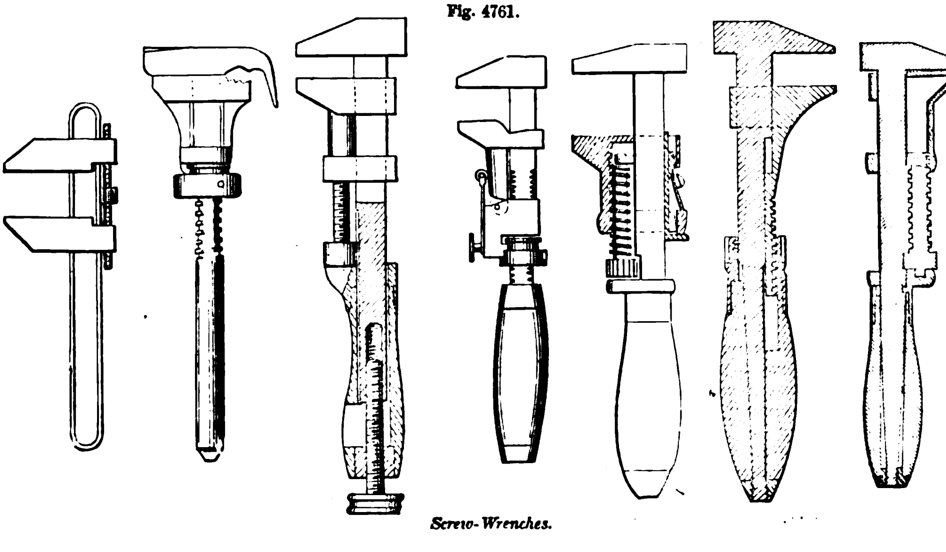
Its shape enables it to be applied to bolts in deep-seated places, not readily reached by the ordinary wrench.

Fig. 4761 shows several varieties, which do not need detailed description.

Scrib'bet. A painter's pencil.

Scrib'bler. (*Cotton and Woolen Manufacture.*) A carding-machine by which fiber is roughly carded preparatory to the final carding. A *scripling-machine.*

Fig. 4761.



Screw-Wrenches.

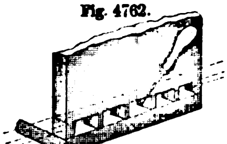
Scrib'bling. (*Cotton and Woolen Manufacture.*) The first rough carding, preparatory to the final carding.

Scrib'bling-en'gine. (*Woolen Manufacture.*) A form of carding-engine for fine, short wool, having one main cylinder, and having, in lieu of the top cards, numerous small rollers lying and rolling upon its upper surface.

Scrib'bling-ma-chine'. (*Woolen Manufacture.*) A machine in which oiled wool receives one or more preliminary cardings before passing through the regular carding-machine. It is a somewhat coarser process than carding, but of the same nature; its purpose being to bring wool to a broad, thin fleece or *lap*. It corresponds to the *breaker* for cotton. See CARDING-MACHINE.

Scribe-awl. An awl used for marking lines to be followed in sawing or cutting out work. Called also *scriber*, *scribing-awl*, *scratch-awl*.

Fig. 4762.



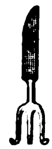
Scribe-Awl.

Scrib'er. A carpenter's marking-tool. A *scribe-awl*.

Scrib'ing. The fitting of the edge of a board to another surface, as the skirting-board of a room is *scribed* to the floor, being marked in position and then cut to match the inequalities.

Scrib'ing-com'pass. (*Saddlery.*) A compass with one pointed leg to act as a pivot, and one scooping edge to act as a marker. It is especially used to remove the gum on patent leather in a line for a row of stitches, and is set open to any degree by the arc and set-screw.

Fig. 4763.



Scribing-Iron.

Fig. 4764.

Scribing-Compass.

It is also used as a scribe in making a line near the edge of a strap, one leg passing along the guide-edge, while the other makes a groove on the line required.

Scrib'ing-ir'on. A scoring-tool for marking logs and casks. A *race-knife*.

Scrimp'ing-bar. (*Calico-printing.*) A grooved bar which spreads cotton cloth right and left, so as to feed smoothly to the printing-machine.

Scrims. Thin canvas glued on the inside of a panel to keep it from cracking or breaking.

Scrin. (*Mining.*) A small vein.

Script. (*Printing.*) A kind of type in imitation of writing. Called *Anglaise* by the French. There are many varieties, some very beautiful. See also SECRETARY; TYPE.

This is Great Primer Title Script.

This is Double Small-Pica Copperplate Script.

This line is English Script.

This is Double Pica Graphotype.

This is Double English Italian Script.

This line is Great Primer Script.

This line is Pica Script.

This is Double Small-Pica Italian Script.

This line is set in Double Small-Pica Running-Hand.

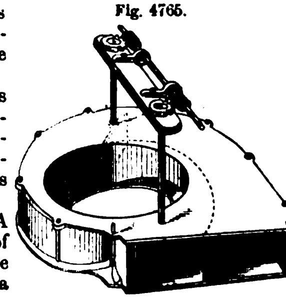
This is Double English Notarial.

Scroll. 1. (*Joinery.*) An ornament of a form derived from, and yet distantly resembling, a partially unrolled scroll of parchment. Instruments are made for laying out scrolls and curves for stair-work, and other irregular forms. See SPIRAL, INSTRUMENT FOR DRAWING.

2. (*Hydraulic Engineering.*) A spiral or converging adjutage around a turbine or other reaction water-wheel, designed to equalize the rate of flow of water at all parts around the circumference of the wheel, by decreasing the capacity of the chute in its circuit. See TURBINE.

A double scroll is seen in the cut, the valves of each being operated by a single rod, and two worms meshing into the segment-racks of the valve-stems. Each chute supplies one half the circumference of the wheel.

Fig. 4765.

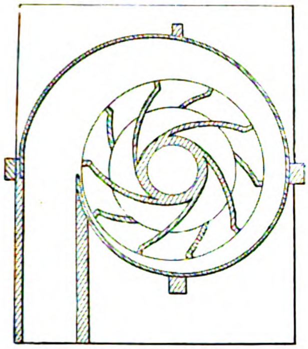


Scroll.

Fig. 4766 shows by a horizontal section the scroll diminishing in sectional area as it passes around the wheel.

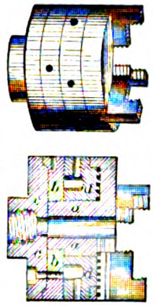
3. (*Ship.*) A piece or pieces of timber bolted to the stem in lieu of a figure-head.

Fig. 4766.



Turbine and Scroll.

Fig. 4767.



Scroll-Chuck.

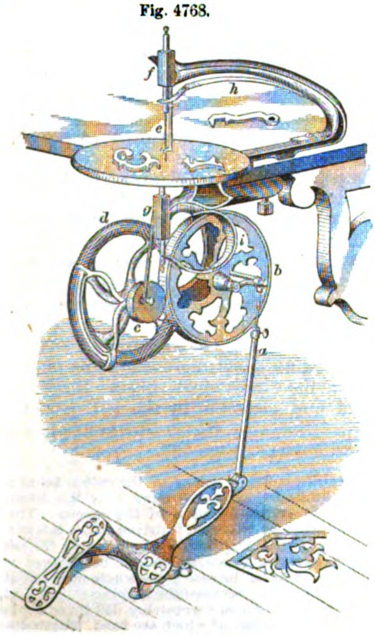
Scroll-chuck. (*Lathe.*) A device for holding and centering work in the lathe. The body of the chuck is formed of three pieces *a b c*; between these is inclosed a ring *d*, which may be revolved independently. In the face of the chuck are three radial grooves, each of which has two feathers projecting from its sides into the body of the groove; the three jaws slide freely along these grooves and feathers. A spiral on the face of the ring *d* enters a counterpart spiral on the inner ends of the jaws, so that by revolving the ring these are caused to approach or recede from the center.

Scroll-gear. A gear-wheel of spiral or *snail* form. See SCROLL-WHEEL.

Scroll-saw. A relatively thin and narrow-bladed reciprocating-saw, which passes through a hole in the work-table and saws a kerf in the work, which is moved about in any required direction on the table. The saw follows a scroll or other ornament, according to a pattern or traced figure upon the work.

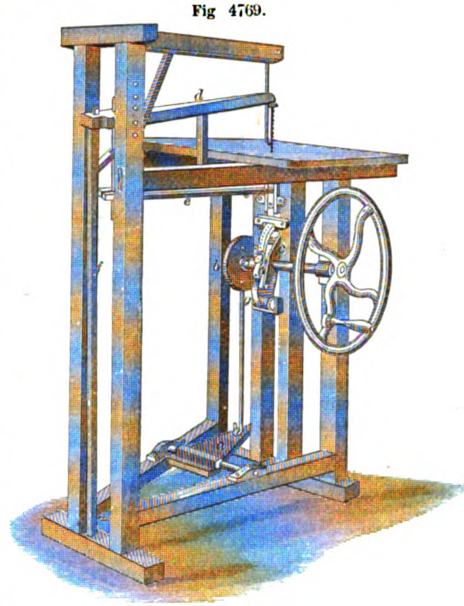
The *band-saw* is a scroll-saw, and operates continuously. See BAND-SAW.

Fig. 4768.



Fleetwood's Scrol'-Saw.

Fig 4769.



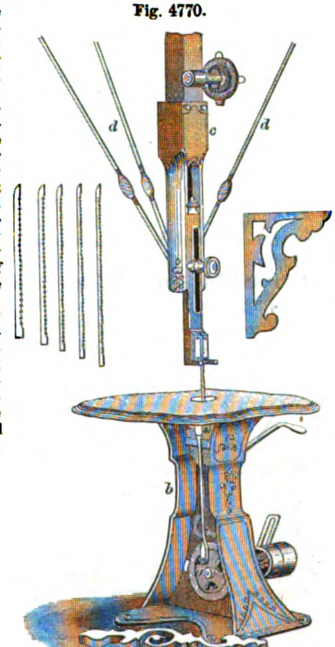
Tapley's Scroll-Saw.

The example, Fig. 4768 (Fleetwood's), is operated by a treadle connected by a pitman *a*, one part of which slides within the other, rendering it adjustable as to length to the friction-wheel *b*, which turns the smaller friction-wheel *c* and fly-wheel *d*. A pitman on the wheel *c* reciprocates the saw *e*, which is connected at each end to guides working in collars *f g* above and below the table on which the work is supported. Springs *h i* attached to the guides maintain the tension of the saw.

Tapley's is operated by a treadle *a* which imparts rotation to the wheel *b* and an arm *c* having rollers at each end. The saw is strained between the bars *d e*; the former attached to an upright wooden spring *f*. The rotation of the arm *c* opens out the endless strap *g*, which is made fast below and attached above to the saw-sash, causing the downward stroke of the saw, which is immediately thrown upward again by the spring *f*. The bar *d* may be raised or lowered to suit saws of different lengths, and the throw of the saw may be varied by the adjustment of a buckle on the strap *g*.

Fay's scroll-saw (Fig. 4770) is reciprocated by a pitman on the wheel *a*. The saw-holders move in vertical guides in the table-support *b* and hanger *c*, which is

Fig. 4770.



Scroll-Saw.

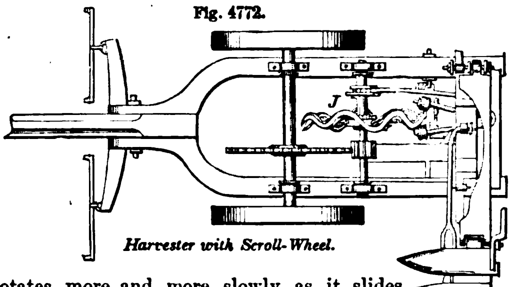
Fig. 4771

Scroll-Wheel.

steadied by tension-rods *d*. Uniform tension is secured at all points of the stroke.

Scroll-wheel. The scroll-gear acts upon the pinion, which slides by a feather on the shaft and

Fig. 4772.



Harvester with Scroll-Wheel.

rotates more and more slowly as it slides inward. It moves relatively faster as it slides outward, when the motion of the scroll-wheel is reversed.

In Fig. 4772, the scroll-wheel *J* is driven by gear and pinion from the main shaft. The friction-rollers are on the opposite sides of the scroll-wheel and impart motion to the cutter-bar.

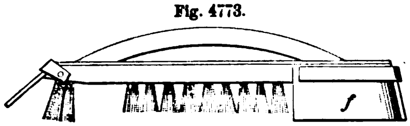
Scrow. Tanners' and curriers' clippings, used for glue-making.

Scrub'ber. 1. (*Gas-making.*) An apparatus for ridding coal-gas of tarry matter and some remains of ammonia. It consists of a tall cylinder filled with bricks, paving-stones, or coke, and having an arrangement by which a stream of water can be admitted at top and removed at bottom.

2. (*Leather.*) A machine in which leather from the tan-pit is washed to cleanse it from adhering particles of bark, hair, gum, sediment of the liquor, and other filth which it has accumulated in the various handlings during the process of tanning. *Scrubbing* is preliminary to *finishing*.

Scrub'bing-brush. A stiff brush used for scrubbing. The example has one or more flexible rubbers

Fig. 4773.



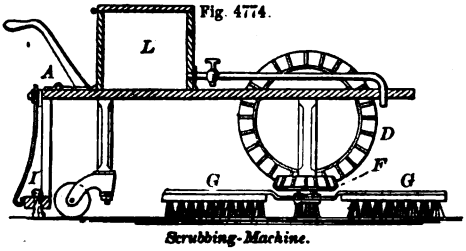
Scrubbing-Brush.

f at the end, which retain the water around the bristles.

Scrub'bing-ma-chine'. An apparatus for scrubbing floors or carpets.

In Fig. 4774, the brushes *G G* are rotated by bevel-gears *D F*; water is supplied by a pipe from the

Fig. 4774.



Scrubbing-Machine.

cistern *L*. The machine rests on rollers, is pushed forward by handles *A*, and has a swab attachment *I*.

Scrutch'er. (*Agricultural.*) A machine adapted to break, beat, or scrape flax, etc., to remove woody matter. See SCUTCHER.

Scuf'fle-har'row. (*Husbandry.*) A harrow with cutting shares instead of mere teeth.

Scuf'fle-hoe. (*Agricultural.*) A thrust-hoe having the blade in line, or nearly so, with the handle.

Scuf'fler. (*Agricultural.*) A form of cultivator used in Britain, and not distinguishable from the *cultivator* and *scarifiers*.

Scull. (*Nautical.*) *a.* A short oar rowed with one hand, two being handled by a single man, as in river-wherries and match-boats.

b. An oar used over the stern by a rocking action obliquely against the water.

c. A small boat.

Scull'ing-pro-pel'ler. See PROPELLER; OAR-PROPELLER; VIBRATING-PROPELLER.

Sculp'er. (*Engraving.*) See SCORPER.

Sculpt'ure-cop'i-er. An instrument or machine on the principle of the pantograph, for copying statuary.

James Watt was working upon a machine for taking reduced copies of busts and statues when he was attacked by his final sickness. He had produced some good specimens of his work, and had distributed them among his friends.

Scum'bling. Giving a kind of rough dotted shadow to objects in a nearly finished drawing. It is performed with a brush having some dark-brown color in it, but nearly dry.

Scum'mer. A perforated ladle or dish used in removing feculences from the surface of boiling solutions. A *skimmer*.

Scup'per. (*Shipbuilding.*) A hole or tube leading from the water-way through the ship's side, to convey away water from the deck.

Scup'per-hose. (*Nautical.*) A canvas or leathern spout on the outside of a scupper-hole, to conduct the water clear of the vessel's side.

Scup'per-leath'er. (*Nautical.*) A flap-valve of leather outside of a lower-deck scupper to keep the sea-water from entering, but permitting exit of water from the inside.

Scup'per-nail. (*Nautical.*) A short nail with a very broad, flat head; used for nailing on scupper-hose, battening down tarpaulins, fastening pump-leathers, etc.

Scup'per-plug. (*Nautical.*) A tapering block, to close a deck-scupper.

Scup'per-shoot. (*Nautical.*) A pipe to conduct deck-water to the sea-level.

Scutch. A wooden instrument for dressing flax or hemp.

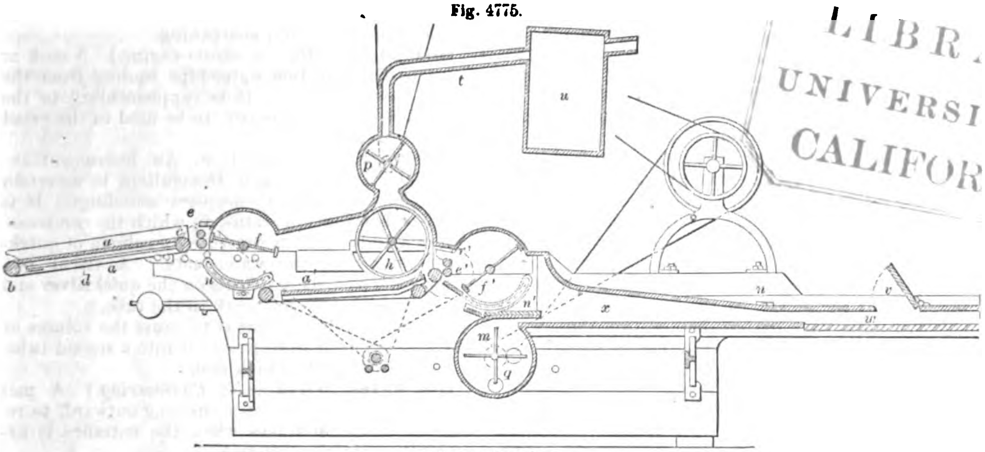
Scutch'eon. 1. (*Locksmithing.*) A cover or frame to a keyhole. A sliding scutcheon is called a *sheave*.

2. A name-plate on a coffin, pocket-knife, or other object. An *escutcheon*.

Scutch'er. (*Cotton-machinery.*) A machine, also known as a *batting-machine* or *blower*, which separates the individual fibers that have been loosened and cleansed by the *willower* or *opening-machine*. See also BATTING-MACHINE, page 251; COTTON-CLEANER, page 633.

This machine is fed by means of the cotton being spread by hand on the feed-cloth *a a*, passing over the rollers *b c*, and moving slowly in the direction of the arrows. The roller *c*, which is 3 inches in diameter, is driven at the rate of four revolutions per minute. The cloth is supported by the table *d*, and consists of a series of bands, which can be strained more uniformly than would be the case if the whole were one cloth. At *e* the cotton is caught between the nipping-rollers *e*, which present it to the batting-arm *f*, revolving 640 times a minute, and having arms, at the end of which are fixed, longitudinally, two narrow thin strips of sheet-iron. These, catching the cotton

Fig. 4775.



Cotton-Scutcher.

presented to them by the nipping-rollers, tear it off, separating the fibers from each other, and letting the dust, etc., fall through the grid *n*. The fibers thus torn asunder are again collected upon a second feed-cloth *a'*, where they are pressed together by the drum *h*, and then again caught by the nipping-rollers *e' r'*, to subject the cotton to a second batting operation at *f'*. As only the heavy impurities pass through the grid *n'*, a sucking action is provided by means of the fan *p* over the perforated compressing-drum, revolving 150 times per minute, by which the light dust is sucked up and conveyed through the channel *t* into the box *u*, where it is deposited. From the second batting-apparatus the cotton fibers are thrown into the closed channel *x*, and are driven through the same by a second fan *m q*, revolving 700 times per minute. At *w* is another grating, consisting of bars slantingly placed, and at *n v* are two doors through which the cotton is taken out.

This batting-machine can produce 500 to 600 pounds of scutched cotton in 12 hours.

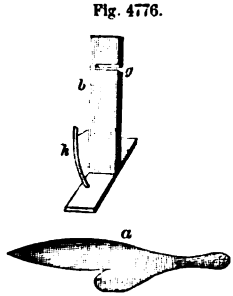
2. (*Flax Manufacture.*) A machine for dressing flax. See SCUTCHING-MACHINE.

3. (*Silk-machinery.*) A beating-engine, in which floss and refuse silk — the fibers having been previously disentangled, straightened, laid parallel, and cut into lengths — is brought to a downy condition, in which it may be treated like cotton by *carding*, *slubbing*, *roving*, and *spinning*.

The scutcher is also used to lighten up the staple and restore the downy condition thereto, after the operations of *cleansing*, *washing*, and *pressing* the fiber. From the second *scutcher* the silk staple passes to the *carding-machine*.

Scutch'ing-ma-chine'. (*Flax Manufacture.*) Scutching is an operation succeeding that of *breaking*, and similar in its operation. Its effect is to still farther separate the woody portions from the fiber, the *shives* from the *hare*, by a beating operation, which makes short bends in the stalk, as it is crimped between the bars of the descending and stationary jaws.

Fig. 4776.



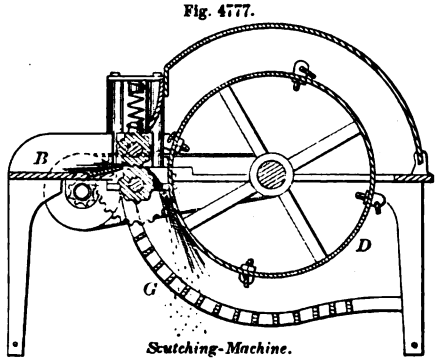
Scutching Sword and Stand.

Scutching is performed with the scutching-sword *a* held in the right hand, while with the left a handful of the bruised stems is introduced into the groove *g* in the stand *b*. A leathern band is stretched between the upright of the stand and the stake *h*, which causes the sword to rebound after each downward blow, thus easing the labor of the workman.

All remaining woody particles are removed by a blunt knife, the flax being laid across the workman's leg, which is covered with a piece of leather.

In the machine (Fig. 4777) for thrashing and scutching flax, the stalks are fed from the table *B* between two fluted rollers, the lower one of which is journaled in fixed bearings, and the upper is yielding, being pressed down by spiral springs. On passing through the rollers the stalks are subjected to the action of a series of swinging beaters pivoted in eyebolts on the

Fig. 4777.



Scutching-Machine.

drum *D*, which rotates at about 10 times the velocity of the rollers. The separated seeds drop through the slatted bottom *G*, and the bruised fiber is conveyed to an opening at the rear of the machine. See also SCUTCHER.

Scutch'ing-mill. A mill in which fiber is scutched. See SCUTCHING-MACHINE.

Scutch'ing-stock. (*Flax Manufacture.*) The part of the machine on which the hemp rests in being scutched.

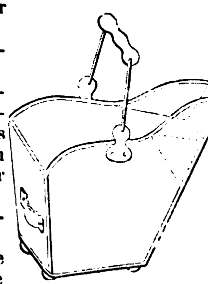
Scutch-rake. A flax-dresser's implement.

Scut'tle. 1. (*Nautical.*) A small opening in a ship's deck or side, closed by a shutter or hatch.

2. (*Building.*) A similar opening in a wall or roof.

3. (*Domestic.*) A coal-bucket.

Fig. 4778



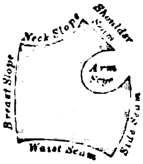
Coal-Scuttle.

Scut'tle-butt. (*Nautical.*) A cask having an opening, covered by a lid, in its side or top. It is lashed on deck, and contains the water required for immediate use.

Scut'tle-cask. (*Nautical.*) See SCUTTLE-BUTT.

Scye. The curve in the front and back, or front side and back, pieces of the waist

Fig. 4779.



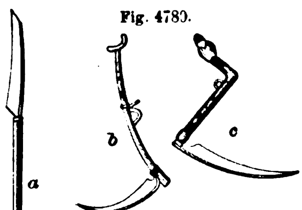
Scye.

of a garment, adapted to fit or suit the contour of the *arm* where it joins the *body* of the garment. The sleeve is adapted to fit this slope.

Scythe. (*Agricultural.*) A cutting implement having a long curved blade and a crooked handle set nearly at a right angle thereto; used for mowing grass. It is worked with a peculiar swinging motion, both hands being employed. For this purpose, the handle has two offsets or projecting pieces (*nibs*) which are grasped by the mower. The implement is of great antiquity, but was probably preceded by the sickle, as the hay crop was not an object of importance to the inhabitants of those warm countries in which the cultivation of cereals was first practiced.

"Of the scythe," says Pliny (A. D. 79), "there are two varieties, — the Italian, which is the shorter and can be handled among brushwood; and the two-handed Gallic scythe, which makes quicker work of it when employed on their extensive domains, for there they cut the grass in the middle only, and pass over the shorter blades. The Italian mowers cut with one hand only."

Fig. 4780.



Scythes.

A straight-handled scythe is used for mowing grass and weeds on the sides of ditches, and is useful in clipping hedges for those who prefer it to shears. It is not easy to give the true scythe-motion to this tool, and the title is a misnomer, though the implement has its uses. See PRUNING-TOOLS.

a is the English *hack-scythe*

b is very different from our mowing-scythes. It more resembles our brier-scythe, lacking, as it does: 1, the graceful curve and length of blade; 2, the peculiar curve of handle, which enables the mower to swing it in so extended an arc; 3, the nibs so placed as to afford a convenient grasp not liable to wrench the wrist or tire the fingers.

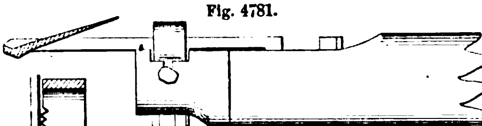
It is the scythe of the Netherlands for mowing.

The Hainault scythe *c* is the general reaping implement of Holland and Belgium. The handle is 14 inches long, with a hand-hold of 4½ inches. The blade is 27 inches in length, the point a little raised, and the entire edge beveled upward, so as to avoid the surface of the ground and the frequent use of the whetstone. It is grasped by one hand, like a reaping-hook.

Great exertions have been made to introduce this into Scotland, but without success; the reaping-hook and sickle maintained their hold until soon after the American harvesting-machine made its appearance at the International Exhibition in London, 1851. See also REAPING; CRADLE; GRAIN-CRADLE.

Scythe-fas'ten-ing. The ring and wedge or

Fig. 4781.

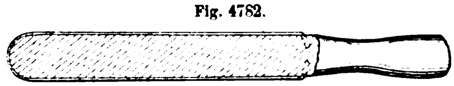


Scythe-Fastening.

equivalent device by which the tang of the scythe is clamped to the end of the scythe-snath.

Scythe-stone. A whetstone or rifle. The example has a steel wire fitted into a groove around

Fig. 4782.



Scythe-Rifle.

its edge, by means of which the edge of the scythe may be burnished after sharpening.

Sea-cock. (*Marine Steam-engine.*) A cock or valve in the injection water-pipe leading from the sea to the condenser. It is supplementary to the usual cock at the condenser, to be used in the event of injury to the latter.

Sea-gage. (*Nautical.*) *a.* An instrument invented by Drs. Hale and Desaguliers, to ascertain depths beyond ordinary deep-sea soundings. It is a self-registering apparatus, in which the condensation of a body of air is caused by a column of quicksilver on which the water acts. A viscid material, such as molasses, floats on the quicksilver and leaves its high-pressure mark in the tube.

Ericsson's improvement is to cause the volume of water thus forced in to pass over into a second tube.

b. A TIDE-GAGE (which see).

Sea-gates. (*Hydraulic Engineering.*) A pair of *dock* or *tidal-basin* gates, opening outward, to resist the action of waves when the entrance is exposed thereto during storms.

Seal. 1. A species of die having a device or motto cut in *intaglio* on its face for the purpose of stamping a device or motto in *relief* on clay, wax, or other material, while in a plastic state, or upon paper.

The signet of Taia, the Queen of Amenophis, is still in existence, in the Egyptian Museum of the Vatican.

The golden seal of Menes is in the Abbott Collection, Historical Society of New York.

The signet-rings of Thothmes III. (gold) and Amunoph III. (silver) have been preserved.

In ancient times the ring usually served as a seal. The most ancient heroes are described as wearing seals. A law of Solon, to prevent counterfeiting seals, forbade the seal-engraver to keep the form of a seal made by him. Ancient seal-rings were of gold, iron, ivory, etc. They were worn by both sexes in Greece, commonly on the fourth finger, but the fingers were sometimes loaded. Gems were frequently used, the onyx being the favorite. The modern have not exceeded the beauty of the ancient gem and cameo cutting.

Hollow cylinders of agate, amethyst, chalcedony, onyx, etc., one and a half to three inches long, and with a diameter one third the length, and engraved with arrow-head characters, are found among the ruins of Babylon, and were used as seals, by impressing upon either clay or wax. The axial hole was for a metallic rod, by which the seal was rolled upon the clay to deliver the impression. Hence the expression in Job xxxviii. 14:

"It is turned as clay to the seal,
And they stand as a garment."

Or otherwise rendered,

"It turneth round like a seal of clay,
And things stand out as though in dress."

In the metaphor, the earth itself is as a clay seal, rolling upon its axis, and all its scenery and busy life are but as images upon the face of the roller.

By inking the surface and delivering an impression, the character might be left white upon the material impressed.

A Babylonian cylindrical seal of jasper is in M. Durero's collection. It has a cuneiform inscription and the image of a winged genius in a flowing Babylonish garment. A clay seal, now in the British Museum, was probably attached to a treaty of peace between Assyria and Egypt, as it displays upon one piece of clay, side by side, the signets of the kings Sennacherib and Sabaco.

Fig 4783 shows two seals of Assyria (*a b*), and also impressions (*c d*) from two cylindrical seals.

c represents the fish god.

d is the royal cylinder of Sennacherib, found in the ruins of his palace at Koyunjik. The seal cylinders of Assyria were made of a great variety of hard stones, including agate, chalcedony, quartz, and jasper. The sides were slightly concave or convex, generally the former. It was perforated axially. The art culminated in the time of Sennacherib The seal, whose impression is shown at *d*, is equal in execution to the best Greek intaglios Besides the king and certain religious emblems, the ibex is shown upon the lotus flower. The material is of translucent green feldspar.

Fig. 4784 represents seals, a cylinder, and two tablets of the ancient Assyrians.

The materials for sealing in ancient times were terra-sigillaris (a kind of clay), cement, paste, wax, and lead.

King Ahab affixed his seal to the death-warrant of Naboth, 899 B. C.

Impressions on lead were attached to Saxon documents.

Fig. 4783.

Assyrian Seals.

Wax was first used on documents about 1213.

Magna Charta is sealed with white wax. In 1445, red wax was used in England. Tavernier mentions the use of gum-lac in Surat. A German recipe of three centuries since recommends

Fig. 4784.

Assyrian Seals, Cylinder, and Tablets.

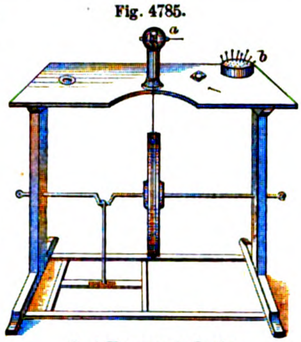
pure resin, with cinnabar, lampblack, smalt, white lead, or orpiment, according to the color desired.

An early specimen of sealing-wax is on a letter, August 3, 1554, from "Gerard Hermann" to "P. H. Von Dann," in Germany. See SEALING-WAX.

2. (*Gas-works.*) A water-trap joint, as in gas-works, where the gas is drawn or forced beneath a plate, whose lower edge is beneath the level of the water in the tar-well. See DIP-PIPE, page 705.

Seal-en-grav'er's Lathe. A table hollowed out at one side, and having a treadle connected with the shaft of a pulley, which has belt connection with the quill of the engine *a*, fastened on its upper surface. *b* is a device for holding the tools, and near it is a cap for containing diamond-powder paste. See SEAL-ENGRAVING.

Fig. 4785.



Seal-Engraver's Lathe.

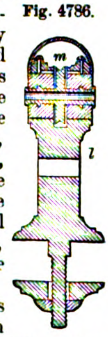
Seal-en-grav'ing. Seal-engraving was very common in ancient Babylon and other cities of Mesopotamia of that era.

The materials were amethyst, carnelian, rock-crystal, agate, bloodstone, chalcedony, onyx, jasper, serpentine, pyrites, etc.

The stones of Ethiopia, used for arrow-heads by the contingent from that country in the army of Xerxes, are spoken of as "the kind used for engraving seals." — HERODOTUS, VII. 69.

Gems, precious stones, glass, and other hard substances which do not admit the application of tools with cutting edges, are engraved either in relief or in intaglio by means of small revolving wheels charged on their edges with fine abrasive powders and lubricated with oil or water. The object to be engraved is applied to the lower edges of the wheels by the fingers, and is turned about during the process, so as to expose every part of the device successively to the action of the little wheels, which gradually produce small hollows and grooves that are, in section, nearly counterparts of the sections of the tools employed in their formation.

Fig. 4786.



Wheel-Head.

The wheels have a great variety of sizes and shapes, and are, in conjunction with the abrading powders, the only means employed to produce the device.

For engraving hard stones, the wheels are made of iron and charged with diamond powder, and are generally lubricated with *oil of brick*, and the surfaces are polished by means of copper wheels charged with rottenstone and water.

For engraving glass, similar but larger tools of copper, charged with emery-powder and olive-oil, are employed, and the polishing is effected with leaden tools charged with pumice-powder and water.

The wheels, called *tools* (*a* to *k*, Fig. 4787), have long, conical stems fitting into the hollow mandrel or *quill* of a small lathe-head or engine (Fig. 4786), mounted on a table, which is hollowed out in front, and has a light treadle for turning the engine with a steady motion. The lathe-head *l* has a conical cap to prevent access of dust, and for steadying the hand of the operator. It contains a pulley *m*, through the hollow bearings of which the quill passes. The quill is of steel, about 2 inches long and ½

Fig. 4787.

Seal-Engraver's Wheels.

inch in diameter, and has a longitudinal groove, into which a feather on the tool fits. It is a part of the lathe, Fig. 4785.

The general shape of the tool is that of a disk rounded on the edges. For cutting fine lines, the edge is sometimes made almost as thin as that of a knife, but for some purposes the tool is made nearly spherical. The tools with rounded edges cut more rapidly, and are used for removing the bulk of the material, while those with flatter edges are employed for smoothing the surface. To prevent the stem from interfering with the action of the tool in this case, it is made tapering. The tools seldom exceed $1/8$ of an inch in diameter, and are made as small as $1/150$ of an inch. Their surfaces must be smooth, as any irregularity tends to chip off pieces of the stone. The diamond powder is mixed into a paste with oil, is kept in a box, and is applied to the edge of the tool as required, being moistened from time to time with oil of brick or sperm oil to keep it from drying on the tool.

The stones are shaped to their general form by the lapidary, and are frequently set before being engraved: if set, they are inserted in a notched piece of cork or bamboo; if otherwise, they are cemented to a wooden handle. If the surface is hard and polished, it is roughened by rubbing on a steel plate charged with diamond powder and oil; if soft, on a leaden plate with emery. The outline of the design is sketched on the stone with a brass point, and the surface within this outline is sunk; the details are then sketched and sunk in succession.

A lens is mounted on the stand, through which the engraver watches the progress of his work, occasionally taking a proof with blue modeling clay, or a composition of beeswax and fine charcoal powder.

Seal'ing. 1. (*Building.*) Securing an object in a wall or other surface by means of mortar or cement.

2. (*Hydraulics.*) Preventing flow or reflux of air or gas in a pipe by means of carrying the end of the inlet or exit pipe below the level of the liquid. See SEAL; SEAL-PIPE; DIP-PIPE, Fig. 1660.

Seal'ing-press. See SEAL-PRESS.

Seal'ing-wax. A composition for securing letters and packets.

Bitumen from Asia was used among the Egyptians and Romans. Pipe-clay, or a cement of pitch, wax, plaster, and fat, was also used.

Sealing-waxes made of resin, and colored with vermilion, lampblack, white-lead, or orpiment, were made in Europe in the sixteenth century. The art seems to have been derived by the Portuguese from India, and to have reached the rest of Europe through Spain. It was long known as *Spanish wax.*

Sealing-wax has a resin for its basis, and has no wax in its composition; but as it took the place of wax as a material for sealing documents, the old name was retained.

The best is made of shellac and Venice turpentine, colored by vermilion or ivory black.

The great official seals of England, Scotland, and India are made of different colors respectively, and of various ingredients, and a great fuss is made about it.

The great seal of England is made according to a recipe preserved by the Lord Chancellor, and it makes excellent grafting-wax, as the writer knows by experiment. It comes rather high for the purpose.

The following is a good recipe: —

Melt 4 pounds of shellac; 1 pound of Venice turpentine; 3 pounds of vermilion. Incorporate by stirring, weigh into portions, and roll into sticks. Polish by exposure to a charcoal fire.

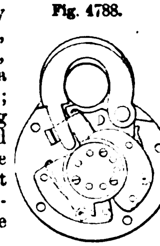
Common sealing-wax consists of resin, turpentine, red-lead.

At the Vienna Exposition were shown small sticks of variously colored sealing-wax, tipped with an inflammable compound, which, when ignited by friction, burns and fuses the wax, permitting it to be used very conveniently, without wasting or dropping, as is usually the case. The quantity in each stick is sufficient for one common or two small seals. Commenting on this, the "Technologist" says that the device is by no means new, being even older than the invention of friction-matches.

Seal-lock. A lock provided with a seal which must be ruptured in the act of unfastening, and which thus indicates the fact in case of its being improperly opened or tampered with.

In Fig. 4788, the paper seal is held down upon the plate through which the key is to pass to reach the tumbler, by a shutter hinged at one end, and, when closed, fitting within a raised frame upon the lock-plate; the shutter has a hook projecting from its free end, which is grasped by a projecting portion of the tumbler at the same instant that another portion of the same tumbler engages with the nose of the hasp.

Fig. 4788.



Seal-Lock.

The lock-bolt has two catches which simultaneously engage with or disengage from the hasp and from the seal-cover, so that a seal cannot be removed from the lock without unlocking the same.

In later locks of this kind variegated glass is employed in making the seals. These are cut into squares $\frac{1}{2}$ or $\frac{5}{8}$ inch in diameter, each containing a letter and number, a photograph having been previously taken of the sheet, and the photograph is also divided into corresponding squares.

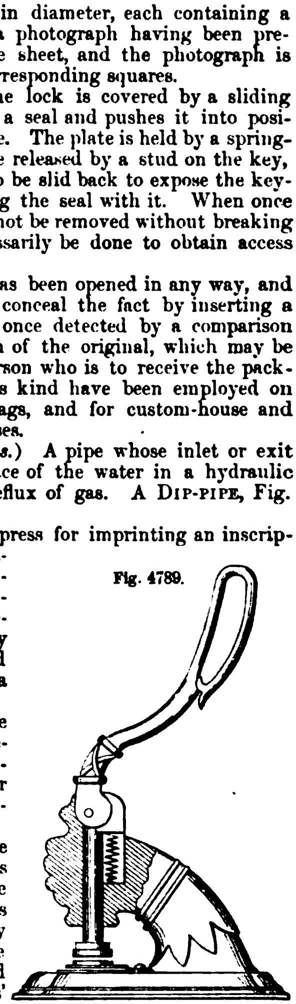
The keyhole of the lock is covered by a sliding plate which receives a seal and pushes it into position over the keyhole. The plate is held by a spring-catch, which may be released by a stud on the key, allowing the plate to be slid back to expose the keyhole, without moving the seal with it. When once in place the seal cannot be removed without breaking it, which must necessarily be done to obtain access to the keyhole.

In case the lock has been opened in any way, and an attempt made to conceal the fact by inserting a fresh seal, it is at once detected by a comparison with the photograph of the original, which may be forwarded to the person who is to receive the package. Locks of this kind have been employed on freight-cars, mail-bags, and for custom-house and various other purposes.

Seal-pipe. (*Gas.*) A pipe whose inlet or exit is beneath the surface of the water in a hydraulic main to prevent reflux of gas. A DIP-PIPE, Fig. 1660.

Seal-press. A press for imprinting an inscription or device on paper or plastic material. In the example, the handle depresses the seal by means of a cam, and is thrown up by a spring.

Fig. 4789.



Seal-Press.

A fly between the die and the bed prevents the surrounding parts of the paper from receiving an impression.

Seal-skin. The skin of the seal is light, but of a close texture, and makes a very dense, heavy leather. It is made into black enameled leather for ladies' shoes, for hunting and riding boots and knapsacks. The pelt is also largely applied for caps and fur clothing. The long hairs are pulled out, leaving the short, fine, soft fur, which is thick on the skin; after which the fur is dyed.

Seam. 1. (*Shipwrighting.*) The space between

two planks of a ship's skin, filled with oakum by *calking*.

2. (*Fabric.*) The junction of two widths of fabric united by sewing.

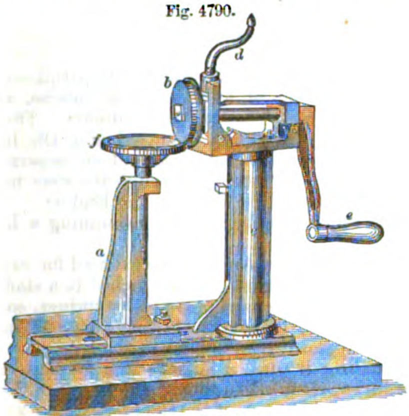
3. (*Mining.*) *a.* A narrow vein or layer.

b. A horse-load.

Seam-ham'mer. (*Coppersmithing.*) A creasing-hammer for flattening seams and joints.

Seam'ing-ma-chine'. A machine for forming the joints at the edges of sheet-metal plates. In that shown, Fig. 4790, this is effected by placing the work on a *former* at the top of a mandrel in the

Fig. 4790.

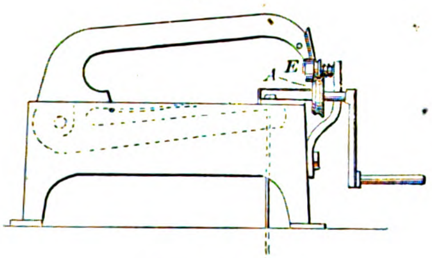


Seaming-Machine.

horizontally adjustable shaft *a* and bringing down upon it the rotating head *b*, journaled in a casing, the upper part of which is hinged, on top of the standard *c*. A screw *d* forces the head tightly down on the seam, and by turning the handle *e* it is caused to rotate, carrying with it the former *f*, pressing the two parts firmly, and closing the seam. See also DOUBLE-SEAMING MACHINE; ROOF-SEAMING MACHINE.

In Fig. 4791, when the cylindrical part of the can is formed and the flange turned upon the bottom, the seam is completed by the grooved rotary-

Fig. 4791.

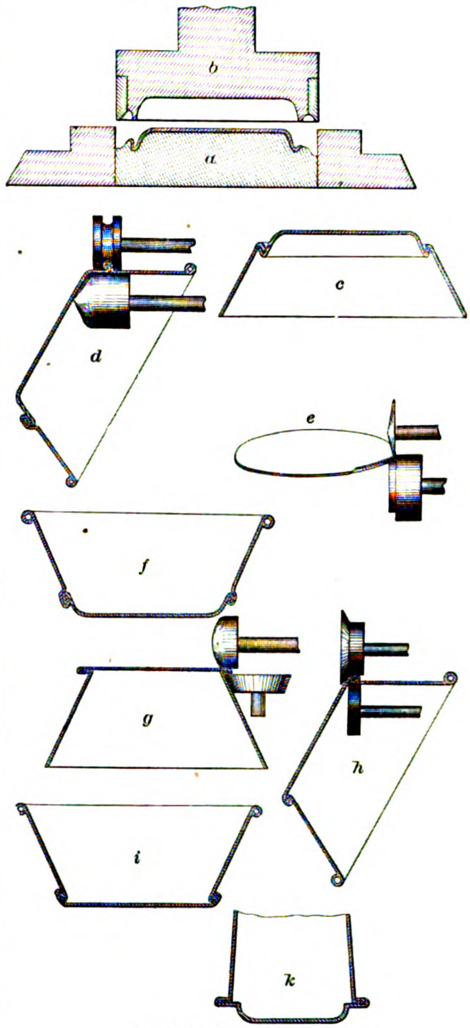


Seaming-Machine.

roller *A* and adjustable rotary pressure-head *E*. The pressure-head is drawn downward by a treadle and raised by a spring.

In Fig. 4792, the bottom of a pan or other vessel is struck up between the dies *a b*, and united to the body by a single pressure between two rollers of proper shape to close the seam, forming the joint shown at *c*. Other methods of performing this operation, and the seams produced thereby, are seen at *d e f g h i k*. See also STAMPING-MACHINE; STRIKING-MACHINE.

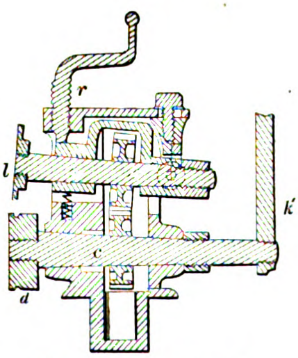
Fig. 4792.



Seaming Sheet-Metal Ware.

Fig. 4793 is another form of seaming-machine, in which the upper axis, carrying the flanging-roller *l*, is depressed by turning the hand-screw *r*, depressing the tin plate into the groove of the roller *d*. The axis *c* is then turned by the handle *k'* spinning up the edge of the tin plate as it passes between the two rollers.

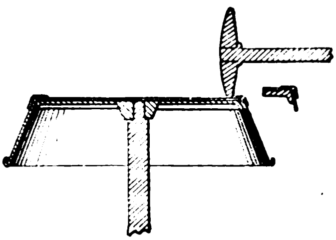
Fig 4793.



Tinman's Seaming-Machine.

Seam'ing-tool. A tool for joining or working the edges of sheets of metal.

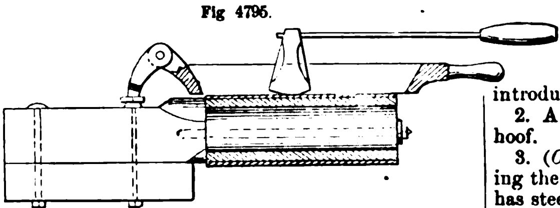
Fig. 4794.



Seaming-Tool for Pans.

(See SEAMING-MACHINE.) Fig. 4794 is a machine for deflecting the bottoms of vessels made of sheet-metal. The inverted pan is laid upon a disk which has a flat central depression and a marginal flange; against the edge of the latter the bottom of the pan is deflected by the rotary head.

Fig 4795.



Tool and Holder for soldering Seams of Sheet-Metal Ware.

Fig. 4795 is a device for seaming sheet-metal cans. The metallic cylindrical former receives the sheet-metal cylinders to be soldered; an adjustable solder-trough clamps the suture, and a soldering-iron passes along to complete the operation.

Seam-lace. (*Fabric.*) A narrow stuff used by carriage-makers to cover seams and edges.

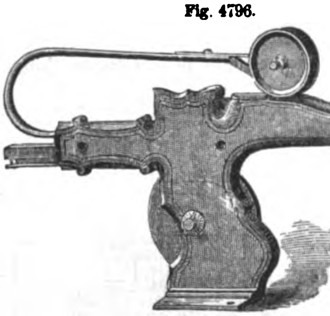
Seam-press'er. 1. (*Husbandry.*) A heavy roller to flatten newly plowed land.

2. (*Tailoring.*) A sadiron or goose, to flatten seams.

Seam-roll'er. (*Boot-making.*) A burnisher, or rubber, for flattening down the edges of leather where two thicknesses are sewn together. Machines for seam-rolling have a jack or holder for the boot-leg and a reciprocating rubber to flatten the seam.

Seam-rub'ber. The roller is attached by the curved spring to a sliding bar, which is reciprocated in ways in the cross-head through suitable gearing

Fig. 4796.



Seam-Rubber.

communicating with the rotary shaft and pinion. The seam to be pressed or rubbed is adjusted over the longer arm of the cross-head beneath the roller.

Seam-set. 1. (*Tin-working.*) A punch used by tinmen for closing the seams prepared on a hatchet stake. (See STAKE.) The face has a groove which shuts down the edges, usually upon a wire.

2. (*Shoemaking.*) A tool for flattening the seams of boots, shoes, or harness.

Fig. 4797.

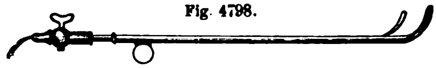
Seam-Set.

Sear. (*Fire-arms.*) The pivoted piece in a gun-lock, which enters the notches of the tumbler to hold the hammer at full or half cock, and is released therefrom by pulling the trigger in the act of firing.

The *half-cock* notch is made so deep that the sear cannot be withdrawn by the trigger.

Search'er. 1. (*Surgical.*) An instrument for

Fig. 4798.



Lithotomy-Searcher.

feeling after urinary concretions. It partakes of the character of a catheter, a douche, and a forceps. The staff is a cannula. The bent ends are joined in introducing the instrument into the urethra, and are separable to grasp the stone. Through the stem may be introduced liquids to wash out the bladder.

2. A kind of probe used in examining a horse's hoof.

3. (*Ordnance.*) An instrument used for examining the bore of a gun. It is attached to a staff, and has steel points pressed outward by springs, so as to enter cavities, if any exist, when pushed in and drawn out and turned around in the bore.

Sear'ing-ir'on. A farrier's iron for cauterizing.

Sear-spring. The spring which causes the sear to catch in the notch of the tumbler.

Sea'son-ing Tub. (*Bakery.*) The trough in which the dough is set apart to rise.

Seat. 1. (*Machinery.*) The part on which another thing rests, as a valve-seat.

2. (*Saddlery.*) *a.* The broad part of a saddle, on which the rider sits.

b. The top piece on a gig saddle.

3. (*Furniture.*) The flat portion of a chair or sofa, to support the person.

Fig. 4799.

Reversible Seat.

Reversible seats are used for concert and school rooms, for railway cars and in some other places. The seat is usually fixed and the back connected to segments, which are pivoted to the arms, the pivots forming the centers of oscillation when adjusted.

4. The lower or fixed plate of a pair of bellows.

5. (*Ordnance.*) That part of the bore of a chambered piece of ordnance at which the shell rests when rammed home.

Sea-wall. (*Hydraulic Engineering.*) A revetment along a line of coast, or the bank of a water-course.

A sea-wall may form one or more sides of a harbor, as in the case of the Heptastadium of Alexandria, the moles of the Pireus and Rhodes, of Civita Vecchia, Ostia, and Antium, as well as those of many modern ports, especially in Europe, whose small rivers afford but narrow refuges.

The Roman embankments of Essex and Lincolnshire, in England, were steep mounds of earth, defended by rows of

piles, the intervals between the rows being filled up with chalk.

Modern embankments on the estuary of the Thames consist of three strata. The rise of tide is 10 feet, and the lower or main portion of the work is made with a base of 5, to 1 vertical The top width of this portion is 20 feet, and on it rests the *outburst* bank, 5 feet high and 8 feet wide at top; having a slope of $1\frac{1}{2}$ to 1; thirdly, the *swash* bank, $2\frac{1}{2}$ feet high, and the same width at top.

The embankments are *pitched* with stone on a solid facing of clay, in positions much exposed, while in others the surface is covered with clay and gravel where it is washed by the water, the upper slope being turfed or protected by a growth of couch grass, ray grass, or lucerne.

Shore defenses are of four kinds: —

1. Artificial constructions which break the force of the waves before they reach the shore.

2. Those which consolidate and elevate the shore itself, so as to enable it to resist the action of the waves.

3. Those which make or assist the accumulation of sand or shingle upon the shore.

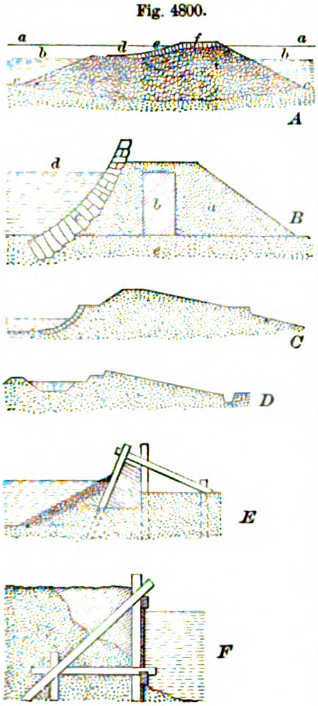
4. Permanent breakwaters, which act as islands in the offing and exclude the waves.

Of the first description *were* the cones of Cessart, placed off Cherbourg. Being destroyed, a breakwater of coursed masonry on a bank of *pierre perdue* was substituted.

Of the same description also are the moored crates of timber, through whose interstices the water passes, the timbers breaking the force of the waves See BREAKWATER.

Of the second description are the dikes of Holland and of France. These are *sea-walls*, and belong to this article

Fig. 4800.



Sea-Walls.

A, Plymouth breakwater.
B, sea-dike with facing wall and core.
C D, inclosure of Zuid Plas, near Rotterdam, Holland.
E, polder bank, Holland.
F, Havre sea-wall.

Of the third description are groins or timber erections, which are common on the sandy coasts of England and France. See GROIN.

The works of Brémontier in the Landes of Bordeaux are also of this character, though they are rather those of the planter than the constructor. His devices were eminently worthy of the engineer on the principle of Leupold's maxim, —

"Artis est naturam imitare."

Of the fourth description are the solid breakwaters of Plymouth, Cherboprg, Cette, at the mouth of the Delaware, Buffalo, and elsewhere.

Sea-walls are made in many places to protect harbors or to save the land from encroachment. When faced with coursed masonry, they may have the form shown at *B*.

a is an earthen embankment; *b*, a solid wall or core of puddle; *c*, a facing-wall of masonry; *d*, the high-water level of the sea or bay; and *e*, the natural bed. The form of the front wall must be adapted to resist the action of the waves, and the embankment must have an internal slope, according to the nature of the materials of which it is composed; for ordinary materials, a base of $1\frac{1}{2}$ to a perpendicular hight of 1 will insure the necessary stability and firmness.

If the entire embankment be formed of loose stones, with occasional facing only of laid masonry, as in the case of the celebrated breakwater at Plymouth, a form of less steepness must be adopted for the sea-face of the embankment.

A, Fig. 4800, is a section of the Plymouth (England) breakwater. The line *a a* shows the level of high-water spring-tides; *b b*, low-water spring-tides; *c c*, original bottom, varying from 40 to 45 feet below low-water mark; *d*, the foreshore; *e*, sea-slope; *f*, top, 45 feet wide. The mass of the work is composed of limestone, from the Overton quarries, distant 4 miles from the spot. The stone is raised in blocks varying from $\frac{1}{2}$ to 10 tons and upward in weight, which are promiscuously thrown into the sea, care being taken that the greater number of the large blocks are thrown upon the outer or sea slope, and that the whole are so mixed together as to render the mass as solid as possible, the rubbish of the quarry and screenings of lime being flung in occasionally to assist the consolidation of the materials. The form of the outer slope, below low-water line, has been effected by the action of the sea, and is ascertained to be at from 3 to 4 feet of base to 1 of perpendicular altitude. From low water upward the work has been set artificially and inclined at 5 to 1. The inner slope next the land is nearly 2 feet base to 1 altitude. The foreshore, shown at *d*, which is from 30 to 70 feet wide at different parts of the work, rises from the toe of the slope to a hight of 5 feet above low water at its outer extremity, and serves to break the waves before they reach the main work; thus diminishing their force, and, at the same time, preventing the recoil of the wave from undermining the base of the slope.

No other country in the world has so stern a contest to wage with the waters for its existence as Holland. Many thousands of square miles of tillable land have been reclaimed, and are only maintained by vigilance in the preservation of the *dunes* or banks of sand which oppose the waters of the ocean and the large estuaries and rivers of the country. The conformation of these is indicated by the illustrations, one of which (*D*) shows a sea-wall, and the other (*C*) one of the subordinate embankments, whereby the interior water-courses are lifted above the level of the country they traverse.

The materials of the Dutch sea-walls or *dikes* vary with the facilities, situation, materials, exposure, slope, etc.

Piling; double sheet-piling, with interposed puddle or rubble; earthen embankments, with or without walls of puddle. to render them water-proof; bundles of reeds, fascines, or gabions, laid in cross tiers with strata of soil, and secured by stakes or masonry.

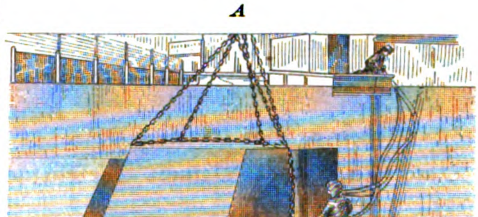
Another form of sea-wall *E* is extensively used in the banks of the polders of Holland. It consists of a double row of sheet-piling inclosing a *puddle dike* of retentive soil. The foot is protected by an apron of rubble.

At Havre an embankment of earthwork is formed behind a vertical inclosure of sheet-piling, as shown at *F*. The piles of the face are fastened by diagonal ties to the rear row of piles. The foot is protected by rubble or coursed masonry, according to the character of the ground, the exposure to currents, etc.

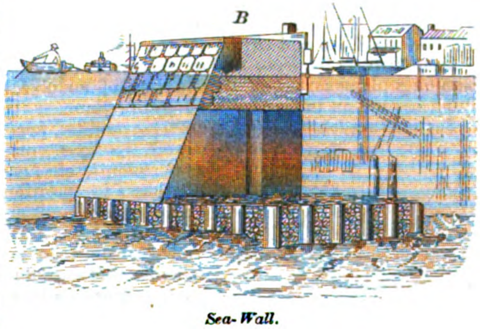
In Fig. 4801, *A B* illustrates the sea-wall now being built along

Fig. 4801.

A



B



Sea-Wall.

the water-front of New York City. Beyond this, piers will project into the stream. In the execution of the work the old wooden docks are removed, and the bed of the river dredged until solid bottom is reached. Piles are then driven, for the width of 27 feet, sawed off to a uniform depth below low water, and the interstices between them filled up to within two feet of their tops with stone thrown over from barges. Upon this a layer of concrete is spread by divers to the level of the tops of the piles. The concrete is composed of 1 part of Portland cement, 2 sand, 4 crushed stone; and, when it has set, blocks of the same are laid upon it to form the wall. These blocks are molded; the larger blocks designed for the front of the wall average 36 tons in weight, and batter 2½ inches to the foot on the outer or water side; square, smaller blocks are used for backing. The upper part of the wall has a granite coping whose exposed portions are dressed.

The sides of the large concrete blocks are grooved to receive a chain by which it is lowered from a derrick; the *setting* is done by divers. The wall extends into the river to various distances, — at Christopher Street 250 feet, — beyond the present front; the intermediate space will be filled in with rubbish and paved. The work, when completed, is designed to extend around nearly the whole circumference of Manhattan Island. At present (November, 1874) operations are in progress at the Battery, at the foot of Canal Street, and at the foot of Christopher Street; all on the North River side. See FLOATING-DERRICK; WHARF.

Sea-way Meas'ur-er. (*Nautical.*) A self-registering log invented by Smeaton. See LOG.

Se-bil'la. (*Masonry.*) A wooden bowl, to hold the sand and water used in sawing or grinding marble, etc.

Sec'ond-coat. (*Plastering.*) The second layer of plastering on lath.

It is called *set* in two-coat work, and *floating* in three-coat work.

Sec'ond-cut File. A file whose teeth have a grade of coarseness between the *bastard* and *smooth*. The grades are: —

Rough.	Second-cut.
Middle-cut.	Smooth.
Bastard.	Dead-smooth.

The angle of the chisel in cutting is about 7° from the perpendicular.

Sec'ond Fut'tock. (*Shipbuilding.*) A frame-timber scarfed on the end of the futtock-timbers. The *futtocks* are a series of lengths of timber, which unite to form the frame, beginning at the *floor-timbers* and terminating at the *top-timbers*.

Sec're-ta-ry. (*Printing.*) A font of type in imitation of an engrossing hand.

This is a Pica Secretary Type.

This is a Great Primer Secretary Type.

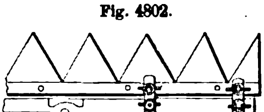
This is Italian Secretary.

Se-cret'ing. A process by which the *hairs* of hare and rabbit skins are rendered fit for felting. The skin is laid upon a table, and the hair side brushed with a solution of mercury, 32; aquafortis, 500; water, 300. The skins are then stoved, causing the retraction and curling of the hairs.

Sec'tion. (*Drafting.*) The geometrical projection on a plane surface of that portion of an object lying beyond an imaginary intersecting plane.

Sections are *longitudinal, transverse, vertical, horizontal, oblique, central, lateral*, etc., according to position and direction.

Fig. 4802.



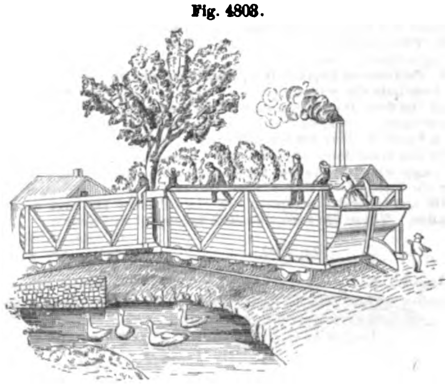
Harvester-Knife.

2. (*Surveying.*) A view showing the inequalities of the ground in reference to a base-line or line of construction.

3. (*Machinery.*) A detachable portion of a machine or instrument when made up of a number of parts: *e. g.* one of the triangular knives; a row which is attached to the cutter-bar of a harvesting-machine.

Sec'tion-al Boat. A boat made up of several independent sections, or, in fact, several boats, jointed together at their ends, so as to conform to sudden bends in the channel, or disconnected, so that each may be separately conveyed over a portage. Boats of this kind were constructed for river navigation in Russia by General Sir Samuel Bentham,

Fig. 4808.



Sectional Boat.

toward the close of the last century, and have been employed on the Morris and Essex Canal in New Jersey. See Fig. 2665, page 1176.

Sectional boats for canal or navigation subject to occasional interruption by bends or rapids are described in King's English patent, 1802. They are specifically intended for use on inclined planes, as substitute for locks where summit water is scarce.

Bond's boat is made in two portions, united by a joint near the mid-length; each has a bulkhead, so as to be separately buoyant; and one is somewhat smaller than the other, so as to pack in the larger for transportation when empty.

Ingalls, January 3, 1865. The boats are linked together consecutively by joints at their ends, which permit a certain amount of flexion.

Heath, November 15, 1864. The abutting ends of the two sections leave a recess between them. The end rails of each project and lap over the deck of the other. The sections are drawn together by a windlass and rope, one of which is made fast to a "dead-eye" arrangement on the other.

Sec'tion-al Dock. (*Hydraulic Engineering.*) The sectional dock is intended to lift a vessel above the surface of the water, in order that its bottom may be cleaned.

It consists of a series of caissons connected with a platform, which is introduced below the vessel, and, the water being pumped from these caissons by means of steam-engines, the vessel is raised by their flotation. The apparatus is towed to any place where it is necessary to apply it.

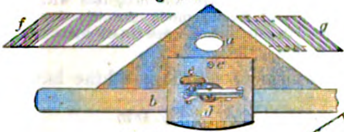
Sec'tion-al Steam-boil'er. (*Steam.*) One built up of portions secured together in such a way that the size may be increased by addition of sections; the working capacity being the sum of the whole, and the individual parts being separately removable for repair or substitution of new pieces. See STEAM-BOILER.

Sec'tion-beam. (*Warping, etc.*) A roller which receives the yarn from the spools, either for the dressing-machine or for the loom; in the latter case it is a *yarn-beam*. See WARPING.

Sec'tion-lin'er. A device for ruling parallel lines. It comprises a triangle *a*, which is held

against the side of a straight-edge *b* by a thumb-screw and a spring beneath the plate *d*, pressing against the under sides of both the ruler and triangle. The under side of the ruler is covered with rubber cloth, which, by its adhesion to the paper, prevents ready displacement, and the triangle is caused to advance equal intervals by depressing the button *e*, causing a pawl on the ruler to move the triangle a distance determined by the previous adjustment of the pawl. This adjustment is effected by means of a screw over the spring, which throws

Fig. 4804.



Section-Liner.

up the pawl after each depression, and permits parallel and equidistant lines to be ruled at various distances apart, at the will of the operator, as shown at *f g*.

Sec'tor. A mathematical instrument used for laying down plans, measuring angles, etc. It has two legs, united by a rule-joint, and graduated. The scales put upon *sectors* are divided into single and double: the former has a line with inches divided into eighths or tenths; a second, into decimals containing 100 parts; a third, into chords; the fourth has sines; the fifth, tangents; the sixth, rhombs; the seventh and eighth have latitudes, hours, etc.

Fig. 4805.

Sector.

The double scale contains a line of lines; a line of chords; third, a line of sines; fourth, tangents to 45°; fifth, secants; sixth, tangents above 45°; seventh, polygons.

In surveying, the instrument is mounted on a leg or tripod, and the bob depending from the axis of the rule-joint indicates the station exactly.

2. (*Astronomy.*) An instrument of long radius and small arc, as the DIP-SECTOR and ZENITH-SECTOR (which see).

Graham made the *sector* by which Bradley detected aberration and the instrument which the French Academicians carried to Lapland to measure an arc of the meridian.

3. (*Gearing.*) A toothed gear shaped like the sector of a circle, its face forming the arc. Its action is reciprocating, and the pitch of its teeth is not necessarily an aliquot part of the circumference.

Sec'tor-al Ba-rom'e-ter. Invented by Magellan. The hight of the mercurial column is found by the angle at which it is necessary to incline the tube, in order to bring the mercury to a certain mark on the instrument.

Sec'tor-cyl'in-der Steam-en'gine. (*Steam.*) An engine whose working-chamber is a sector of a cylinder, in which a rectangular piston oscillates to and fro like a door on its hinge. The axle of oscillation is a rocking-shaft to which the piston is fixed; and by means of an arm projecting from one of the outer ends of that shaft and a connecting-rod, motion is communicated to the crank.

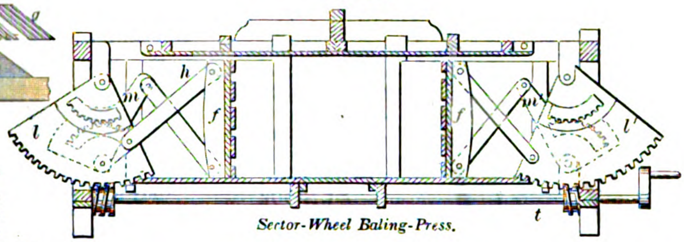
Sec'tor-gear. See SECTOR, 3; SECTOR-WHEEL.

Sec'tor-wheel. (*Gearing.*) *a.* A wheel, or rolling lever, which has the shape of a sector of a circle, a portion bounded by two radii and an arc.

It is used as a gear-wheel in machines when an impulse of moderate length is required, and has a reciprocating rotary motion.

In the illustration shown, — as an example of the use of a sector-wheel, — it is embodied in a form of baling-press, in which the followers *f f* are coincidently advanced or retracted, to press the bale or open for a new charge, as the case may be. The right and left hand screws of the shaft *t* operate cogged sectors *l l'*, whose oscillation actuates the toggles *h m m'* by which the followers are mutually approached to press the hay, etc., into the compass of a bale.

Fig 4806.



Sector-Wheel Baling-Press.

The motion derived from the worms on the shaft is imparted by means of three sector-gears, at each end, to toggles which move in unison, and are pivoted to different parts of the follower, so as to make it move squarely in the box.

b. A cog-wheel whose perimeter is formed of sectors of varying radii, imparting a variable motion to a wheel of counterpart form. A *variable wheel.*

Sec'troid. (*Architecture.*) A term applied to the surface of two adjacent groins in a vault.

Se-dan'; Se-dan'-chair. An upright conveyance for one person, much in vogue during the last century. It was usually carried by two men, by means of a pole on each side.

A similar contrivance, termed *sella*, was used by the Romans under the Empire; the poles (*asseres*) were removable.

The name is derived from Sedan, in France, where they were originally made. Their introduction into England dates back to 1581.

Sir Sanders Duncomb obtained a patent or monopoly of their manufacture for 14 years.

In the reign of James I. the Duke of Buckingham incurred great odium by using one, requiring "free Britons to perform the work of beasts."

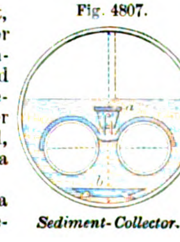
"Come in a sedan from the other end of the town." — PEPYS'S *Diary*, 1667.

The reigns of Queen Anne and the first Georges seem to have been the golden age of the sedan-chair.

Sed'i-ment-col-lect'or. (*Steam.*) A device to prevent the deposition of sediment on the bottom of boilers. An inverted hollow cone, whose mouth is a little above the water surface of the boiler. It communicates with the rest of the boiler by triangular openings near its upper edge. Scum and temporarily floating crystals of salt and solid matter passing into the comparatively still water of the cone, settle to the bottom, or apex of the cone, and are thence blown off.

Scott's (English) patent, 1827, consists of a vessel or series of vessels placed longitudinally of the boiler, and acting as a false bottom to receive the deposit. The water within these remains tranquil, while that outside may be in a state of violent ebullition.

Fig. 4807.



Sediment-Collector.

The upper collector *a* is a cast-iron trough suspended be-

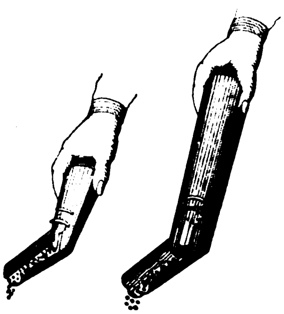
tween the flues, and partially or entirely covered with one or two cast-iron lids. This catches and retains the finer deposits which float near the surface.

The lower collector *b* is merely a shallow tray on four legs, slightly elevated above the bottom of the boiler, which receives the heavier particles deposited. See also INCRUSTATION IN BOILERS, PREVENTING.

Seed-drill. A machine for sowing seed in rows. See GRAIN-DRILL; SEEDING-MACHINE.

Seed'er. Fig. 4808 is a seed-sower for gardens. It has a gate to graduate the rate of discharge as the implement is drawn along in the little furrow made by pressure of the share, or previously by means of a hoe. See SEEDING-MACHINE; GRAIN-DRILL, etc.

Fig. 4808.

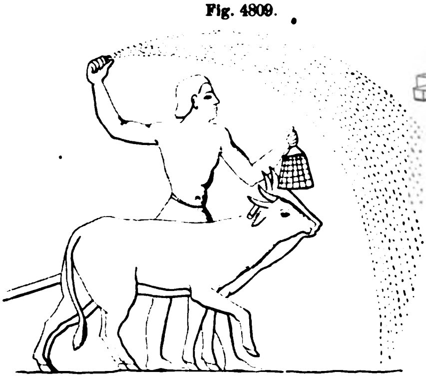


Seeder.

Seed'ing-ma-chine'. (*Husbandry.*) An implement for sowing seed. The term, in its general sense, may include machines for planting in hills, drills, or broadcast, but it is confined more usually to machines for distributing seed in drills or broadcast.

Seeding in Egypt was done upon the mud left by the retiring Nile. When Osiris retired within his banks, the fertilized ground brought forth, and the husbandman who scattered the seed from his basket

Fig. 4809.



Seeding in Egypt (from a Pyramid near Memphis).

was followed by the plows, the bush-harrow, or by a flock of sheep or goats, whose feet hid the seed beneath the surface of the soil.

There were three different modes of seeding grain in use among the Romans in the times of Varro and Columella.

1. The seed was thrown upon plowed ground and then plowed in.
2. The land was *ribbed*, or, as we say, *listed*, and the seed drilled by hand along the top of the ridge.
3. The land was *listed*, the seed sown broadcast, and covered by harrowing down the ridges.
4. The seed (such as vetches) was sown broadcast on unplowed land, and was then plowed in.

The Chinese have used a grain-drill for ages. At the present day their drill consists of a wheelbarrow carrying the seed-hopper, and having three hollow teeth, 28 inches in length, which draw a furrow into which the seed drops. This machine follows the plow, and is itself followed by the roller. See SEEDING-PLOW.

A native machine used in British India is substantially similar.

We find drills, both for seed and manure, mentioned by Worlidge in his "Husbandry," 1669.

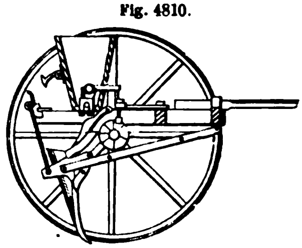
Evelyn, who was one of the founders of the Royal Society of England, and who died in 1706, wrote in high commendation of a *drill* which was the invention of Don Joseph de Lescatello, a nobleman of Carinthia, in 1663. This consisted of a seed-box, having a cylinder furnished with wheels to distribute the seed, and dropped the seed regularly in the furrow. It was fastened behind the stilts of the plow. The inventor was rewarded therefor by the Emperor Rudolphus II. He afterward took out a patent, in Spain!

It was recommended as saving 1/8 of the seed otherwise necessary on a given area. The Earl of Sandwich forwarded it from Spain to England.

In 1730, the invention came under the notice of Jethro Tull, the inventor of the horseshoe. He was delighted with the suitability of the instrument for his mode of cultivation, and its success was thenceforth established. See GRAIN-DRILL; CULTIVATOR; HOE; PLOW, etc.

Fig. 4810 is one form of seeding-machine having hollow shares drawn by drag-bars, and dropping into the furrow the seed which is uniformly fed from the hopper above.

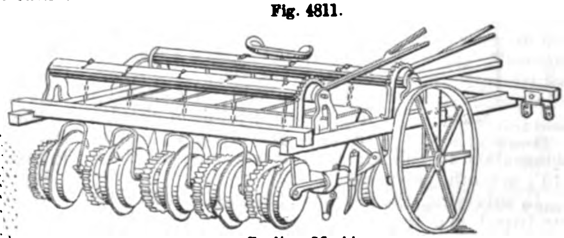
Fig. 4810.



Seed-Drill.

In Fig. 4811, the seed mechanism is actuated by the roller, which forms the earth into ridges, for protection of the seed. The relative vertical position of the parts is adjustable, to regulate the depth of planting. The rear rollers cover the seed. See also GRAIN-DRILL, Figs. 2278 - 81, pages 1002 - 4.

Fig. 4811.



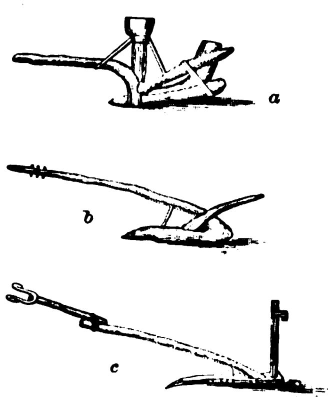
Seeding-Machine.

Howard's English grain-drill is driven by steam, sows a land 16 feet wide, and drills and harrows 20 acres per day.

Seed'ing-plow. A plow with a box, which drops or scatters seed in the furrow or on the fresh-turned earth.

a is an Assyrian plow from the "black stone" of Lord Aberdeen. The lithic record is of the time of Esarhaddon. It shows a grain-drill, with bowl for the seed, and a tube to lead it into the furrow.

Fig. 4812.



Oriental Plows.

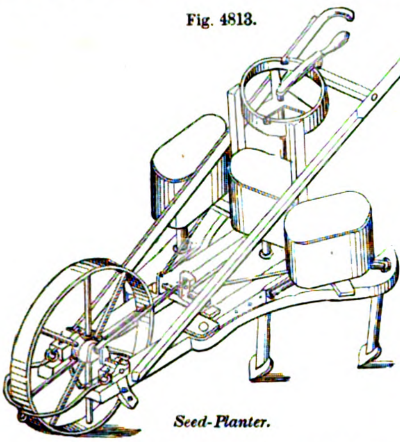
b is the modern Turkish plow.

c, the modern Arab plow.

Seed-plant'er. An implement for planting seed in hills.

Fig. 4813 is a hand implement, to be drawn by one horse. The seed-drill has a forward wheel, connecting by a crank and rod with the rod-shaft, which

Fig. 4813.



Seed-Planter.

communicates by rods with the seed-slides of the separate hoppers, which discharge into the seed-tubes of the shares. The side-bars are pivoted to the main frame, and are adjustable laterally by rack-bars and a central pinion.

Fig. 4814 is a machine for planting in check rows, so that the field may be cultivated both ways, in hills, instead of only one way, in drills.

The ground, having been marked out one way, is crossed by this machine, and as it reaches each intersection with the previous furrows, the lever is moved by the man who rides on the machine, and the seed is dropped. See Corn-planter, page 627.

Seed-sow'er. A machine for sowing grain, grass or clover seed, broadcast.

It is properly distinguishable from a grain-drill and a corn-planter, the former of which deposits the seeds and the latter the corn in hills. In *hill*, in *drill*, or *broadcast* are the three modes, and the latter is *sowing*. See Corn-planter; Grain-drill.

See'hand. (*Fabric.*) A fine muslin of a grade between nainsook and mull.

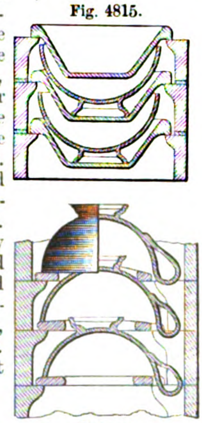
See'saw Pan. (*Sugar-manufacture.*) A rocking pan or boiler for evaporating saccharine juices. See Fig. 1890, page 813.

Seg'gar; Sag'gar. (*Pottery.*) An open box of clay, which receives articles of plastic clay or in the biscuit condition, and protects them while being baked in the kiln. The *seggars*, with their contents, are placed one above another in the kiln, the bottom of one forming the cover of the one below it. See Pottery-kiln.

The *seggars* vary in size and shape with the form and proportions of the contained ware.

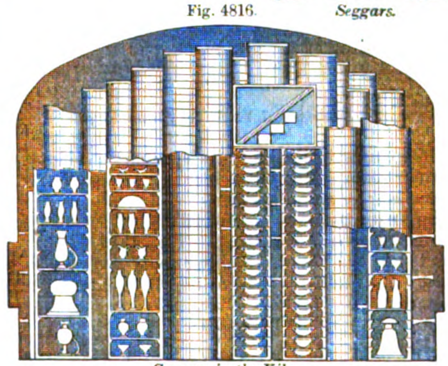
Seggars are made of fire-clay and old ground seggars molded into the shape required and baked. The articles are supported in the seggars by rings, ridges, or studs of fire-clay. In some cases the pieces rest one on another.

Fig. 4815.



Seggars.

Fig. 4816.



Seggars in the Kiln.

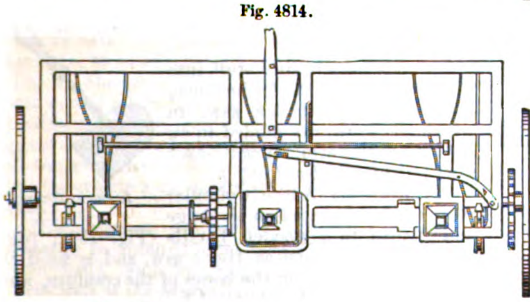
A kiln holds 30,000 average pieces inclosed in their seggars, a cylindrical pile of which is called a *bung*.

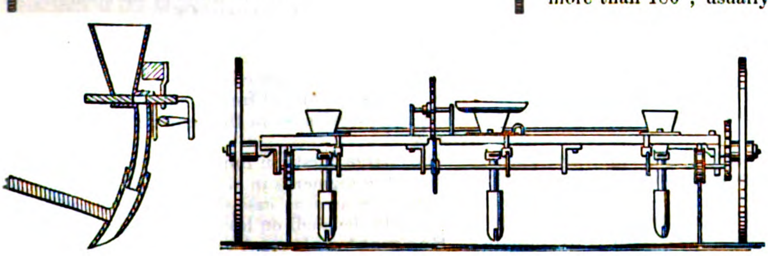
Fig. 4817 shows seggars for dishes and plates; they consist of a series of rings, and the plates rest on pins.

The term is one belonging to the potteries, and is variously spelt *seggar*, *saggar*, *segger*, *sagger*.

Seg-ment'al Arch. (*Architecture.*) One described from a center, and having less or more than 180°; usually less. The Washington aqueduct bridge, built by General Meigs, over Cabin John Creek, Maryland, consists of a single arch of this kind; it has a span of 220, a rise of 57 feet, and its span is exceeded by but one other stone arch in the world. See Stone Arch.

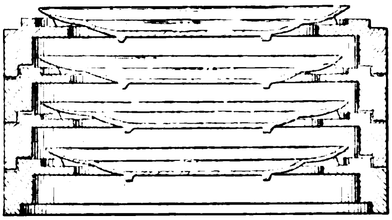
Fig. 4814.





Seed-Planter.

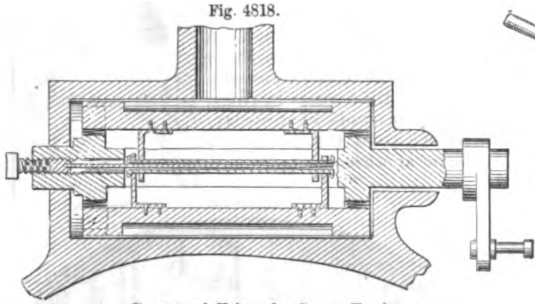
Fig. 4817.



Seggars.

Seg-ment'al Valve. A valve whose seating surface is a portion of a cylinder. In Fig. 4818, the segmental valves are connected by links which enter the slot of the stem. The links have rectangular holes traversed by tapering bars having a wedge between them which is swiveled in, and adjusted by a temper screw in the end of the stem to adapt them to their seats. The valve-blocks are also forced to their seats by spiral springs.

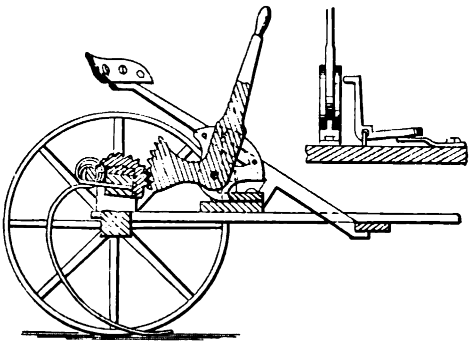
Fig. 4818.



Segmental Valves for Steam-Engine.

Seg'ment-gear. A curved cogged surface, occupying but an arc of a circle. Fig. 4819 shows it as applied to the hay-discharging apparatus of a sulky-rake. To discharge the rake, the operator presses his foot upon the stop and disengages it from the lever, which is then drawn backward by hand to raise the teeth.

Fig. 4819.

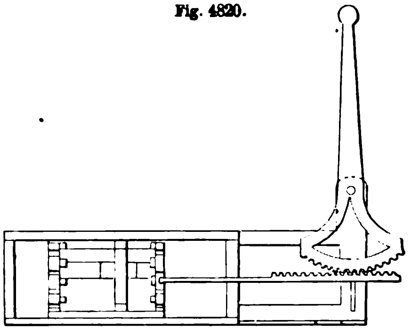


Segment Gear and Wheel.

Fig. 4820 shows a segment-rack applied to a rack on the staff of a dasher which reciprocates in a washing-box.

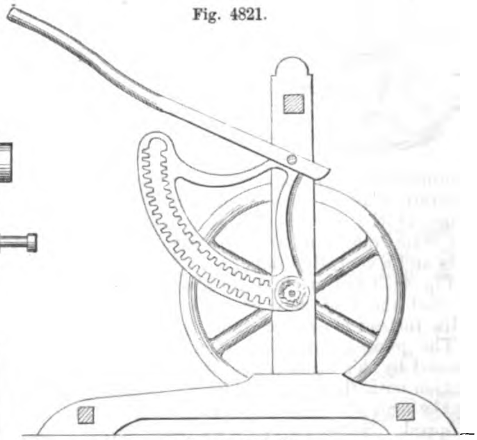
Seg'ment-rack. A cogged surface differing from the ordinary rack in being curved, so as to oscillate upon a center instead of reciprocating in slides or guides. In the example, the object is to convert the oscillating motion of one shaft into a continuous revolving motion of another shaft.

Fig. 4820.



Segment Gear and Rack.

Fig. 4821.

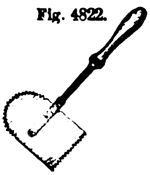


Segment-Rack.

Seg'ment-saw. 1. (*Wood-working.*) *a.* A *veneer-saw.* One whose active perimeter consists of a number of segments attached to a disk or hub. The invention of General Sir Samuel Bentham before 1800. See VENEER-SAW.

b. A saw which cuts stuff into segmental shapes; as, for instance, Sir Samuel Bentham's saw, in which the work was guided in an arc by a radius arm. A *chair-back* saw. It may be *band* or *jig.*

Fig. 4822.



Segment-Saw.

2. (*Surgical.*) A nearly circular plate of steel serrated on the edge and riveted to a wooden handle (Fig. 2502, page 1100). It is known as Hey's saw, and is used in surgical operations on the bones of the cranium, and the metacarpal and metatarsal bones.

Seg'ment-shell. (*Ordnance.*) An elongated projectile invented by Sir W. Armstrong.

The iron body is coated with lead, and contains a number of segments of iron in successive rings, leaving a hollow cylinder in the center for the bursting-charge.

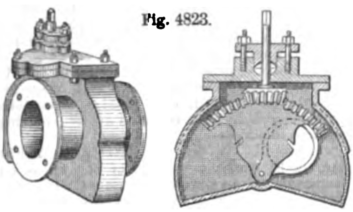
The charge bursts on impact or by a time-fuse, and scatters the segments in all directions.

It may be used as case-shot by arranging the fuse to explode the shell on leaving the muzzle.

Seg'ment-valve. A valve having a seating surface consisting of a portion of a cylinder. The valve

(Fig. 4823) for gas or water pipes is adjusted to the desired width of opening by means of a bevel-pinion

Fig. 4823.

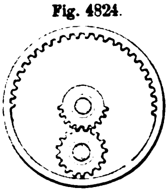


Segment-Valve.

working into a corresponding rack on the back of the valve. The case has a removable cover enabling the working parts to be taken out without disturbing the main pipe.

Seg'ment-wheel. A wheel a part of whose periphery is utilized. In the illustration, the wheel has two cogged segmental portions, which act alternately upon the pinion, giving a slow forward and quick reverse motion.

Fig. 4824.



Segment-Wheel.

Seg'ment-win'dow. (*Architecture.*) A window of segmental shape. A form of dormer or attic window, commoner aforetime than at present.

Seine. A large fishing-net.

Seine-boat. A fishing-boat from which the seine is cast.

Seis'mo-graph. An electro-magnetic apparatus for registering the shocks and undulatory motions of an earthquake.

Seis-mom'e-ter. An instrument for detecting earthquake shocks and recording their duration. The agitation or change of level of a mercurial column sets to work a delicate electric apparatus, which records the time of the first shock, the intervals between the shocks, and the duration of each; their nature, whether vertical or horizontal, the maximum intensity; and, in the case of horizontal shocks, the direction is also shown. The observatory established by the Italian government on the flank of Mount Vesuvius for watching the indications of threatened eruptions is provided with instruments of this class, which are sufficiently sensitive to be affected by any violent shocks occurring in the great Mediterranean basin. On the occasion of a late eruption in the Greek archipelago, Professor Palmieri was enabled to announce that a great disturbance had occurred long before the news of the event had reached Italy. Shocks occasioned by disturbances of Mount Etna are readily observable.

The eruptions are preceded by earthquakes, increasing in intensity and frequency for some days beforehand, and by irregularities in the diurnal variations of the magnetic needle.

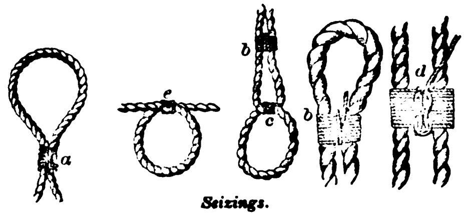
Seis'mo-scope. An instrument for recording the mensuration of the force and duration of earthquakes. A *seismometer*.

Seiz'ing. (*Nautical.*) *a.* The rope-yarn or stuff used for seizing.

a, eye seizing.
b, throat seizing.
c c, round seizing.
d, seizing secured with reef-knot.

b. Binding two ropes, or the two parts of the same rope, together, by means of smaller stuff.

Fig. 4825.



Seizings.

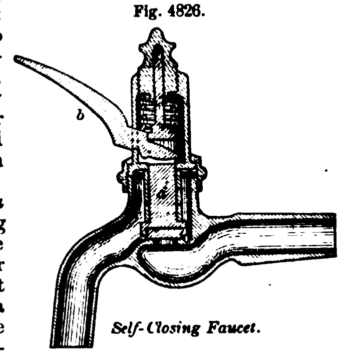
Self-act'ing Valve. One moved by the fluid, in contradistinction to one moved by the application of mechanical devices.

Self-clos'ing Bridge. A pivot bridge opened by canal-boats in passing. Made by Snyder Brothers, Williamsport, Pa. See patents: —

Schneider and Montgomery, September 4, 1860; Selfor, October 9, 1861; Winkler and Berndt, January 19, 1869; May 28, 1872; and October 8, 1872.

Self-clos'ing Fau'cet. A faucet having a valve which is held down to its seat by a spring to prevent the escape of liquid, and is raised by means of a lever when the liquid is to be drawn off.

Fig. 4826.



Self-Closing Faucet.

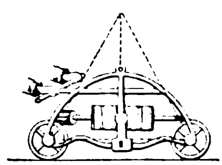
The valve *a* has an opening to receive the tail of the lever *b*, by which it is raised when a liquid is to be drawn; at other times it is held down by a spring.

Self-feed'ing Fur'nace. A magazine furnace in which fresh fuel from a hopper falls into the furnace as the coal is consumed.

Self-con-tained' En'gine. An engine and boiler attached together complete for working. Similar to the portable engine, but without traveling gear.

Self-re-cord'ing Lev'el. This machine is adapted for obtaining a *profile* or vertical section of a line of survey by passing over the track. A *grade-indicator.*

Fig. 4827.



Surveyor's Level.

The carriage traverses on wheels of known circumference, and one of these is geared to a drum, so as to rotate the latter at such a rate that a given length of the profile paper wrapped thereon will correspond to a certain distance traveled. The paper unwinds from one roller and wraps upon another, being subjected to the action of a pencil on the pendulum, which swings toward one end or the other of the drum as the carriage ascends or descends a hill, only maintaining a central position when traveling a dead-level. The drum can be shifted vertically to accord with any required scale.

Self-reg'is-ter-ing Ba-rom'e-ter. A barometer provided with devices for automatically registering variations of atmospheric pressure. See BAROMETROGRAPH; BAROGRAPH.

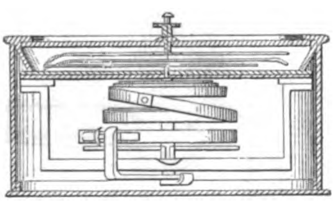
Self-reg'is-ter-ing Com'pass. An arrangement by which the compass prints a record of the

course in which the ship is steered. The compass carries on its under side a number of types, corresponding with the points of the compass. A strip of paper, moved by clock-work, passes under the card at that side which is next the bow of the vessel, and between the paper strip and the card itself is an inked type, which also travels slowly. At certain intervals the compass-card is tilted so as to bring the type which happens to be immediately above the paper strip at the time down upon the inked type, thus marking on the paper the course in which the vessel is being steered. The invention of Albini.

Another self-recording compass is that of Gordon, December 8, 1863, in which the course of a ship is recorded by dropping little pellets into boxes. It consists of a registering marine log and a compass divided into compartments for the reception of pellets, and an apparatus for dropping a pellet into one of said compartments whenever the vessel has made a certain distance, the delivering-tube or portion of the said dropping apparatus being so controlled as to always point in the direction in which the vessel is moving through the water. See MARINER'S COMPASS.

Self-reg'is-ter-ing Ther-mom'e-ter. One in which the indications of the instrument are recorded at regular intervals of time. The thermometer-needle is attached to a coiled metallic ribbon, whose expansion and contraction by change of temperature oscillate the needle. The independent needles are actuated by this one, and denote the extremes reached. These independent needles have thumb-burrs by which they may be turned. See THERMOMETER.

Fig. 4828.



Self-Registering Thermometer.

Sel'vage. 1. (*Locksmithing.*) The edge-plate of a lock through which the bolt shoots.

2. (*Nautical.*) A piece of very flexible rope, composed of yarns not twisted together, but laid parallel and bound with marline.

3. (*Fabric.*) The edge or list of cloth, woven so as to prevent raveling.

Sel'va-gee. (*Nautical.*) A rope or ring made by a number of spun yarns laid parallel and secured by lashings. It is sometimes used in place of rope, being less likely to slip, and is more elastic.

Sem'a-phore. An apparatus for conveying information by visible signs, such as oscillating arms or flags by daylight, and by the disposition of lanterns by night. The various combinations may serve to indicate the numbers corresponding to certain expressions in a tabulated code, or may be employed to represent the letters of the alphabet.

In the prophecy of Jeremiah (588 B. C.), chap. vi. verse 1, we find: —

"O ye children of Benjamin, gather yourselves to flee out of the midst of Jerusalem, and blow the trumpet in Tekoah, and set up a sign of fire in Beth-haccerem; for evil appeareth out of the north, and great destruction."

Homer, some 400 years before, had compared the aureola which surrounded the head of Achilles to the signals made in besieged cities, by fires at night and clouds of smoke by day; and Æschylus, more than a century after Jeremiah, using perhaps a poetical license, makes Agamemnon announce the fall of Troy to Clytemnestra by beacon-fires, whose rays, darting from the Asiatic shore to Lemnos, were repeated from Mount Athos, whence the grateful news was in like manner telegraphed to Argos. Fire-signals were prepared by Mardonius to notify his master, "the great king" Xerxes, then at Sardis, of the second taking of Athens.

At a later period, Polybius describes a semaphoric system improved by him, in which messages were transmitted by spelling out the words. The letters of the Greek alphabet were divided into five parts, which were inscribed on an equal number of boards affixed to upright posts between two walls. The number of the post and the number of the letter on each board was indicated by the successive exhibition of from one to five torches above the wall. The signal in each case, as in modern systems of semaphoric telegraphy, was repeated at the receiving-station, to guard against mistakes.

Æneas, who lived in the time of Aristotle, invented a method of telegraphing in which a number of the phrases most frequently occurring in war were written at various elevations upon an upright board on a float in a vessel of water. Each station was provided with one of these, and at a given signal the water was allowed to flow from the vessels at each station until the required message on the board was on a level with the top of the vessel at the transmitting station, when a second signal was made, and the flow of water stopped; as the apparatus at each was precisely similar, the same inscription would at this moment be exactly on a level with the top of the vessel at both stations.

Signaling by the waving of flags and lanterns is practiced on railroads, and has been embodied into a code capable of great variety of expression in the United States Signal Service.

The Chinese and the ancient Scythians were in the habit of communicating information by means of fires and smoke, and the same practice prevailed within comparatively recent times among the Scottish Highlanders and the inhabitants of the borders.

From existing indications, fire telegraphy must have been extensively employed by the ancient mound-building race which preceded the Indians who inhabited North America when it first became known to Europeans. Throughout the West, notably in the Scioto and Miami Valleys, mounds of earth thrown up in elevated positions are found which were evidently designed for this purpose. The permanent nature of the fortifications and the character of the entombed remains suggest that the region was at one time inhabited by a nation or nations more numerous and possessing a higher degree of political organization than their successors.

Fremont speaks of the signal-fires lighted by the Digger Indians and other aborigines inhabiting the margin of the great basin inclosed by the Rocky Mountains and the Sierra Nevada, to warn their neighbors of the progress of his party.

General Custer, in the "Galaxy" for July, 1874, thus describes the process: —

"First gathering an armful of dried grass and weeds, this was carried and placed upon the highest point of the peak, where, everything being in readiness, the match was applied close to the ground; but the blaze was no sooner well lighted and about to envelop the entire amount of grass collected, than Little Robe commenced smothering it with the unlighted portion. This accomplished, a slender column of gray smoke began to ascend perpendicularly. This, however, was not enough, as such a signal, or the appearance of such, might be created by white men, or it might take its rise from a simple camp-fire.

"Little Robe now took his scarlet blanket from his shoulders, and with a graceful wave threw it so as to cover the smouldering grass; when, assisted by Yellow Bear, he held the corners and sides so closely to the ground as to almost completely confine and cut off the column of smoke. Waiting but for a few moments, and until he saw the smoke beginning to escape from beneath, he suddenly threw the blanket aside, and a beautiful balloon-shaped column puffed upward like the white cloud of smoke which attends the discharge of a field-piece.

"Again casting the blanket on the grass, the column was interrupted as before, and again in due time released, so that a succession of elongated egg-shaped puffs of smoke kept ascending toward the sky in the most regular manner. This bead-like column of smoke, considering the hight from which it began to ascend, was visible from points on the level plain 50 miles distant."

During the Revolution, various methods were employed for signaling the movements of the enemy. Among others was a movable mast, having a barrel at top, a flag, and a cross arm from which a basket was suspended The various combinations to be effected by these means were capable of expressing a limited number of signals.

The Marquis of Worcester seems to have had in his mind an arrangement analogous to that of Polybius, the sight being aided by telescopes, then recently discovered. Such, at least, may be guessed of the very foggy description.

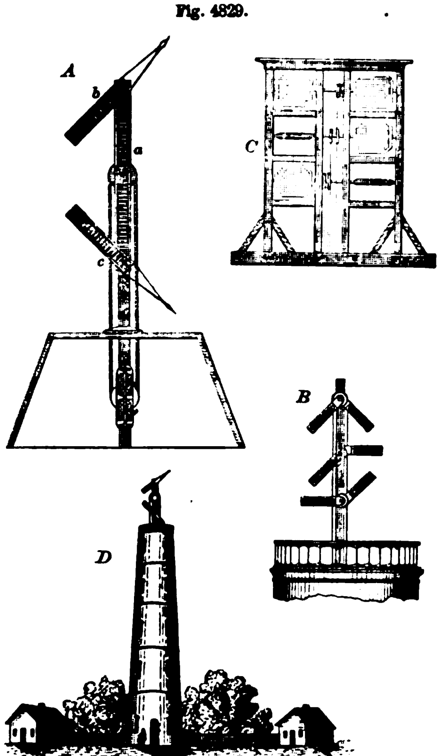
The learned and practical Dr. Hook followed in the same line, about twenty years afterward, and did not leave the matter in any uncertainty.

About 1700, Amontous exhibited a semaphore in operation, but the "Grand Monarque" was too busy with his Versailles and Marly to attend to it.

In the stirring times of the French Republic, when the National Convention was watching the Army of the North, Chappe constructed a semaphoric telegraph reaching from the Tuileries to Lisle.

As at present constructed, the Chappe telegraph (*A*, Fig. 4829) is composed of three pieces, — one large, called the regu-

Fig. 4829.



Semaphores.

lator, *a*, and two small, *b c*. The regulator is pivoted at its center, so that it may describe a vertical circle, and slides up and down a mast.

Its signaling positions are four: vertical, horizontal, right oblique, and left oblique, each of the latter forming an angle of 45°.

The indicators are pivoted to the ends of the regulator, and each may be placed in seven different positions, affording seven different signals in each position of the regulator; the various combinations which may thus be effected by changing the positions of the regulator and of the indicators are very numerous; in practice, however, no signal is made with the regulator in a vertical or horizontal position, so that the whole number is reduced to 196 simple and distinct signals, which, however, may be caused to succeed each other in such order as to form an indefinite number of combinations in accordance with a prearranged code.

Fig. 4830.

Semaphore.

The Prussian semaphore *B* consists of an upright mast having three wings on each side, pivoted in pairs one above the other, their combinations forming 4,096 signals.

In the English semaphore *C* an upright frame is divided into two compartments, each of which contains three octagonal panels turning on horizontal pivots.

Under the Emperor Nicholas I. a magnificent and expensive semaphoric system was introduced into Russia. The apparatus is placed on the summits of towers sufficiently high to overlook the tall pines with which the face of the country is covered, and placed at distances of five or six miles apart along the principal roads. This has succumbed to the less showy but more generally useful electric telegraph, and the lofty and conspicuous towers are now going to decay (*D*, Fig 4829).

Fig. 4830 shows a simple form of semaphore for railways. It consists of an upright post, whose top is adapted to receive a lantern, and having a pivoted arm which may be set in various positions by cords and levers below.

The basis of the signal system is simple. The three positions of the arm by day, and the three colors of a lamp by night, comprehend the alphabet and vocabulary of ordinary practice.

The arm horizontal, or a red light, intimates danger, and the necessary stoppage of the train.

The intermediate position of the arm, or a green light, enjoins caution, and a diminished speed.

The arm dependent or vertical, or a white light, implies that no obstruction exists, and that the train may proceed.

The value of carrier-pigeons was so plainly shown during the Franco-German war, that the French government has decided to erect a large house and to keep constantly in it for the next six years 5,000 pairs of pigeons for breeding purposes. Each fortress is to have a pigeon-house, with a capacity for 1,000 birds, and two general stations are to be established, with accommodations for 60,000 birds. The Germans, too, are breeding carrier-pigeons on a large scale for the use of the army.

Sem′i-cir′cle. A surveying instrument for taking angles. See DEMICIRCLE.

Sem′i-cir′cu-lar Arch. (*Architecture.*) One describing 180°. The versed sine is the radius of the describing circle.

Sem′i-grand Pi-a′no-for′te. A piano-forte having the shape and movement of a grand, but possessing only two strings to a note.

Sem′i-lor. A brass for cheap jewelry, etc. Copper, 5; zinc, 1. See ALLOY.

Sem′i-steel. A grade of steel. Puddled steel. Metal worked in the puddling-furnace, and the process terminated before all the carbon has been removed. See STEEL.

Sen′dal. (*Fabric.*) A thin kind of silk.

Sen′e-ca-oil. *Rock-oil.* The former name of petroleum or naphtha when it was collected from springs by the Seneca Indians and sold as a liniment. See PETROLEUM.

Sen′i-cal Quad′rant. An old form of quadrant consisting of several concentric quadrantic arcs, divided into eight equal parts by radii with parallel right lines crossing each other at right angles. It was made of brass or wood, with lines drawn from each side intersecting one another, and an index divided by sines also, with 90° on the limb, and two sights on the edge to take the altitude of the sun. It was in great use among French navigators. — ADMIRAL SMYTH.

Fig. 4831.

Sennit.

Sen′nit. 1. Braided cordage made by plaiting three or any odd number of ropes together (Fig. 4831).

2. A coarse hempen yarn.

3. Plaited straw or palm-leaf slips for hats, etc.

Sen′no-type. (*Photography.*) Another name for HELLENOTYPE (which see).

Sen′si-tive Pa′per. Paper prepared for photographic purposes. See next article. See also PHOTOGRAPHY.

Sen′si-tiz′ing. (*Photography.*) Applied to paper or to films.

The production on or in a surface or film of an insoluble salt of silver, generally chloride, iodide, or bromide of silver, which, under the actinic action of light, becomes colorably changed, or experiences such a change in its molecular constitution that, by a subsequent process of development, colorable changes are made to appear. In the former case, the image is at once *apparent*; in the latter, it is *latent* till the subsequent process has taken place. The process generally depends upon a double decomposition. For instance, paper charged with chloride of sodium being floated upon a solution of nitrate of silver, a film of chloride of silver, plus an excess of nitrate of silver, is formed upon the paper, the metal sodium uniting with nitric acid and passing into the bath. Or, in the case of the collodion film upon glass, the glass is floated with collodion containing bromides and iodides of the alkaline metals in solution, and the collodion "sets" upon the glass as a gelatinous film. It is then plunged into a bath of nitrate of silver, when a similar decomposition takes place, resulting in the production of insoluble bromides and iodides of silver, which become entangled in the film, while

the nitrates of the alkaline metals pass into the bath. The collodion film thus prepared is sensitive to light.

There are two exceptions where the double decomposition does not take place: —

1. In daguerreotyping. The production of a sensitive surface upon the plate by the action of the free vapors of iodine or bromine upon the surface of a clean metallic silver plate.

2. In the sensitizing of organic matter, such as gelatine, albumen, or gum, by the direct addition of salts of chromium, usually bichromate of potash.

Sen'si-tiz'ing-box. A dark chamber in which the operations described in the preceding article may be performed. See Hudson's patent, January 2, 1866.

Sep'a-rat'ing-sieve. A compound sieve used in powder-mills for sorting the grains according to their different sizes.

Sep'a-rat'ing-weir. A weir of masonry so contrived as to allow the waters to flow away during floods, but having an intercepting channel along the face of the weir to collect the water in medium stages.

Sep'a-ra'tor. 1. (*Husbandry.*) *a.* A machine for thrashing grain in the straw. See THRASHING-MACHINE.

b. A machine for clearing grain from foul, — dust, seeds, and chaff. See FANNING-MILL, page 825; WINNOWING-MACHINE; GRAIN-SCREEN, page 1007.

2. (*Metallurgy.*) *a.* A large pan set below the amalgamating pan in a mill. See SETTLER; SILVER-MILL.

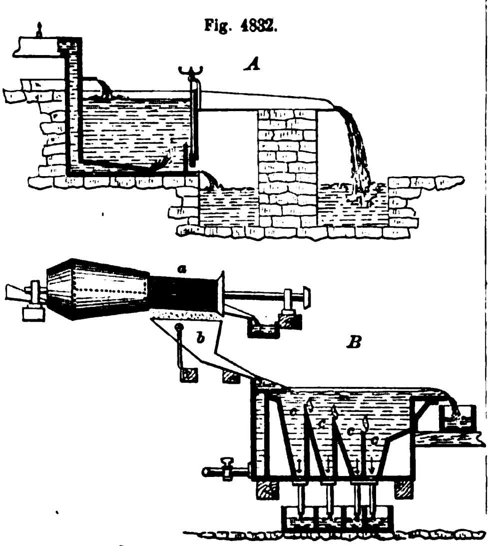
b. An ore-sorting apparatus in which an ascending current of water is directed against a descending shower of the comminuted ore, floating off the lighter and worthless portions, while the metalliferous matters sink to the bottom.

It will be observed that the resistance they experience while descending through water will be in proportion to the surface exposed; and, as the volumes of bodies vary according to the cubes of their relative dimensions, while the surfaces only vary as the squares of their measurements, it will be seen that the *force* of movement animating them is regulated by their *cubes*, while their *resistance* is in proportion to their *squares*.

In Wilkin's separator (*A*, Fig. 4832), the slimes and water are carried into a cistern from a trough above; a jet of water entering the bottom of the cistern carries the finer portions upward, where they are discharged, the heavier parts passing off through an opening below.

In another apparatus *B*, the slimes passing through a perforated trommel *a* are conveyed by a chute *b* into a cistern divided by partitions *c c c* into several compartments having apertures beneath. A pipe with a cock for regulating the flow of water enters the cistern at one end near the bottom, causing a longitudinal current therein; the particles, according to size, settling in the different compartments, pass out through the apertures in the bottom, the surplus water and finest portions being carried off at one end of the cistern. See also SIZING-CISTERN; LEAD-BATH, page 1269; CONCENTRATOR.

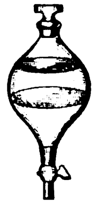
Fig. 4832.



Separators for Metallurgic Slimes.

3. (*Weaving.*) An instrument used by a weaver in spreading the yarn threads uniformly upon the beam of the loom. It resembles a comb, having teeth projecting from a head, and is of a length equal to the width of the web. The yarn threads pass between the teeth, and are maintained in the order in which they were disposed by the *warping-mill*. The instrument is also known as a *ravel*.

Fig. 4833.



Separator.

The *separator* or *ravel* is also used in spreading sized yarn upon the *balloon*; a large reel on which they are dried by rapid rotation in a steam-heated chamber.

4. A device for separating essential oils which are heavier than water from the water which comes over with them in the process of distillation. It consists of a bulbous glass vessel having a close-fitting stopper and an opening at bottom, provided with a stop-cock, by which the oil is drawn off, leaving the water remaining in the vessel.

5. A device or process for separating animal and vegetable fiber. The processes are usually destructive of one or the other. See, —

English patent, 2,621 of 1854. Animal matters dissolved by caustic alkali; or vegetable matters by acid.

105 of 1856. Sulphate of zinc, sulphuric acid; followed by washing in water, alkaline soap, etc.

970 of 1858. To destroy and separate the vegetable, sulphuric acid, and wash. To destroy the animal, potash or soda, sulphuric-acid solution. Rinse. Boil in chloride of lime and potash.

2,977 of 1859. Acid bath; press; wash; mechanical means. See Sykes, United States patent, No. 56,291, July 18, 1866. The wool is treated with diluted sulphuric acid, and the acid neutralized by lime-water, and the wool dried.

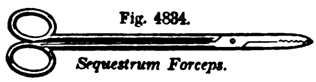
Sep'a-ra-to'ri-um. (*Surgical.*) An instrument for separating the pericranium from the skull.

Sep'a-ra-to-ry Fun'nel. A vessel of globular or spindle shape, having a narrow mouth, closed by a stopper, and terminating in a downwardly tapering pipe, frequently provided with a valve. It is often tubulated, and sometimes provided with two handles like a vase. It is used for separating chemical mixtures. See Fig. 4833.

Se'pi-a. A pigment prepared from the dark-brown secretion of the cuttle-fish.

Se'ques-trum For'ceps. (*Surgical.*) An instrument for removing portions of necrosed or exfoliated bone.

Fig. 4834.



Sequestrum Forceps.

Ser'aph-ine. (*Music.*) An enlarged form of the accordeon, introduced by Green. It was an organ with free-reeds, a key-board, and bellows worked by a pedal. It was the progenitor of the parlor organ, and has suffered a number of names, — *æolophon*; *physharmonica*; *æolomusicon*; *poikilorgue*; *harmonium*; *melodeon*; *symphonium*.

Serge. (*Fabric.*) *a.* A coarse-twilled woolen stuff, used for lining gig-saddles, etc.

b. A light silken stuff, twilled on both sides.

Ser-gette'. (*Fabric.*) A thin serge.

Ser'pent. 1. (*Music.*) A wooden wind-instrument covered with leather. It serves as bass to the horns and cornets, and has the same compass as the bass ophicleide, with rather more agility, pre-

cision in tone, and sonorousness. Its compass is three octaves and one note. It has three parts, — a mouthpiece, neck, and tail.

The *bassoon* is a low instrument of the serpent kind. It is written on the bass clef, and has a compass of from D below to A♭ above the clef.

Fig. 4835.

Serpentone (*from Bonanni*).

Fig. 4835 represents an instrument, Plate XXVI. of Bonanni's "Description des Instrumes Harmoniques," Rome, 1776. It is described as an instrument of very low tone, made use of in France and Germany as a bass to flutes and hautboys. It is hung from the neck of the performer, and would, if straight, be about six feet long. It has six holes for the fingers of the player.

2. (*Pyrotechny.*) A small paper tube filled with mealed powder or rocket composition, not very compactly driven. Serpents are used for filling paper shells or the pots of rockets, and pursue a wavering serpentine course through the air when ignited.

Ser′pen-tine. 1. (*Stone.*) A hard spotted or veined rock. It has many colors variously disposed. Greens and reds are prominent.

2. (*Ordnance.*) An old form of cannon of seven inches bore. The handles represented serpents.

Ser-pette′. A curved pruning-knife.

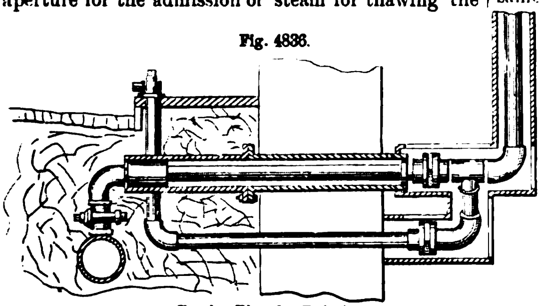
Serre-fine′. (*Surgical.*) A small clip used to compress a severed artery pending the farther conduct of the operation.

Serre-nœud. (*Surgical.*) An instrument used to tighten ligatures. See LIGATURE-TYER.

Ser′vice-pipe. One for conducting gas or water from the main into a building.

Fig. 4836 shows one arrangement. The pipe conveying water from the main is surrounded by a casing forming a chamber around the pipe. This casing extends to the inside of the building, and has an aperture for the admission of steam for thawing the

Fig. 4836.



Service-Pipe for Buildings.

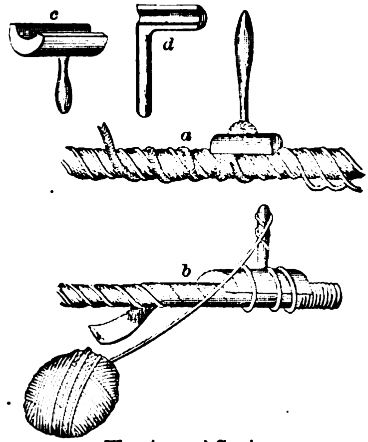
pipes. A wooden casing covers the pipes and their connections on the inside of the building, and has doors opposite the union and elbow joints.

Serv′ing. (*Nautical.*) Filling the interspaces between the strands of a rope by winding a smaller cord around it, as shown at *a*, Fig. 4837, is termed *worming*. The rope is then *parceled* by winding around it old canvas well tarred, the edges overlapping, to prevent water from penetrating, and is finally *served* by wrapping closely with spun yarn, to prevent chafing, as shown at *b*. In this process the *serving-mallet c*, or, for small jobs, the *serving-board d*, is employed.

Serv′ing-board. (*Nautical.*) A flat board used in serving ropes.

Serv′ing-mal′let. (*Nautical.*) A mallet-shaped tool used for wrapping spun yarn tightly around a rope. Several turns of the stuff are taken around the mallet, and as the mallet is rotated around the

Fig. 4837.



Worming and Serving.

rope which lies in the hollow, the stuff is tightly and closely wrapped around the rope. See *c*, Fig. 4837.

A *serving-board* is a flat piece of hard wood, with a handle, for similar duty on small ropes.

Set. 1. (*Machinery.*) *a.* A tool used to close plates around a rivet before upsetting the point of the latter to form the second head.

b. The lateral deflection of a saw-tooth, to enable it to free itself, by cutting a *kerf* wider than the blade.

This is done by a SAW-SET, which see.

c. An iron bar, bent into two right angles on the same side, used in dressing forged iron.

2. (*Locksmithing.*) A device for preventing the opening of a lock without its proper key.

3. (*Plastering.*) Or *setting-coat.* The last coat of plaster on walls for papering.

The last coat, for painting, is called *stucco.*

Set-fair indicates a particularly good troweled surface.

4. (*Metal-working.*) When metal is subjected to any strain, either tensile or compressive, the material is lengthened or shortened in proportion to the force exerted. When released from the strain it resumes its original length, unless the force exerted exceeded its limit of elasticity. If this occurs, the material receives what is called a *permanent set.*

5. (*Saddlery.*) The filling of deer's hair or other stuffing beneath the *ground seat* of a saddle, to bring the top seat to its shape.

6. An arrangement or combination of tools or machines acting in concert.

In the large saw-mills of Ottawa, Canada, at the Chaudiere Falls, a *set* consists of a *slabbing-gang* and *stock-gang* for the large logs; a *Yankee-gang* for the logs of 21 inches diameter and under; a *double-edger* for squaring the edges of the boards, and a *double-butter* for squaring the ends of the same. See SAW-MILL.

Set-bolt. (*Shipbuilding.*) *a.* One used as a *drift*, to force another bolt out of its hole.

b. A bolt used to bring a plank to its bearings. A *bringing-to* bolt.

Set-ham'mer. A hammer in which the handle is merely *set* in, not wedged; so as to be readily reversed.

Set-off. 1. (*Building.*) The part of a wall which forms a horizontal ledge when the portion above is reduced in thickness.

2. (*Printing.*) The accidental transferrence of ink from one recently printed sheet to another.

Se'ton-nee'dle. (*Surgical.*) A needle by which a number of threads of linen, silk, or cotton are introduced beneath the skin to keep up an irritation and discharge.

Set-pot. A copper pan, used in varnish-making. It is heated by a spiral flue which winds around it, and is used for boiling oil, gold size, Japan, and Brunswick black, etc.

Set-screw. (*Machinery.*) A screw employed to hold or move objects to their bearings. As the bits in a cutter-head, or brace.

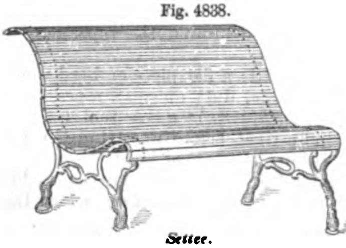
Sett. (*Piling.*) A piece forming a prolongation of the upper end of a pile when the latter has been driven beyond the immediate reach of the hammer.

Set-tee'. 1. (*Nautical.*) A Mediterranean vessel with a single deck, two masts, and lateen sails.

2. (*Household.*) A long-backed seat, for four or more persons. It is not upholstered; occasionally has rockers.

In Fig. 4838, the frame is of metal, to which longitudinal slats of wood with ventilating openings between are secured by rivets or bolts and nuts.

Fig. 4838.

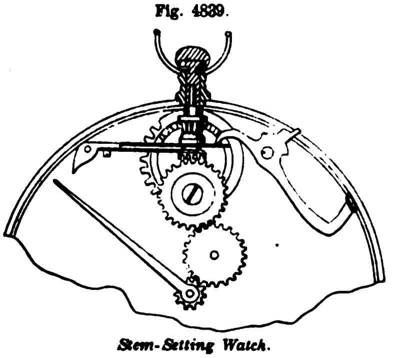


Settee.

Set-tee'-sail. (*Nautical.*) A sail intermediate in shape between a *lug-sail* and a *lateen*; that is, it has a weather leech of small hight.

Set'ter. (*Porcelain.*) A *seggar* adapted and shaped to receive an article of porcelain biscuit, for firing in the kiln. *Seggars* proper contain a pile of plates or other articles, but *setters* are specifically adapted for a single article of porcelain. Like *seggars*, they are made of a marly clay, and have lids, or each forms a lid for the one below it, when they are reared in *bungs* in the kiln. A *bung* is a pile of *seggars* or *setters* in place.

Fig. 4839.



Stem-Setting Watch.

Set'ting. 1. The sharpening of a razor on a hone. An intermediate process between *grinding* on a stone and *strapping*.

2. Displaying laterally the teeth of a saw in alternate directions, so as to increase the width of the kerf and allow the blade to move freely without rubbing and heating. See SAW-SET.

3. (*Masonry.*) *a.* Fixing stones in position in a wall.

b. The hardening of mortar, concrete, or plaster.

4. (*Plastering.*) A finishing coat of *fine-stuff*, laid on by a trowel; it is alternately wetted with a brush and smoothed with a tool until a fine surface is obtained.

5. (*Watchmaking.*) *a.* The jewel which is clasped by the bezel; or one which serves as a bushing for an arbor or pivot.

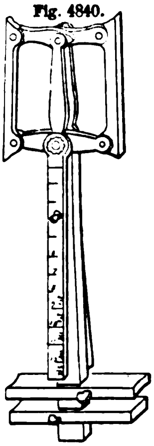
b. The adjustment of the hands.

Fig. 4839 shows Lange's plan for setting the hands by means of the stem.

Set'ting-coat. (*Plastering.*) The finishing coat of plastering which is laid upon the *floating* coat. The latter overlays the *rendering* coat. The setting-coat is of *fine* stuff, the others of coarse stuff.

Set'ting-gage. An apparatus for setting axles of wheels. By adjusting the graduated arms of the instrument in accordance with the dish and hight of the wheel, the pitch of the axle-arm may be readily determined; the object being to avoid the geometrical calculations usually involved. See also AXLE-SETTER, page 202; and AXLE-GAGE, page 201.

Fig. 4840.



Axle-Setter.

Set'ting-ma-chine'. (*Spinning.*) A machine for setting wire teeth in cards for carding-machines.

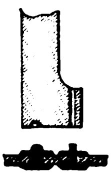
Set'ting-out Rod. (*Joinery.*) A rod used in setting out frames, as windows, doors, etc.

Set'ting-pole. (*Nautical.*) *a.* A pole by which a boat or raft is pushed along, one end resting on the bottom, and the other usually applied to the shoulder, while the man walks the length of the deck.

b. A pole driven into the bottom, and used for mooring a boat in fishing, etc.

Set'ting-punch. (*Saddlery.*) A punch with a tube for setting down the washer upon the stem of the rivet, and a hollow for riveting down the stem upon the washer.

Fig. 4841.



Setting-Punch.

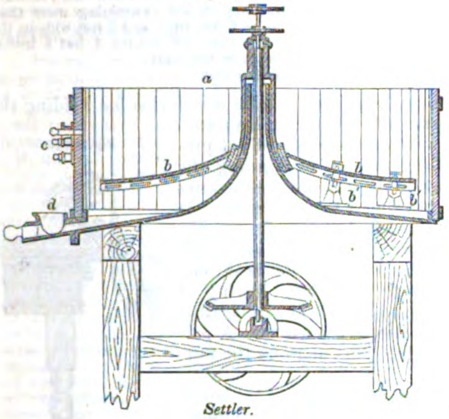
Set'ting-rule. (*Printing.*) A smooth piece of brass, the width of the *measure* of the column, and the hight of the type. It is used in the composing-stick, being withdrawn from beneath each completed line and laid above it to commence a fresh line.

Set'ting-up Ma-chine'. (*Coopering.*) A machine in which the staves of a cask are set up in order and held for hooping.

Set'tler. (*Metallurgy.*) An apparatus for extracting the amalgam from slimes received from the amalgamating-pan. It consists of a tub *a*, in which a series of sweeps or stirrers *b* provided with shoes *b' b'* are caused to rotate, imparting a centrifugal motion to the slimes, the lighter portions being drawn off through sluices *c* at various hights. These

are opened in turn from above downward, so as to draw off the lightest slimes first. The mercury and silver, sinking to the bottom, are received in an

Fig. 4842.



Settler.

annular trough, whence they pass into the cup *d*. The sweeps are adjustable as to hight by means of a screw. Also called a *separator*. See SILVER-MILL.

Set-up. 1. (*Metal-working.*) The steam-ram used in the squeezer which operates on the *loup* or ball of iron from the puddling-furnace. The action is to *up-set* or condense longitudinally the bloom, previously elongated by the action of the squeezer which ejects the cinder.

2. (*Bakery.*) One of the beech scantlings which form a frame around the congregated loaves in the oven and keep them in place.

Set-work. (*Plastering.*) Two-coat plastering on lath. *Laid and set.*

Sev'er-y. (*Architecture.*) A bay or compartment of a vaulted ceiling.

Sèvres Por'ce-lain. Porcelain of fine quality, made at the French government works, at Sèvres. It is principally of a peculiarly fine and delicate quality, for ornament rather than use.

Berlin, Dresden, and Munich have national ceramic works.

Sew'age. The surface drainage, slops, excrementitious matter, and other filth carried off by sewers.

Sewerage is a term applied to the sewers and drains of a town collectively.

When the sewers merely receive the street drainage and the liquid refuse from kitchens, etc., the disposition of this comparatively innocuous matter presents but little difficulty; it is discharged into the nearest running stream without danger of contamination.

Where, as is the case in densely populated cities and towns, water-closets empty into the sewers, the sewage not only tends to seriously contaminate the water into which it is discharged, but the foul gases generated therefrom, especially where the mouths of the sewers are wholly or partially closed at high water, are forced back into the houses, and prove very detrimental to health. This may, to some extent, be obviated by pipes leading from the soil-pipe to the highest part of the building, and open at top. This allows access of air to the drain, prevents the accumulation of gases, and facilitates their escape.

As the matters carried off by sewers contain a large proportion of fertilizing material, it has been proposed to collect and utilize them. The average value assigned by the English Rivers Pollution Commission is \$4 10 per 100 tons. The sewage of London is estimated at 260,000,000 tons yearly, worth over \$10,000,000.

To deodorize this and render it available for manure, various processes have been tried or suggested.

The lime process consists in mixing the sewage with milk of lime and agitating it. On settling, a putrescible mud subsides, and the comparatively clear liquid flows off. This process was not successful in England, the mud becoming very offensive in drying, and containing but a small proportion of valuable ingredients.

In Blyth's process, it was attempted to recover the ammonia from the sewage by the employment of superphosphate of lime and a salt of magnesia, to form an insoluble phosphate of magnesia and ammonia. The Sewage Commission considered this as ineffectual and costly.

In Holden's process, sulphate of iron, lime, and coal-dust are mixed with the sewage. The product is worthless as a manure.

In what is known as the *A B C* process, alum, blood, clay, and charcoal, mixed with water, are run into the sewage in a continuous stream. The results are said to be good.

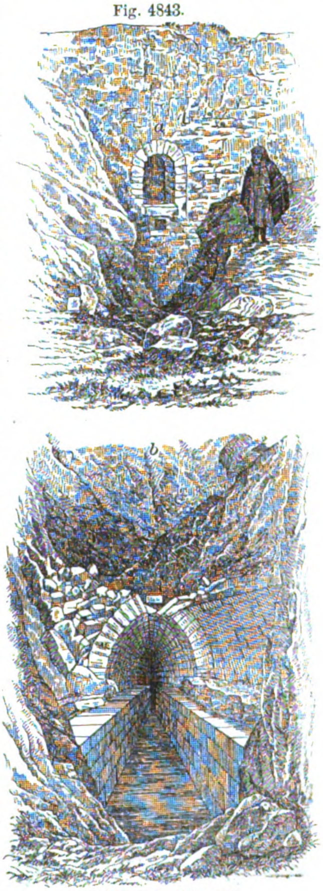
Dr. Morfit employs the mother water derived from the precipitation of pure phosphates of lime from hydrochloric solutions of mineral phosphates of lime, as practiced in his process for preparing fertilizers.

For deodorizing cesspool deposits, the dry-earth process is very efficacious; the earth, thoroughly dried and pulverized, is mixed with the contents of the cesspool, which may then be used at once as a fertilizer, or dried and kept until wanted, without giving out an offensive odor.

The cesspools of Paris, called *fosses d'aisances*, are usually, in interior dimensions, about 9 feet 10 inches × 5 feet 7 inches × 4 feet 11 inches, made of stone, and plastered inside, to prevent filtration, and provided with a manhole at the top, which is arched. They must undergo a municipal inspection before being used. The contents, when sufficiently fluid, are removed by pumping. More recently, removable air-tight tubs, termed *fosses mobiles*, which are placed in vaults made as nearly air-tight as possible, have been introduced into houses of the better class.

The contents of the cesspools are drawn off into air-tight wrought-iron vessels, termed *tinettes*, and conveyed by carts to two large elevated reservoirs at Montfaucon; these have an area of about $2\frac{1}{2}$ acres, and are apparently 12 feet deep; one being filled as the other is emptied. An overflow drain with sluice-gates at each end allows the liquid matter to run off into a basin at a lower level, where it deposits matters which may be held in mechanical suspension. On its banks are sal-ammoniac works, which are supplied from this source by pumping. The surplus liquid flows by a central sluice into two smaller reservoirs, where it is allowed to deposit its more easily precipitated matters, undisturbed by the pumps, the remainder flowing into four smaller basins, where the fertilizing materials still in solution are precipitated by straw, dead leaves, etc., and the water, now comparatively pure, is let off into the main sewer, which empties into the Seine, below Paris. In one plan the cesspools are emptied by exhausting the air from the carts which are made of boiler-plate iron; the liquid mass being forced into the cart through a pipe by atmospheric pressure.

Fig. 4843.



Sewers in Nineveh.

Sew'er. An underground channel for carrying off the surface water and liquid refuse matter of cities and towns.

Sewerage appears to have been carried to

a high degree of perfection at a very remote period of antiquity, those of Nineveh and Rome being among the best preserved remains of those ancient cities.

The most remarkable sewer of Rome was (and is) the Cloaca Maxima of Tarquinius Priscus, 588 B. C., formed to carry off the waters brought down from the adjacent hills to the Velabrum and Valley of the Forum. It had 3 concentric arches, the inner one a semicircle of 14 feet diameter, formed of hewn blocks, without cement. The whole sewer was 32 feet high, having a sectional area of 448 feet. (See Cresy's "Dictionary of Civil Engineering"; Smith's "Dictionary of Grecian and Roman Antiquities") Agrippa sailed through this sewer in a boat, and Nero caused some of his victims to be thrown into the sewers. So numerous were they that Pliny terms Rome *urbs pensilis*, a city supported on arches.

The arch has long been supposed to be of Roman origin; but this is abundantly disproved by remains in Egypt, Assyria, and Ethiopia. (See ARCH.) The Romans were the first to give it prominence in architecture, the Egyptians using it sparingly and hiding it, as it was not considered appropriate to their style: neither was it. The oldest arch in Europe is the Cloaca Maxima.

Fig. 4843 shows (*a*) an Assyrian arched drain of the Northwest palace Nimroud, and (*b*) one of the Southeast palace on the same old site. All the arches yet discovered are of brick, made of voussoir shape for the purpose. Some are sun-baked, and others kiln-burned. The greatest span found is 15 feet. They are usually semicircular. The only exception is that shown at *b*, in which ordinary bricks are used, the extrados being gained by wedges of mortar.

In no modern city, perhaps, is the system so complete as in Paris. Its origin dates back as far as the year 1412. The excavations made in order to obtain the limestone of which the city is largely built, and the catacombs, were subsequently made available for sewerage purposes, and now few streets are without these subterranean channels. The principal ones convey both foul and clean water, the former flowing along a trench at the bottom and the latter through pipes supported on brackets. They have one set of openings from the street to receive the drainage, another for the ingress and egress of the workmen, and a third for ventilation.

The *egout Rivoli*, under the street of that name, is probably the largest and most imposing. It has broad, neatly kept footpaths, and a railway along which visitors are conveyed in trucks pushed by men until its junction with the main sewer, when they are transferred to boats which convey them to the Place de la Madeleine, where a winding iron staircase leads to the street above.

Intermediate between this and the house drain are ten sizes of sewers, all except the two smallest having footways for the passage of the scavengers.

Telegraph lines, insulated with gutta-percha, and a pneumatic tube for the conveyance of parcels, are led through this sewer, and at intervals are vertical shafts provided with iron ladders through which the workmen can escape when it becomes flooded by rains. See SUBWAY.

The main sewer is cleaned by means of large barges having in front an iron plate which nearly fills the channel, and has three openings at its lower edge; as the barge is drawn up stream, the solid matter is forced through these and collected in a receptacle. Those that are too narrow for barges are cleaned by a similar device attached to a truck running upon rails on the footpath.

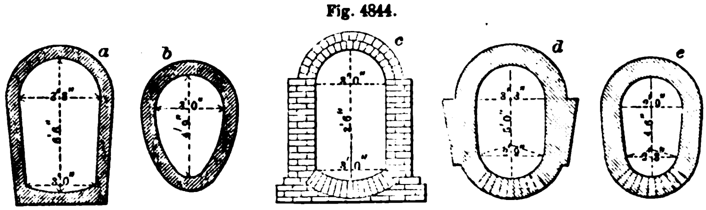
Up to the commencement of this century, the sewers of London were used exclusively for carrying off the surface-water and slops; cesspools, the contents of which were carried away in carts, being used for the reception of excrementitious matters. Subsequently these were diverted into the sewers, which discharge into the Thames. These were enlarged in 1855, but it was found that those receiving the drainage of the lower parts of the city were closed by high tides, forcing the filth and noxious gases back through the drains into the streets and houses. To remedy this, attempts at disinfection were made, but their want of success led to the adoption of a plan for intercepting the sewers by tunnels back from the river, and conveying their contents to a reservoir eight miles below the city, where they are deodorized, the liquid matter drawn off into the Thames, and the solid sold for agricultural purposes.

In Fig. 4844, *a* illustrates the shape and dimensions of a sewer employed in some of the London districts. In Paris, the form *b* is generally employed. *c* is used in the Westminster district, London. This form is not calculated to give the greatest strength, and in some instances the sides have been crushed in by the pressure.

An oval form *d e* is adopted by the Holborn and Finsbury Commission. Sewers draining streets containing more than 200 houses are required to be 5 feet high and 3 feet wide in the clear; those for streets of less than 200 houses, 4 feet 6 inches high, and 2 feet 6 inches wide in the clear.

London has 1,000 miles of sewers.

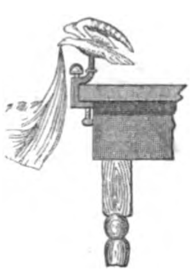
Fig. 4844.



Sewers (London and Paris Patterns).

Sew'ing-bird. This is a device for holding the work while sewing, and is a substitute for the old and yet prevailing custom of pinning the work to the dress above the knee in running a hem or seam. It has assumed many forms, the bird being ornamental and holding the work in its beak, one part of the bill having a spring to keep it closed against the stationary portion. A pair of spring jaws answers the purpose.

Fig. 4845.

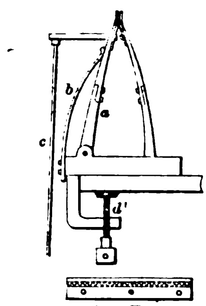


Sewing-Bird.

Sew'ing-box. A lady's work-box for sewing materials.

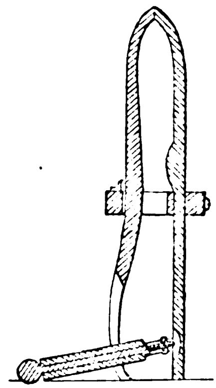
Sew'ing-clamp. (*Leather.*) A device for holding a piece of work while being stitched. In that illustrated, the movable jaw *a* is held to the leather by the spring *b*, and is thrown back by a rod or rope *c*, connected to a treadle. A screw *d* secures the clamp to a work-bench. The jaws may be serrated to take better hold of the work.

Fig. 4846.



Sewing-Clamp.

Fig. 4847.



Sewing-Horse.

Sew'ing-horse. (*Leather.*) A harness-maker's clamp for holding leather while being sewed. In the example, the clamping jaws of the horse are extended below the seat, and are provided with a treadle-lever, which is adjustable to suit varying thicknesses of articles to be sewn.

Sew'ing-ma-chine'. 1. Sewing-machines for fabric are of several classes: —

a. Those in which the needle is passed completely through the work, as in hand-sewing.

b. Those making the *chain-stitch*, which is wrought by the crochet-hook or by an eye-pointed needle and auxiliary hook.

c. Those making a fair stitch on one side, the up-

per thread being interwoven by another thread below.

d. Those making the *lock-stitch*, the same on both sides.

The last is the latest and best. See also *infra*, SEWING-MACHINE (for books), page 2119, and SHOE-SEWING MACHINE, Plate LIX.

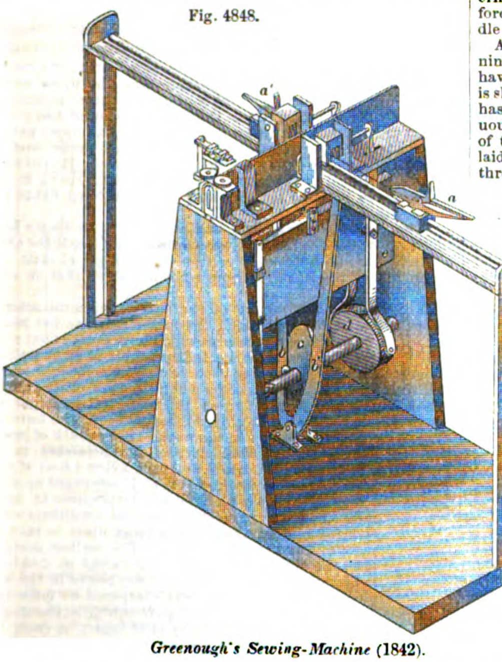
a. The stitch made by passing the needle completely through the goods, in the manner of hand-sewing, was the first performed by machinery. Such are classed as *short-thread machines*.

The needle with two points and an eye at midlength was patented in England in 1755. The embroidering-machine of Heilmann, patented (to Bock) in England, May 2, 1829, No. 5,788, for that purpose, was for a machine in which a large number of needles, each with an eye in the middle and a point at each end, or tambour-needles, are simultaneously actuated over a moving web of cloth, so as to repeat the patterns at various points from one "governing design" and on a more minute scale if desired. See also English patent, No. 6,931, of 1835.

Of Lye's sewing-machine, patented in the United States in 1826, no record exists. The fire of 1836 consumed all the records, and but few comparatively were restored, by means of recopying from the patents returned for that purpose.

J. J. Greenough's patent of February 21, 1842, had a similar needle, which was passed through and through the material by means of pinchers traveling on a track, and opened and closed automatically. The machine was specially designed for leather and other hard material, and the needle was preceded by an awl which pierced a hole. The material to be sewed was held between clamps provided with a rack, which was moved both ways, alternately, to produce a *back-stitch*, or continuously forward to make the shoemaker's stitch. The material was fed automatically at a determinate rate, according to the length of stitch required. The machine had a weight to draw out the thread, and a stop-motion to arrest the machinery when a thread broke or became too short. The needle was threaded with a length of thread, and required refilling. The feed was continuous to the length of the rack-bar, and then it had to be set back. The machine was not specifically useful, but possessed some valuable points. It holds a creditable place in the history.

Fig. 4848.



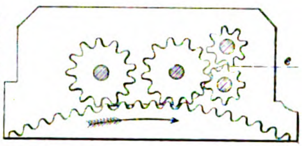
Greenough's Sewing-Machine (1842).

Fig. 4848 is a perspective view of the machine. One of the pincher-heads *a* is seen on the track, the other *a'* is nearly hidden by other portions of the machine. The levers *b b'* work the nipper-heads by means of cords, and are moved by cams *c c'* on the revolving shaft. A cam *d* on the shaft works the lever *e*, which reciprocates transversely and works the feed. The motions were all obtained from the revolution of a crank like the machine of Saint, 1790. That of Thimonnier, 1830, had a vertical needle worked by a treadle motion to depress the lever by a direct downward pull. Each of the machines mentioned was, however, much nearer to the type of the present machine than that of Greenough. The overhanging arm, vertically reciprocated needle, continuous thread, and automatic feed were patented in England fifty-two years before Greenough's, and sixty years before the Singer attained its excellence, as we shall have occasion to show presently.

The Corliss machine, patented in the United States December 27, 1843, No. 3,389, was of the same general mode of operation as the Greenough. It had eye-pointed needles reciprocated in horizontal paths through holes previously made by awls in the material fastened between clamps and fed in front of the needles. The feed was automatic, the length of the holding clamp. The motions were derived from peculiarly shaped cams on a revolving shaft. Many other details are worth enumerating would space permit.

An early form of sewing-machine, perhaps the earliest, was that employed for sewing lengths of calico together previous to the processes of bleaching, dyeing, and printing. The edges of the pieces being laid together and passed between fluted rollers, were thereby doubled or crimped and pressed on to the needle, which was held stationary in a horizontal position. See English patents No. 10,134 of 1844; also running stitch machine, No. 11,025 of 1846; No. 12,752 of 1849. The same feature is also seen in the United States patents, Smith and Chadbourne, April 16, 1850, and in No. 3,672, July 22, 1844, and shown in Fig. 4849. The cloth is crimped and forced on to the needle *e*.

Fig. 4849



Rodgers's Running-Stitch Machine.

Fig. 4850 is another form of the same kind of machine. The hand-crank works the feed-rollers and also the toothed rollers, which crimp the cloth and force it on to the needle *c*.

Another form of running-stitch machine having a curious analogy to the spiral needle for staphylorаphy is shown in Fig. 4851. This machine, patented November 3, 1874, has a spiral needle, shaped like a corkscrew, and with a continuous groove, in which the thread lies, being secured at the point of the needle by a spring. The edges to be sewed together are laid in the track of the needle, which is revolved, and passes through both edges once at each revolution. A bag is shown at *b*. See also Bean's patent, March 4, 1843, which used a common sewing-needle, and corrugated the cloth by means of gear-wheels, and forced it on to the needle.

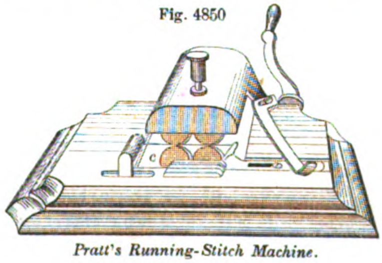
b. The *chain-stitch* or *tambour-stitch* is one consisting of a series, the bight of the thread being thrust through a former loop, and leaving a loop which in turn is enchained by the next-formed bight; and so on. There are several modes of making it, and while it was perhaps the first successful in a machine, it has been to a large extent superseded by other stitches. Several cheap forms of machines yet use it, and one kind, which has many friends, the "Willcox and Gibbs."

It may be made by a crochet needle and looping-hook, or by an eye-pointed needle and detaining-hook. It was the first machine-stitch in which the thread was continuous, the previous attempts having all been in imitation of hand-sewing, with a certain length of thread, threaded in the needle.

The first sewing-machine to make the chain-stitch is described in the English patent of Thomas Saint, July 17, 1790, which will be referred to presently. It is not known that working machines were ever made on this plan, but it cannot be ignored in a history which deals with records. Explicit notice is deferred for reasons explained farther on. Fig. 4854.

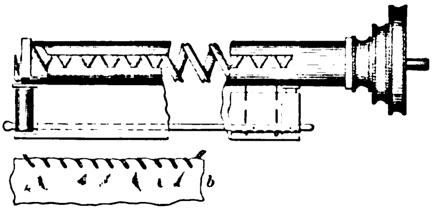
Next in order of date, making the chain-stitch, is Duncan's machine, English, No. 2,769, of 1804. It had a number of hooked needles, which passed through the

Fig. 4850



Pratt's Running-Stitch Machine.

Fig. 4851.



Garland's Spiral Needle for Sewing Bags.

cloth, then each was supplied with thread by a feeding-needle, which passed the thread around the crochet-needle and under the barb. As the needles receded, each drew a loop through the loop previously drawn by it through the cloth. The cloth was stretched between two cylinders placed parallel to each other in an oblong frame, which slid horizontally in another frame. Thus, either a horizontal or a vertical motion might be given to the cloth, or, by a combination of motions, an oblique direction. See also English patent, No. 10,102 of 1844.

Of the same class as the last two cited was the machine of Thimonnier, patented in France in 1830, and used for years in making army clothing. A fuller description of this machine is deferred so as to bring it into more immediate contact with the really valuable machines, of which it was, in many important respects, the forerunner. It had a thread-carrier beneath the goods, a crochet-needle which descended through the goods from above and caught up a loop which enchained the previous loop. Here we first see the presser-foot. This feature of a lower thread-carrier and hook needle is to be seen in the most valuable shoe-sewing machines of the present day.

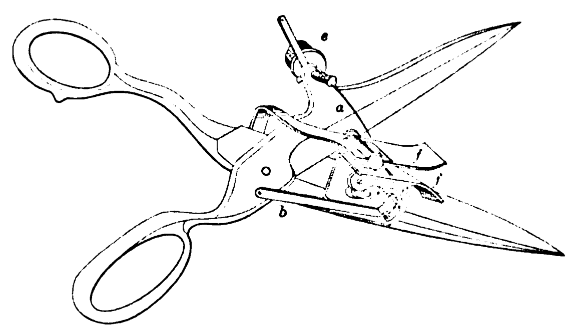
Sneath's machine was for producing *chain*-stitch ornaments on bobbinet in the process of making. It had a *curved needle with two eyes* for introducing a thread through the lace, and leaving a loop thereof; a pair of barbed points carried the loop over to the place where it was entered by the needle on its next stroke.

The eye-pointed needle is found in Newton and Archbold's English patent, No. 8,948 of 1841. This was some years after Walter Hunt's machine, and several years before Elias Howe applied himself to the task. We shall refer to this presently. In the English patent, No. 8,948, the eye-pointed needle carried a thread through the fabric and left a loop, which was caught by a hook and drawn lengthwise over the spot where the needle would pass through it on its next stroke. These features were afterward shown in the Johnson and Morey patent, February 6, 1849, and are yet extant in some machines of approved quality, though not of the highest class.

While considering this class of machines, it may be as well to adduce two rather amusing instances of the *chain*-stitch machines.

Fig. 4852 is a sewing-machine attached to a pair of scissors. The needle *a* is attached to the upper member of the scissors, as is also the bar *b* attached to the loop-check *c*, which is pivoted on the lower member of the scissors. *e* is the spool. The

Fig. 4852



Cutting and Sewing Machine.

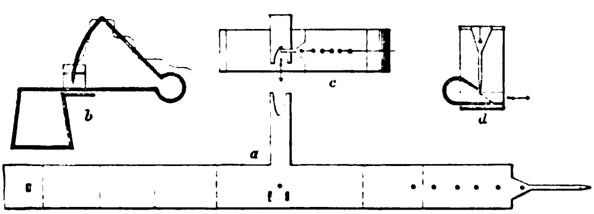
cloth passes between the plates *f f*, and the rate of sewing depends upon the length of the cut at each closing of the scissors, each stroke making a stitch. The eye-pointed needle carries the thread through the cloth, and leaves a loop on the hook; the next descent carries the thread through the former loop, making a chain-stitch.

Fig. 4853 is a sewing-machine made of a single slip of sheet-metal, and designed to make the chain-stitch.

a is the strip of metal, which is bent into the forms shown in the other figures, which are respectively, a side (*b*), top (*c*), and end (*d*) view. The thread is rove through the holes of the needle-holder and the eye of the needle, and, on being pressed through the cloth, pushes back the feeder. On rising, it leaves a loop on the under side, and, the feeder advancing, pushes the cloth along and the loop beneath it; the next time the needle comes down it passes through the former loop, and so on continuously.

c. The looping of one stitch by the loop of another is shown in Fisher and Gibbon's English patent, No. 10,424, of 1844. One thread is on a lower curved eye-pointed needle, which passes upward through the fabric, whereupon the upper eye-pointed needle enters between the former one and its thread; the curved needle, descending, leaves a loop upon the upper

Fig. 4853.



Sewing-Machine made of a Single Slip of Metal.

needle, the fabric being fed the length of a stitch; the curved needle again ascends, and, at the same time, the upper needle is moved in such a manner that it passes its thread around the curved needle and then retires through the loop of the needle thread previously upon its stem. After this, the upper needle, again advancing, enters between the curved needle and its thread, as before, and the movements are repeated. The enchaining of one thread by the loop of another thread is shown in several forms in Plate LVII. See also the Grover and Baker machine, Fig. 4863.

d. The last in order of date, and the best, is the simple lock-stitch, in which one thread is passed through a loop in the other one, and then both drawn so as to pull the bight of each into the middle of the fabric, making a fair line of stitches on each side.

In considering this section of the subject, we must refer to one or two inventions in which the lock-stitch was not made, but which possessed some features which have proved their right to live, and which seem to be indispensable in every well-ordered machine.

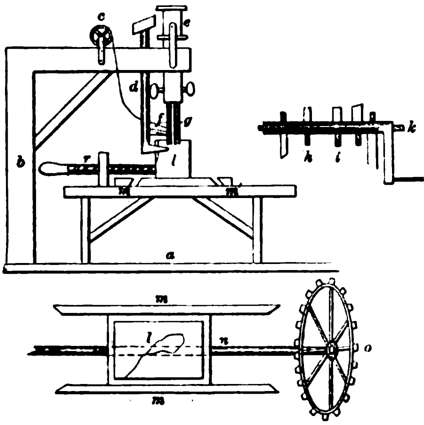
Ultimate success is attained by a multitude of efforts, and it is not fair, in our admiration of the perfected, to forget the weary, ill-appreciated, and unpaid efforts of those who have the earliest devoted themselves to the work. The growth of invention is in the direction of simplicity, but it is necessary, in the first place, to conceive the needs, and then follow a host of temporary expedients, — mere patchwork, as it afterward appears. In the course of time rises a reorganizer who proposes to devise means adequate to meet the changed conditions which supervene when a machine is called upon to take the place of the human operator. The earliest machine used the needle and needleful of thread in making a running-stitch. Then the eye was placed in the middle of the needle, which was sharpened at both ends to save turning it about when returning it, the needles being pushed and drawn by steel fingers on each side of the goods. The invention was as yet an implicit copying of the human manipulation, and the next change merely shifted the mode from the stitch of the *seamstress* to that of the *tambour-worker*. The needle was passed through the goods and returned, leaving a loop, which was detained, so as to be entered by the needle at its next descent, leaving another loop, and so on. A modification has been mentioned, consisting of a crochet-hook passed through the goods, bringing back with it a loop of thread from below, and enchaining it with the previous loop. This is all the small-beer of invention; the imitation of hands to use the familiar needle or the crochet-hook. There may be sedulous application and a certain merit in it, but there is no genius. The man of mark will find a new departure. He must devise new modes of procedure adapted to the needs of the new steel man, who is automatic but unskillful, and one of whose principal requirements is continuity of motion. If one must stop and thread his needle, he might as well return from the click and hum of the metal to the clatter of tongues which need no oiling.

The new elements were not invented all at once. One of the most important was overlooked for fifty years after it had been patented. Another was invented, made, and exhibited, and then slept a profound sleep of twelve years. Another was invented and patented, but was in a useless shape, and lay dormant until really valuable inventions were made, when it arose and claimed them as mere adaptations.

There is no important machine for sewing fabrics, now manufactured, that does not use all of the three elements mentioned, — the continuous thread, the eye-pointed needle, and the continuous feed, — but the former two of these had been in existence for sixty and twenty years respectively before they were united with the latter one, which, coming in the fruition of time, was more quickly recognized as a necessity.

Precedence in time is one of the governing elements in apportioning merit in invention. Some things may be perfectly invented, before assuming any concrete form in wood or metal. A man may be his own draftsman, or may call in his assistant to make the working drawings for a given kind of compound engine or a balanced valve. The workmen are the mere agents, and the engine or apparatus stands as the work of the designer. The ideas of a practiced engineer are concrete in the mind, as the attributes and accessories are all present in the conception of the thing; but with essayist and experimentalist the relations are different. With him the figure assumed in the mind is as yet untried, and unascertained conditions are yet to be provided for as they occur. With all allowance for the probable fact that no more than an experimental machine was actually made, yet the sewing-machine described in the English patent of Thomas Saint, No 1,764. and dated July 17, 1790, must still be regarded as a very remarkable link in the historical chain. It was intended for "quilting, stitching, and sewing, making shoes, and other articles by means of tools and machines." It possessed (1) a *horizontal cloth-plate;* (2) an *overhanging arm*, on the end of which was

Fig. 4854.



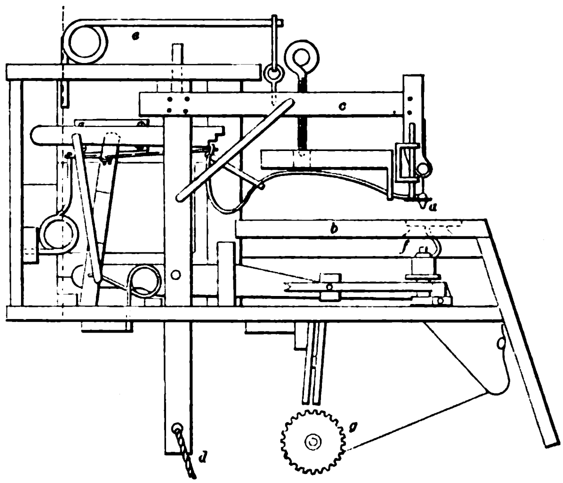
Saint's Sewing-Machine (1790).

(3) a *vertically reciprocating straight needle*, and on the top of which was (4) a *thread spool, giving out its thread continuously;* (5) an *intermittent automatic feed* between stitches; made the *chain-stitch;* and had thread tighteners above and below. This is marvelous. Its parallel is to be found in the sixteenth-century revolvers and repeating fire-arms in the European museums; weapons that were made before the voyage of Columbus.

The machine consisted of a bed-plate *a* with a post *b*, having a projecting arm on which was the thread-spool *c*; a shaft, rotated by a hand-crank and carrying cams by which all the motions of the machine were obtained; the same overhanging arm carried a spindle *d* for tightening the stitch, and a needle and awl-carrier *e*, into which a needle *f* and awl *g* were secured by set-screws, and moved by cams *h i* on the shaft *k*. The needle was notched at its lower end to push the thread through the hole made by the awl, and thus form a loop. The work was supported on a box *l* sliding between guides *m m* and advanced by a screw *n* turned by a toothed wheel *o*, which was engaged by a projection from an arm depending from the shaft *k*, at each revolution of the latter. A looper was operated by the bent point of the spindle *d* in a manner still employed in some of the chain-stitch machines. The screw *r* served to adjust the box *l* on the guide-plate, and provision was made for varying stitches for different kinds of work. The drawing has the peculiar features which should indicate that it was copied from a roughly made machine. The stiffening of certain parts of the frame was an incident of its making, and would not be necessary in a mere drawing. The overhanging arm would stand well enough, in a drawing, without the brace.

In 1830, Barthlemy Thimonnier patented a sewing-machine in France, which was so far successful that, in 1841, eighty of them, made of wood, were in use for sewing army clothing at a shop in Paris. They were destroyed by an ignorant and infuriated mob, just as the Jacquard loom and the Hargreaves spinning-jenny had been years before. Thimonnier escaped with his life, and again set to work. The Revolution of 1848 found him with another set of machines, capable of making 200 stitches per minute, and sewing and embroidering any material, from muslin to leather inclusive. Again the mob defeated his project and periled his person. He was in very straitened private circumstances, and the repeated destruction of the machines, built with money solicited from his friends, wearied at last even the admirers of his genius and energy.

Fig. 4855.



Thimonnier's Sewing-Machine (1830).

His machine was, like that of Saint, just described, in the form which subsequent experience has justified; that is, it had a vertical needle descending from the end of an overhanging arm *c* and piercing the goods, which was fed beneath upon a flat table *b*. The feed was by hand. Contrary to the machine of Saint, whose motions were derived from a crank, the needle in the Thimonnier machine was depressed by a treadle and cord *d*, and returned by a spring *e*. The Saint machine had a *forked* needle to push an *upper thread* through a hole previously made in the goods, when it was caught by a loop-check and detained, so that the again descending thread was enchained in the former loop, making a *chain-stitch*, consisting of a *series of loops on the under side*. The Thimonnier machine had a *crochet* or barbed needle which plunged through the goods and caught a *lower thread* from a thread-carrier and looper *f* beneath, and brought up a loop, which it laid upon the upper surface; descending again, it brought up another loop and enchained it with the one last made, making a *chain-stitch*, consisting of a *series of loops on the upper side*. Their points of similarity were those in which they resemble the best modern machines, — the flat cloth-plate, vertical post, and overhang-arm, the vertically reciprocated needle, and the continuous thread *g*. A nipple *a* sleeved upon the stem of the needle rested upon the goods during the descent of the needle, and was lifted when the needle was clear of the goods: the latter was then moved a distance equal to the length of a stitch, the needle and presser-foot (as the nipple *a* may be called) descended again, in its ascent carried another loop of thread through the loop previously made, and so on. Thimonnier died in poverty in 1857.

The Thimonnier machine, patented in France, August 5, 1848, and in the United States September 3, 1850. No. 7,622, had some advantages over his French machine of 1830, but retained its main features. The needle-bar was still worked by treadle and spring. See for his French patents Brevets D'Invention, Tom. V. page 168, and Plate XXVIII.; Tom XIV. page 71, and Plate XIV.

Between 1832 and 1834, Walter Hunt, of New York, made and sold sewing-machines which embraced a *curved eye-pointed needle* at the end of a vibrating arm, and a shuttle, making what is known as the *lock-stitch*. He neglected to pursue the business, which consequently attracted little attention at the time. His extreme versatility prevented success; his inventions absorbed his time, and he seemingly had none left for se-

curing the pecuniary results of his genius. He just missed, and by mere inattention, one of the grandest opportunities of the century. The main features of his machine had been patented, eight years previous to Hunt's application, to another inventor, — Elias Howe. When Hunt applied for a patent in 1854, it was refused him on the ground of abandonment.

The name of Elias Howe is indissolubly associated with the history of the sewing-machine. With inventive abilities inferior to those of Walter Hunt, he had an adaptedness to follow out a single object persistently, and he reaped the field. His patent was dated September 10, 1846, and was extended for seven years in 1860. In his petition to Congress, July 15, 1867, for a second extension of his patent, he acknowledged having received about $ 1,185,000, but considered that his invention was worth $ 150,000,000. If he had received the latter sum he would have been still more certain that it was worth $ 1,000,000,000, and so on.

The sewing-machine is no exception to the ordinary rule that an invention is a growth rather than an inspiration. The original machine, as we have seen, had a simple needle, and made a *running* stitch; next we see a machine which made a succession of loops, forming a *crochet* stitch; here the machine paused awhile. A score of years was passed in devising modes of feeding, continuous or intermitting, by various arrangements of parts. The greatest advance up to that time was the *lock-stitch*, invented by Hunt, and made by passing a shuttle containing a lower thread through the loop of an upper thread carried down through the cloth by an eye-pointed needle. This was also the feature of the Howe machine.

Howe was very properly declared the first inventor, technically, as the *laches* of Hunt had placed him outside of the protection of the law. This was framed (as determined by the decisions of the courts, which have so construed the law as to make distinct the point, which was, at best, indefinite) for the reward of inventors who make public their improvements. The legal point was with Howe, and bitterly Hunt rued his carelessness. He declared he would invent imitation stitched work more accurate than the original: the result was the paper collar with imitation stitching.

The original Howe machine had a curved eye-pointed needle attached to the end of a vibrating lever and carrying the upper thread. (See Fig. 4856.) The shuttle, carrying the lower thread between the needle and the upper thread, was driven in its race by means of two strikers carried on the ends of vibrating arms worked by two cams. The cloth was suspended by pins from the edge of a thin steel rib called a baster-plate, which had holes engaged by the teeth of a small intermittingly moving pinion. This was the feed, and clumsy enough. The invention soon fell into the hands of mechanicians of great ability, who timed the movements, proportioned and adjusted the parts, and added new features, without which the invention must have languished and failed of any remarkable success.

Elias Howe seems to have set himself to the problem in 1843; in 1844 he devised the curved needle and interlocking shuttle; in May, 1845, he had a machine at work. In 1846 it was patented. Thereafter the struggle in the United States and in England was to obtain funds for manufacture, and many weary, hungry days were passed by the indomitable inventor. He sold various shares of his invention from time to time, but when the tide turned in his favor he repurchased the rights, and soon made a compact property of it. It was not all smooth sailing even then, but the parties disposed to dispute his broad claims were induced to come under agreements of tribute or of neutrality. It was very well done. The original claims which concerned the eye-pointed needle and shuttle gave coherence to the confederate parties. The bond of union has since been the mode of feeding. A. B. Wilson's four-motion feed is so superior to all others, that but few first-class machines are made without it. This patent expired in 1873, and the dominant claim now is the Bachelder patent, which had no particular value in itself, but was, perhaps, really the first continuous feed, and so gained an utterly unexpected prominence and a lease of life for three terms, in all twenty-eight years, ending in 1877, although the device was but the substitution of a continuous spiked band for the plate of limited length. It is not true that Bachelder was the first to *horizontalize* the machine; that was done nearly sixty years previous. It had an endless band or cylinder studded with a row of points which carried the fabric to and past the needle. It was a decided improvement on Howe's baster-plate, which had to be run back for each length of sewing.

Without impugning the genius of the earlier inventors, it may fairly be said that the present proximate perfection of the machine is due to the men who took up the work where Howe left it, — to Singer, A. B. Wilson, and others.

Furthermore, the machine is much indebted to the skill and enterprise of the mechanics and tradesmen in whose hands it has grown to the wonderful proportions it now exhibits.

The Wilson shuttle, reciprocating in a curved race, was patented in 1850.

Lerow (1850), reciprocating eye-pointed needle and a shuttle traveling in an endless shuttle-race.

Robinson (1851) had two curved needles with notches or eyes and two thread-guides. Produced either the ordinary or the *back stitch*.

Singer's machine (1851) had a vertical needle-movement and a roughened feed-wheel extending through a slot in the table. A spring presser-foot alongside the needle held down the work. Motion was communicated to the needle-arm and the shuttle by gearing.

Grover and Baker (1851) used two needles and a shuttle carrying a filling-thread to form a double-loop stitch. The upper needle passed through the fabric and made a loop through which the lower needle passed horizontally, forming a second loop. See 13, Plate LVII.

The A. B. Wilson four-motion feed (1852) and the Wilson rotating hook (1851), which catches the loop of the upper thread and drops a bobbin through it, are features of the Wheeler and Wilson, — one of the most admired machines. As has been said, no substitute has been found for the four-motion feed. The shuttle has, however, more friends than the rotating hook.

Johnson's machine of 1853 made a double-loop stitch by two needles carrying continuous threads, and passing, by a horizontal thrust, through the cloth, which was suspended by clamps between them.

In Singer's chain-stitch machine (1854), the loop of the needle-thread was carried over a retaining pin by a hook and held until the next loop was formed, which was received by the looper and passed through the former one. Thus, a loop was passed through a loop, instead of, as in the tambour-stitch, passing the needle-thread and needle through the former loop. The feed in this machine was by the presser-foot, which had a rough under surface.

In Avery's machine (1854) (10, Plate LV.), the stitch is formed by interlooping threads from two needles, the lower one working at an angle of 45° with the upper one.

Noyes (1872), a lock-stitch with two commercial spools, the loop being made around the lower spool by a revolving hook.

Plates LV., LVI. show the principles of action of the sewing-machines. The numbers correspond with those on the Plates.

Description of Plates.

Single-Thread Chain-Stitch Machine.

1. The bearded needle pierces the cloth and draws up the loop from below; the cloth is then fed, the needle retaining the loop and descending through the cloth for a new loop, which enchains the thread.

2. The loop formed by the eye-pointed needle is seized and distended by a reciprocating loop-taker until penetrated by the needle at its second descent.

3. Similar to the above, excepting that the loop-taker vibrates.

4. The loop-taker *a* rotates. The Willcox and Gibbs pattern.

5. The looper is operated by the pressure of the needle, retreating before it and seizing the loop as the needle returns.

6. Needle-loop caught by a stationary hook that detains the loop as the cloth is fed, the next descent of the needle passing through the loop.

7. Latch-needle for enchaining or knitting the loop. See Stitch 6, Plate LVII.

Two Threads.

8. The loop of the needle-thread is caught by a thread carried by a reciprocating looper *a*. See Stitch 13, Plate LVII.

9. Similar to the above, but having a vibrating looper *a*.

10. Two needles penetrating fabric from opposite sides, and making Stitch 16, Plate LVII.

Lock-Stitch by Shuttles.

11. The loop of the needle-thread interlocked by the thread of the reciprocating shuttle *a*. Singer pattern, Stitch 19, Plate LVII. Florence, Howe, Wilson, Weed.

12. Similar as to the needle-thread; shuttle vibrates in an arc of a circle. "Domestic" pattern.

13. The loop of the needle-thread is taken by a rotating shuttle *a*.

14. The shuttle *a* is stationary, and the loop of the needle-thread is passed over it by a vibrating arm *b*.

Lock-Stitch by Revolving Hooks.

15. The rotating looper *a* enters the loop of the needle-thread and carries it around a loose disk-bobbin *b* on the face of the hook. Wheeler and Wilson pattern.

Leather-sewing Machine.

16. A waxed-thread machine. A hook-needle *a* below the cloth takes thread from a thread-carrier *b* above the cloth, draws down the thread, and enchains it below. An awl *c* perforates the leather for the passage of the needle; a cast-off *d* discharges the loop.

Sole-sewing Machines.

17. Machine for making "turned" shoes. The shoe and last are carried on a jack *a*. A chain-stitch is formed by a hooked needle, which passes through the sole and upper, and takes its thread from a thread-carrier. The awl *b* perforates the material for the passage of the needle. Dunham's patent, September 9, 1862.

18. The shoe is supported on a horn provided with a thread-carrier. A hooked needle penetrates the sole and upper, and takes the thread from the thread-carrier and forms the chain portion of the stitch in a channel cut in the outer face of the

(*Continued on page* 2116.)

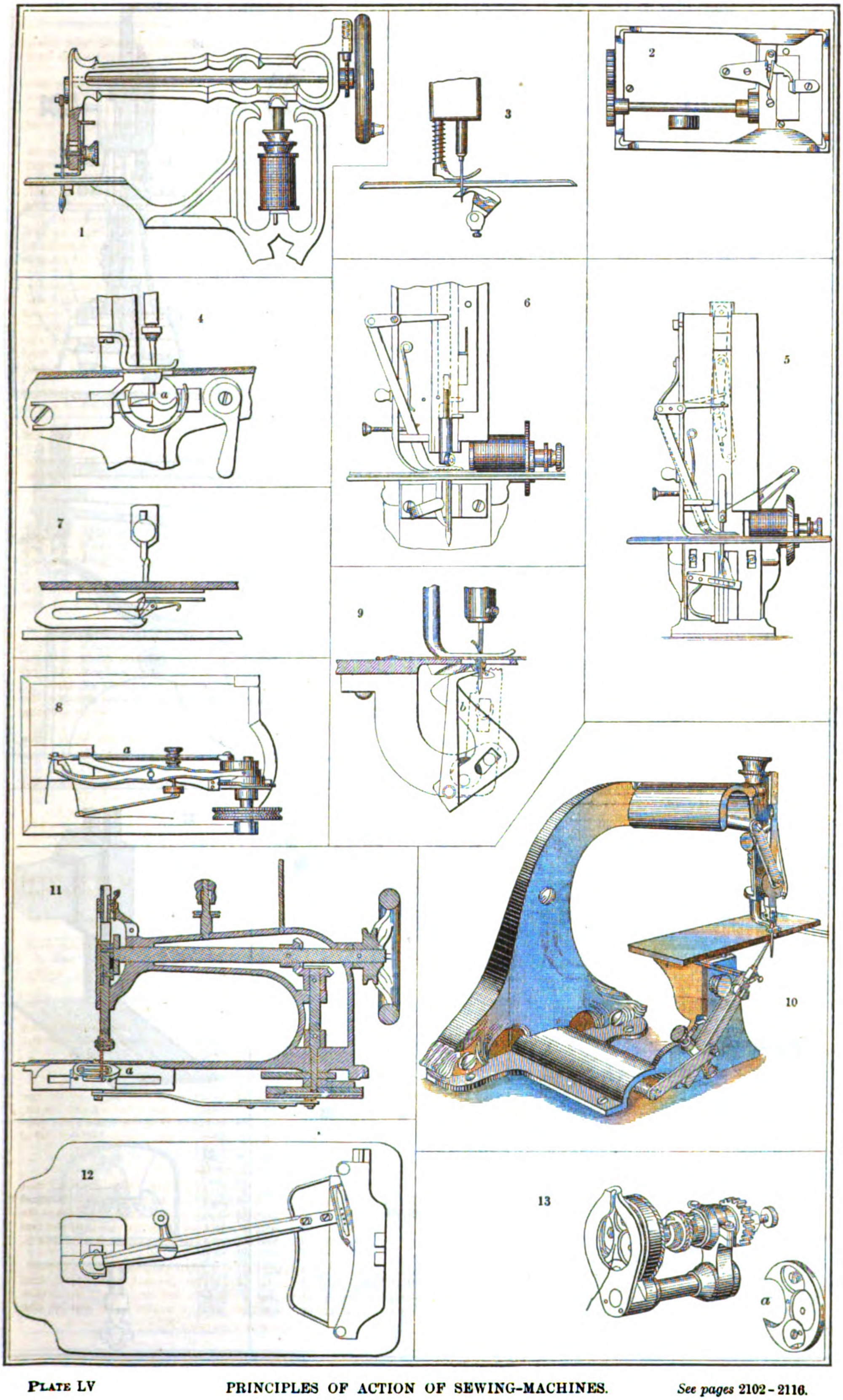


PLATE LV PRINCIPLES OF ACTION OF SEWING-MACHINES. *See pages 2102 - 2116.*

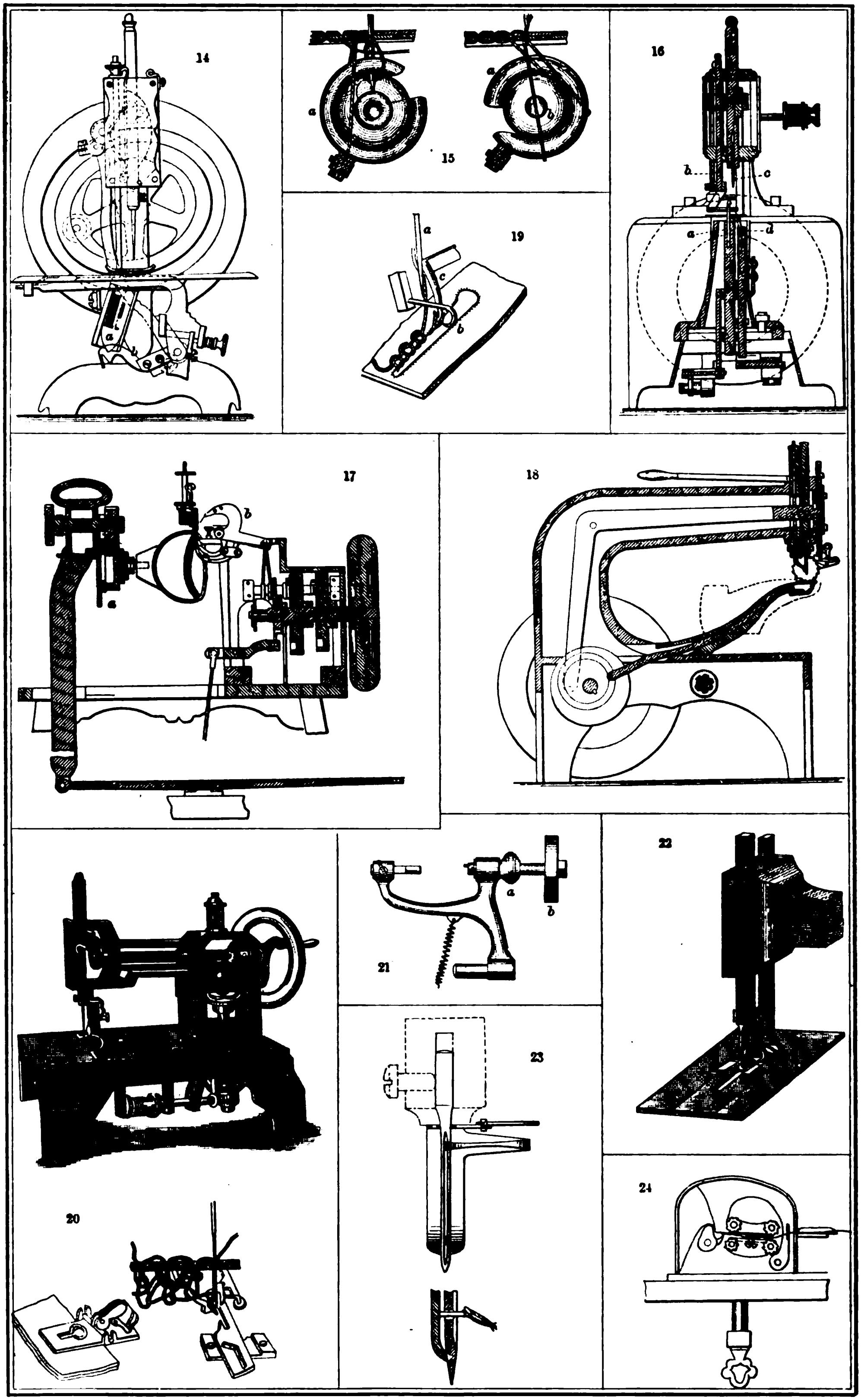


PLATE LVI. PRINCIPLES OF ACTION OF SEWING-MACHINES. *See pages* 2102 – 2116.

CLASSIFICATION OF SEWING-MACHINES

Patented in the United States.

The figures in parentheses refer to corresponding figures on Plates LV., LVI.

CLASS A. MAKING CHAIN-STITCH.

1. *One thread*.....
   - *a.* Bearded needle (1).
   - *b.* Reciprocating loop-taker (2).
   - *c.* Vibrating loop-taker (3).
   - *d.* Rotating loop-taker (4).
   - *e.* Loop-taker operated by needle (5).
   - *f.* Stationary hooks or guides for holding loop in path of needle (6).
   - *g.* Latch-needle for enchaining loop (7). See also C, 1, 3, and 4; also E, 1; also F, 14 and 20.
2. *Two threads*....
   - *a.* Reciprocating under-thread carrier (8).
   - *b.* Vibrating under-thread carrier (9).
   - *c.* Rotary under-thread carrier.
   - *d.* Two needles, each penetrating fabric (10). See also E, 2.
   - *e.* Two or more kinds of stitches.

CLASS B. MAKING LOCK-STITCH.

1. *By shuttle*......
   - *a.* Shuttles reciprocate (11).
   - *b.* Shuttles vibrate (12).
   - *c.* Shuttles rotate (13).
   - *d.* Stationary shuttles (14).
   - *e.* Shuttle carries commercial spool.
2. *By revolving hooks*........
   - *a.* Wheeler & Wilson pattern (15).
   - *b.* Commercial spool for under-thread.
   - *c.* Hooks of various other patterns, making chain and lock stitch.

CLASS C. SEWING LEATHER.

1. *Machines* (16).
2. *Waxing devices.*
3. *Hose sewing.*
4. *Sole sewing*....
   - *a.* Curved needle (17).
   - *b.* Straight needle (18).

CLASS D. FEEDING.

1. *Needle.*
2. *Wheel or band.*
3. *Reciprocating surface above cloth*
4. *Reciprocating surface below cloth.*
5. *By movement of table.*
6. *By pressure against thread.*

CLASS E. BUTTON-HOLE.

1. *One thread* (19).
2. *Two threads* (20).
3. *Attachments for ordinary sewing-machines.*

CLASS F. MISCELLANEOUS PARTS.

1. *Bobbin-winders* (21).
2. *Cloth and slide plates.*
3. *Cutting and trimming fabrics on machine* (22).
4. *Lifting presser-foot.*
5. *Mounting machines on table.*
6. *Needles.*
7. *Needle-sharpener* (21).
8. *Needle setters and threaders* (23).
9. *Oil-can holder.*
10. *Oiling thread.*
11. *Presser-foot.*
12. *Quilting.*
13. *Regulating speed.*
14. *Running-stitch* (24).
15. *Sewing hats.*
16. *Sewing on buttons.*
17. *Sewing straw braid.*
18. *Sewing knitted goods.*
19. *Sewing umbrellas.*
20. *Short thread.*
21. *Shuttles.*
22. *Spools and bobbins.*
23. *Stitches.* See Plate LVII.
24. *Take-up.*
25. *Tension devices.*
26. *Thread-cutters.*
27. *Miscellaneous.*

CLASS G. ATTACHMENTS.

1. *Binders.*
2. *Braiders.*
3. *Corders.*
4. *Embroidering.*
5. *Guides.*
6. *Hemmers.*
7. *Rufflers and gatherers.*
   - *a.* Tension-plates.
   - *b.* Reciprocat'g blades
8. *Tuck creasers and markers.*
9. *Tuckers and plaiters.*
10. *Welt-guides.*
11. *Variety of work.*

CLASS H. TABLES AND STANDS.

1. *Tables.*
2. *Cases and cabinets.*
3. *Covers*
4. *Trays.*
5. *Lamp-brackets.*
6. *Work-holders*
7. *Aprons, guards*, etc.
8. *Chair.*
9. *Casters.*

CLASS I. MOTORS.

CLASSIFIED LIST OF SEWING-MACHINES AND ATTACHMENTS

Patented in the United States from Feb. 21, 1842, to March 9, 1875.

(* Reissue.)

CLASS A.—MAKING CHAIN-STITCH.

1. *One Thread.* (*a.*) *Bearded Needle.*

No.	Name.	Date.
7,622	Thimonnier	Sept. 3, 1850.
15,695	Gardner	Sept. 9, 1856.
18,904	Hubbard	Dec. 22, 1857.
21,234	Jackson	Aug. 17, 1858.
22,179	Hook	Nov. 30, 1858.
23,285	Boynton	Mar. 15, 1859.
24,027	Hook	May 17, 1859.
24,061	Spencer	May 17, 1859.
24,973	Jenks	Aug. 2, 1859.
25,013	Harrison	Aug. 9, 1859.
25,262	Harrison	Aug. 26, 1859.
30,854	Handle	Dec. 4, 1860.
*1,592	Hook	Dec. 15, 1863.
67,535	Hancock	Aug. 6, 1867.
79,579	Lamson	July 7, 1868.
79,901	Einhorn	July 14, 1868.
80,789	Weaver	Aug. 4, 1868.
80,861	Fox *et al.*	Aug. 11, 1868.
83,909	Bonnaz	Nov. 10, 1868.
83,910	Bonnaz	Nov. 10, 1868.
95,186	Berger	Sept. 28, 1869.
106,943	Lake	Aug. 30, 1870.
148,182	Cornely	Mar. 3, 1874.
159,673	Hill	Feb. 9, 1875.

1. (*b.*) *Reciprocating Loop-Taker.*

No.	Name.	Date.
6,437	Conant	May 8, 1849.
7,369	Reynolds	May 14, 1850.
*268	Morcy *et al.*	June 27, 1854.
16,136	Watson	Nov. 25, 1856.
16,387	Johnson	Jan. 13, 1857.
16,566	Gray	Feb. 3, 1857.
17,508	Harris	June 9, 1857.
17,571	Harris	June 16, 1857.
17,717	Sage	June 30, 1857.
17,744	Lathbury	July 7, 1857.
18,071	Behn	Aug. 25, 1857.
18,823	Moore	Dec. 8, 1857.
19,015	Clark	Jan. 5, 1858.
19,072	Clark	Jan. 12, 1858.
19,129	Clark	Jan. 19, 1858.
19,135	Rixford *et al.*	Jan. 19, 1858.
19,285	Angell	Feb. 9, 1858.
19,409	Clark	Feb. 23, 1858.
19,660	Hendrick	Mar. 16, 1858.
19,532	Gray	Mar. 2, 1858.
19,665	Gray	Mar. 16, 1858.
20,413	Dimock	June 1, 1858.
20,742	Thomson	June 29, 1858.
21,015	Moore	July 27, 1858.

1. (*b.*) *Reciprocating Loop-Taker* (continued).

No.	Name.	Date.
21,230	Buell *et al.*	Aug. 17, 1858.
21,751	Gibbs	Oct. 12, 1858.
21,929	Sangster	Oct. 26, 1858.
22,226	Bishop	Dec. 7, 1858.
22,275	Boyd	Dec. 14, 1858.
24,003	Boyd	May 17, 1859.
25,084	Barnes	Aug. 16, 1859.
25,381	Buell	Sept. 13, 1859.
*829	Reynolds	Sept. 27, 1859.
28,097	McCurdy	May 1, 1860.
56,902	Cately	Aug. 7, 1866.

1. (*c.*) *Vibrating Loop-Taker.*

No.	Name.	Date.
7,659	Batchelder	Sept. 24, 1850.
12,573	Stedman	Mar. 20, 1855.
12,798	Stedman	May 1, 1855.
16,554	Pratt	Feb. 3, 1857.
16,745	Pratt	Mar. 3, 1857.
17,930	Herron	Aug. 4, 1857.
18,0[illegible]0	Watson	Aug. 11, 1857.

A. 1. (c.) *Vibrating Loop-Taker* (continued).

No.	Name.	Date.
18,371	Watson	Oct. 6, 1857.
18,639	Harrington	Nov. 17, 1857.
18,834	Watson	Dec. 8, 1857.
19,155	Sangster	Jan. 19, 1858.
19,612	Raymond	Mar. 9, 1858.
19,684	Coates	Mar. 23, 1858.
19,793	Reynolds	Mar. 30, 1858.
19,876	Savage	Apr. 6, 1858.
19,903	Atwood *et al.*	Apr. 13, 1858.
19,979	Bosworth	Apr. 20, 1858.
20,481	Clark	June 8, 1858.
20,753	West *et al.*	June 29, 1858.
20,763	Miller	June 29, 1858.
20,990	Carpenter	July 27, 1858.
21,049	Hook	July 27, 1858.
21,250	Fitz *et al.*	Aug. 24, 1858.
21,322	Clark	Aug. 31, 1858.
21,466	Clinton	Sept. 7, 1858.
21,672	Harris	Oct. 5, 1858.
21,713	White	Oct. 5, 1858.
21,722	Hendrick	Oct. 5, 1858.
22,148	Perry	Nov. 23, 1858.
22,719	Fosket *et al.*	Jan. 25, 1859.
24,098	Carhart	May 24, 1859.
24,335	McCurdy	June 14, 1859.
26,201	Pearson	Nov. 22, 1859.
32,415	Cooper	May 28, 1861.
32,456	Stoakes	May 28, 1861.
32,782	Norton	July 9, 1861.
32,785	Raymond	July 9, 1861.
32,925	Raymond	July 30, 1861.
33,085	Hodgkins	Aug. 20, 1861.
34,932	Williams	Apr. 8, 1862.
38,450	Palmer	May 5, 1863.
45,236	Folsom	Nov. 29, 1864.
46,064	Bartlett	Jan. 31, 1865.
*2,210	Bartlett	Mar. 27, 1866.
54,816	Goodspeed	May 15, 1866.
56,990	Piper	Aug. 7, 1866.
60,669	Bartram	Jan. 1, 1867.
61,176	Driggs	Jan. 15, 1867.
*2,745	Hodgkins	Aug. 20, 1867.
*2,746	Hodgkins	Aug. 20, 1867.
68,196	Hills	Aug. 27, 1867.
69,666	Hodgkins	Oct. 8, 1867.
76,385	Bartlett	Apr. 7, 1868.
80,889	Willmarth	Aug. 11, 1868.
81,821	Rowley	Sept. 1, 1868.
83,492	Hancock	Oct. 27, 1868.
83,750	Willmarth *et al.*	Nov. 3, 1868.
84,959	Myers	Dec. 15, 1868.
86,057	Canfield	Jan. 19, 1869.
86,695	Russell	Feb. 9, 1869.
93,354	Foot	May 25, 1869.
96,160	Smith	Oct. 26, 1869.
99,481	Rudolph	Feb. 1, 1870.
99,704	Porter	Feb. 8, 1870.
103,050	Keable	May 17, 1870.
109,705	Young	Nov. 29, 1870.
117,101	Necker	July 18, 1871.
124,808	Goodes	Mar. 19, 1872.
125,301	Johnson	Apr. 2, 1872.
126,921	Beckwith	May 21, 1872.
133,351	Beckwith	Nov. 26, 1872.
137,618	O'Neil	Apr. 8, 1873.
138,996	Davis	May 20, 1873.
146,721	Taylor	Jan. 20, 1874.

1. (d.) *Rotating Loop-Taker.*

No.	Name.	Date.
17,427	Gibbs	June 2, 1857.
18,915	Lazelle	Dec. 22, 1857.
20,686	Johnson	June 22, 1858.
*573	Gibbs	July 13, 1858.
21,089	Smith	Aug. 3, 1858.
21,100	Wheeler *et al.*	Aug. 3, 1858.
21,129	Gibbs	Aug. 10, 1858.
22,007	Avery	Nov. 9, 1858.
28,851	Gibbs	June 26, 1860.
29,268	Hicks	July 24, 1860.
33,439	Marble	Oct. 8, 1861.
38,931	McCurdy	June 16, 1863.
46,303	McCurdy	Feb. 7, 1865.
*2,655	Gibbs	June 18, 1867.
74,328	Fales	Feb. 11, 1868.
*3,247	Fales	Dec 29, 1868.
108,827	Rayer *et al.*	Nov. 1, 1870.
152,618	Dinsmore *et al.*	June 30, 1874.
154,827	Beck	Sept. 8, 1874.
160,512	Dinsmore	Mar. 9, 1875.

1. (e.) *Loop-Taker operated by Needle.*

No.	Name.	Date.
12,923	Robertson	May 22, 1855.
18,285	Jenks *et al.*	Sept. 29, 1857.
18,350	Nettleton *et al.*	Oct. 6, 1857.
19,535	Sangster	Mar. 2, 1858.
19,723	Sangster	Mar. 23, 1858.
20,684	Snow	June 22, 1858.
20,688	Barnes	June 29, 1858.
21,299	Jackson	Aug. 24, 1858.
*599	Robertson	Sept. 14, 1858.
21,833	Hubbard	Oct. 19, 1858.

1. (f.) *Stationary Hooks or Guides for holding Loop in Path of Needle.*

No.	Name.	Date.
13,064	Robertson	June 12, 1855.
14,324	Robertson	Feb. 26, 1856.
16,434	Gibbs	Jan. 20, 1857.
16,609	Robertson	Feb. 10, 1857.
17,186	Atwater	May 5, 1857.
*560	Robertson	May 18, 1858.
21,402	Atwater	Sept. 7, 1858.
21,537	Hubbard	Sept. 14, 1858.
40,622	Heyer	Nov. 17, 1863.

1. (g.) *Latch-Needle for enchaining Loop.*

No.	Name.	Date.
10,974	Singer	May 30, 1854.
109,632	Lamb	Nov. 29, 1870.
127,145	Bouscay	May 28, 1872.

A. 2. *Two or more Threads.* (a.) *Reciprocating Under-Thread Carrier.*

No.	Name.	Date.
6,439	Batchelder	May 8, 1849.
7,931	Grover *et al.*	Feb. 11, 1851.
10,597	Johnson	Mar. 7, 1854.
10,622	Hodgkins	Mar. 7, 1854.
10,842	Singer	May 2, 1854.
11,284	Leighton	July 11, 1854.
12,074	Stedman	Dec. 12, 1854.
12,146	Ward	Jan. 2, 1855.
*355	Johnson	Feb. 26, 1856.
16,237	Jennings	Dec. 16, 1856.
17,049	Nettleton *et al.*	Apr. 14, 1857.
18,793	Fetter	Dec. 1, 1857.
19,732	Clark	Mar. 23, 1858.
20,471	Shaw *et al.*	June 1, 1858.
*568	Grover *et al.*	June 15, 1858.
*617	Batchelder	Nov. 2, 1858.
22,220	Raymond	Nov. 30, 1858.
*706	Stedman	Apr. 26, 1859.
24,022	Gray *et al.*	May 17, 1859.
24,629	Grout	July 5, 1859.
25,004	Farr	Aug. 9, 1859.
25,471	Silvey	Sept. 13, 1859.
25,785	Barrett	Oct. 11, 1859.
25,946	Budlong	Nov. 1, 1859.
26,336	Clark	Dec. 6, 1859.
26,346	Dickenson	Dec. 6, 1859.
26,638	Rowe	Dec. 27, 1859.
27,079	Smith	Feb. 7, 1860.
27,082	Thomson	Feb. 7, 1860.
27,260	Rowe	Feb. 21, 1860.
27,761	Newlove	Apr. 3, 1860.
28,176	Holly	May 3, 1860.
28,538	Ruddick	May 29, 1860.
28,785	Smith	June 19, 1860.
30,641	Payne	Nov. 13, 1860.
31,156	Earle	Jan. 22, 1861.
31,208	Bruen	Jan. 22, 1861.
31,334	Smith	Feb. 5, 1861.
31,429	Rice	Feb. 12, 1861.
31,601	Howlett	Mar. 5, 1861.
32,323	Wilder	May 14, 1861.
*1,244	Grover *et al.*	Dec. 3, 1861.
37,585	Madden	Feb. 3, 1863.
*1,543	Batchelder	Sept. 22, 1863.
40,296	Wagner	Oct. 13, 1863.
*2,125	Batchelder	Dec. 12, 1865.
55,029	Hayes	May 22, 1866.
61,102	Rehfuss	Jan. 8, 1867.

2. (a.) *Reciprocating Under-Thread Carrier* (continued).

No.	Name.	Date.
70,152	Baker	Oct. 29, 1867.
82,366	Wagner	Sept. 22, 1868.
88,499	McLean	Mar. 30, 1869.
95,581	Gray	Oct. 5, 1869.
102,586	Peabody	May 3, 1870.
105,961	McLean	Aug. 2, 1870.
122,131	Fanning *et al.*	Dec. 26, 1871.
129,013	Fanning	July 16, 1872.
145,287	Fanning *et al.*	Dec. 9, 1873.

2. (b.) *Vibrating Under-Thread Carrier.*

No.	Name.	Date.
9,053	Grover *et al.*	June 22, 1852.
12,066	Lyon	Dec. 12, 1854.
14,956	Grover	May 27, 1856.
19,059	Fetter	Jan. 5, 1858.
*572	Grover *et al.*	July 6, 1858.
21,224	Uhlinger	Aug. 17, 1858.
21,670	Grover	Oct. 5, 1858.
21,752	Grover	Oct. 12, 1858.
22,143	Harkness	Nov. 23, 1858.
*646	Lyon	Jan. 4, 1859.
24,737	Hensel	July 12, 1859.
25,087	Booth	Aug. 10, 1859.
25,730	Grover *et al.*	Oct. 11, 1859.
25,876	Barnes	Oct. 25, 1859.
25,913	Robertson	Oct. 25, 1859.
25,963	Fosket *et al.*	Nov. 1, 1859.
28,959	Booth	July 3, 1860.
30,031	Washburn	Sept. 11, 1860.
31,829	Ross	Mar. 26, 1861.
31,897	Mallary	Apr. 2, 1861.
32,007	Shaw	Apr. 9, 1861.
32,496	Fuller	June 4, 1861.
33,414	Bollman	Oct. 1, 1861.
33,778	Grover	Nov. 26, 1861.
36,405	Grover	Sept. 9, 1862.
37,202	Shaw	Dec. 16, 1862.
37,502	Grover	Jan. 27, 1863.
39,207	Baldwin	July 14, 1863.
39,892	Day	Sept. 15, 1863.
43,146	Wickersham	June 14, 1864.
50,469	Hart	Oct. 17, 1865.
56,641	Tucker	July 24, 1866.
93,415	Cobb	Aug. 10, 1869.
100,139	Grover	Feb. 22, 1870.
114,573	Little	May 9, 1871.
152,813	Speirs	July 7, 1874.

2. (c.) *Rotary Under-Thread Carrier.*

No.	Name.	Date.
30,478	Johnson	Oct. 23, 1860.

2. (d.) *Two Needles, each penetrating Fabric.*

No.	Name.	Date.
9,338	Avery	Oct. 19, 1852.
9,365	Hodgkins	Nov. 2, 1852.
9,582	Johnson	Feb. 22, 1853.
9,665	Johnson	Apr. 12, 1853.
10,354	Blodgett	Dec. 20, 1853.
10,880	Avery	May 9, 1854.
12,233	Conant	Jan. 16, 1855.
13,616	Harrison	Oct. 2, 1855.
18 470	Robertson	Oct. 20, 1857.
*613	Blodgett	Oct. 12, 1858.
25,968	Hudson	Nov. 1, 1859.
57,500	Halsey *et al.*	Aug. 28, 1866.
*3,214	Conant	Nov. 24, 1868.
93,615	Hancock	Aug. 10, 1869.

2. (e.) *Two or more Kinds of Stitches.*

No.	Name.	Date.
26,059	Scofield	Nov. 8, 1859.
77,889	Kerr	May 12, 1868.

CLASS B. — MAKING LOCK-STITCH.

1. *By Shuttle.* (*a.*) *Shuttles reciprocate.*

No.	Name.	Date.
4,750	Howe	Sept. 10, 1846.
5,942	Bradshaw	Nov. 28, 1848.
*188	Blodgett *et al.*	Jan. 14, 1851.
8,282	Atkins *et al.*	Aug. 5, 1851.
8,294	Singer	Aug. 12, 1851.
9,556	Palmer	Jan. 25, 1853.
9,641	Thompson	Mar. 29, 1853.
10,757	Parker	Apr. 11, 1854.
10,763	Harrison	Apr. 11, 1854.
10,875	Coon	May 9, 1854.
10,879	Hodgkins	May 9, 1854.
10,975	Singer	May 30, 1854.
10,994	Stevens *et al.*	May 30, 1854.
11,161	Hunt	June 27, 1854.
*278	Singer	Oct. 3, 1854.
11,884	Ambler	Nov. 7, 1854.
12,011	Weed	Nov. 28, 1854.
12,336	Wilder	Jan. 30, 1855.
12,389	Horn	Feb. 13, 1855.
12,902	Durgin	May 22, 1855.
12,969	Singer	May 29, 1855.
13,201	Stedman	July 3, 1855.
13,630	Cowperthwaite	Oct. 9, 1855.
13,637	Singer	Oct. 9, 1855.
13,763	Singer	Nov. 6, 1855.
13,966	Singer	Dec. 18, 1855.
14,433	Watson	Mar. 11, 1856.
16,030	Singer	Nov. 4, 1856.
*452	Bradshaw	Apr. 14, 1857.
*453	Bradshaw	Apr. 14, 1857.
17,679	Howe *et al.*	June 30, 1857.
18,880	Behn	Dec. 15, 1857.
19,439	Newton	Feb. 23, 1858.
19,823	Bartholf	Apr. 6, 1858.
*567	Durgin	June 15, 1858.
20,761	Dugdale	June 29, 1858.
21,258	Howe	Aug. 24, 1858.
*600	Harrison	Sept. 14, 1858.
22,160	Burnet *et al.*	Nov. 30, 1858.
22,517	Singer	Jan. 4, 1859.
23,577	Hicks	Apr. 12, 1859.
23,789	Shaw *et al.*	Apr. 26, 1859.
24,847	Planer	July 19, 1859.
24,870	Hall	July 26, 1859.
25,002	Emswiler	Aug. 9, 1859.
25,885	Crosby	Oct. 25, 1859.
25,918	Sawyer *et al.*	Oct. 25, 1859.
26,057	Rose	Nov. 8, 1859.
26,234	McCurdy	Nov. 22, 1859.
26,462	Miller	Dec. 13, 1859.
26,536	Thorne	Dec. 20, 1859.
27,132	Juengst	Feb. 14, 1860.
27,546	Jones	Mar. 20, 1860.
27,574	Langdon	Mar. 20, 1860.
28,287	Little	May 15, 1860.
28,371	Hoffman	May 22, 1860.
28,804	Yeutzer	June 19, 1860.
28,993	McCurdy	July 3, 1860.
28,996	Mueller	July 3, 1860.
28,999	Penny *et al.*	July 3, 1860.
29,202	Sutton	July 17, 1860.
30,012	Tracy	Sept. 11, 1860.
30,634	Leavitt	Nov. 13, 1860.
30,731	Heyer	Nov. 27, 1860.
31,171	Irwin	Jan. 22, 1861.
31,209	Johnson *et al.*	Jan. 22, 1861.
31,325	Nivelle	Feb. 5, 1861.
31,411	Smith	Feb. 12, 1861.
31,691	Juengst	Mar. 12, 1861.
*1,154	Howe	Mar. 19, 1861.
32,297	Jones *et al.*	May 14, 1861.
32,315	Sherwood	May 14, 1861.
32,335	Smith	May 21, 1861.
34,081	Welch	Jan. 7, 1862.
34,739	Stebbins	Mar. 25, 1862.
34,906	Singer	Apr. 8, 1862.
36,084	Hall	Aug. 5, 1862.
*1,388	Atkins *et al.*	Jan. 20, 1863.
37,913	Howe	Mar. 17, 1863.
37,985	Smith	Mar. 24, 1863.
38,740	Halligan	June 2, 1863.
39,256	Langdon	July 14, 1863.
41,916	Guinness	Mar. 15, 1864.
43,927	Planer	Aug. 23, 1864.
44,063	Atwater	Sept. 6, 1864.
44,332	Melone	Sept. 20, 1864.
45,278	Stackpole	Nov. 29, 1864.
45,972	Cadwell	Jan. 24, 1865.
*1,930	Atkins *et al.*	Apr. 11, 1865.
47,673	Winsley	May 9, 1865.
49,262	Halligan	Aug. 8, 1865.
53,353	Smith	Mar. 20, 1866.
53,743	McCurdy	Apr. 3, 1866.
54,145	Halligan	Apr. 24, 1866.
54,577	Melone	May 8, 1866.
55,182	Warth	May 29, 1866.
58,181	Tyler	Sept. 28, 1866.
60,241	Reed	Dec. 4, 1866.

1. (*a.*) *Shuttles reciprocate* (continued).

No.	Name.	Date.
62,287	Reed	Feb. 19, 1867.
62,999	Bennett	Mar. 19, 1867.
64,830	Barclay	May 21, 1867.
68,009	Stebbens	Aug. 20, 1867.
68,835	Bosworth	Sept. 17, 1867.
71,131	Cadwell	Nov. 19, 1867.
77,665	Slater	May 5, 1868.
78,729	Fairfield	June 9, 1868.
78,817	Farnam	June 9, 1868.
78,818	Parham	June 9, 1868.
79,037	Waterbury	June 16, 1868.
80,345	French	July 28, 1868.
81,191	Meyer	Aug. 18, 1868.
81,328	Barclay	Aug. 25, 1868.
83,406	Porter	Oct. 27, 1868.
85,633	Barnes	Jan. 5, 1869.
86,163	Jones	Jan. 26, 1869.
86,164	Jones	Jan. 26, 1869.
*3,281	Guinness	Feb. 2, 1869
87,559	Gird	Mar. 9, 1869.
88,039	Hawkins	Mar. 23, 1869.
88,603	Billings	Apr. 6, 1869.
88,936	Winter	Apr. 13, 1869.
89,040	Guinness	Apr. 20, 1869.
89,064	Muir	Apr. 20, 1869.
89,489	Lyon	Apr. 27, 1869.
89,987	Griswold	May 11, 1869.
90,552	Jones	May 25, 1869.
93,511	Andrews	Aug. 10, 1869.
93,921	Stoops *et al.*	Aug. 17, 1869.
93,881	Heckendorn	Aug. 17, 1869.
93,962	Butterworth	Aug. 24, 1869.
94,112	Hoffman	Aug. 24, 1869.
94,467	Bradish	Sept. 7, 1869.
95,499	Melone	Oct. 5, 1869.
94,700	Heery	Sept. 14, 1869.
98,064	Hurtu *et al.*	Dec. 21, 1869.
99,138	Bennor	Jan. 25, 1870.
99,743	Smith	Feb. 8, 1870.
99,783	Meyer	Feb. 15, 1870.
102,808	Gowen	May 10, 1870.
103,070	Moltz	May 17, 1870.
*3,994	Meyer	May 24, 1870.
103,444	Garaghty	May 24, 1870.
104,871	Melone	June 28, 1870.
109,443	Parham	Nov. 22, 1870.
109,816	Gird	Dec. 6, 1870.
110,735	Buker	Jan. 3, 1871.
111,129	Macaulay	Jan. 24, 1871.
112,189	Smith	Feb. 28, 1871.
112,678	Bennor	Mar. 14, 1871.
112,747	Stackpole	Mar. 14, 1871.
113,407	Dinsmore	Apr. 4, 1871.
114,424	Dulaney	May 2, 1871.
115,117	Sidenberg	May 23, 1871.
117,380	Buker	July 25, 1871.
117,640	Jones	Aug. 1, 1871.
117,797	Meyer	Aug. 8, 1871.
118,404	Tate	Aug. 22, 1871.
118,450	Grover	Aug. 29, 1871.
118,928	Hahn	Sept. 12, 1871.
121,965	Secor	Dec. 19, 1871.
122,747	Wagner	Jan. 16, 1872.
124,167	Shuttock	Feb. 27, 1872.
124,854	Price *et al.*	Mar. 19, 1872.
125,708	Waterbury	Apr. 16, 1872.
125,807	Gordon *et al.*	Apr. 16, 1872.
126,755	Stebbens	May 14, 1872.
126,911	Stocker	May 21, 1872.
129,818	Haund	July 23, 1872.
130,005	Baker	July 30, 1872.
130,357	Brown	Aug. 13, 1872.
130,775	Wagner	Aug. 20, 1872.
131,061	Hunter	Sept. 3, 1872.
131,062	Hunter	Sept. 3, 1872.
132,124	Wagner	Oct. 6, 1872.
134,101	Rice	Dec. 17, 1872.
134,119	Whitehill	Dec. 17, 1872.
134,154	Mooney	Dec. 24, 1872.
134,463	Coles	Dec. 31, 1872.
*5,305	Hicks	Mar. 4, 1873.
136,823	Eldredge	Mar. 18, 1873.
138,898	Koch *et al.*	May 13, 1873.
139,444	Webster	May 27, 1873.
143,766	Hunter	Oct. 21, 1873.
146,502	Applegate	Jan. 20, 1874.
146,679	Hunter	Jan. 20, 1874.
146,761	Griswold	Jan. 27, 1874.
*5,752	Muir	Feb. 3, 1874.
148,024	Bishop	Mar. 14, 1874.
151,886	King	June 9, 1874.
152,500	Manning	June 30, 1874.
152,798	Hall	July 7, 1874.
153,767	Happe	Aug. 4, 1874.
*6,003	Koch *et al.*	Aug. 11, 1874.
156,171	Morian	Oct. 20, 1874.
159,065	Bartlett *et al.*	Jan. 26, 1875.

1. (*b.*) *Shuttles vibrate.*

No.	Name.	Date.
7,776	Wilson	Nov. 12, 1850.
9,139	Miller	July 20, 1852.
11,534	Harris	Nov. 14, 1854.
11,971	Parham	Nov. 21, 1854.
13,195	Woodruff	July 3, 1855.
13,242	Woodruff	July 10, 1855.
*345	Wilson	Jan. 22, 1856.
15,635	Johnson	Aug. 26, 1856.
*414	Wilson	Dec. 9, 1856.
16,234	Gibbs	Dec. 16, 1856.
16,281	Landfear	Dec. 23, 1856.
16,321	Woodruff	Dec. 23, 1856.
18,068	Wickersham	Aug. 25, 1857.
18,069	Wickersham	Aug. 25, 1857.
20,175	Smith	May 4, 1858.
20,531	Sangster	June 8, 1858.
21,461	Woodruff	Sept. 7, 1858.
22,137	Spencer *et al.*	Nov. 23, 1858.
22,255	Mackenzie	Dec. 7, 1858.
23,157	Cooper	Mar. 8, 1859.
26,130	Singer	Nov. 15, 1859.
26,366	Mitchell	Dec. 6, 1859.
26,586	Harrison	Dec. 27, 1859.
27,208	Davis	Feb. 21, 1860.
28,610	Scofield *et al.*	June 5, 1860.
31,625	Richards	Mar. 5, 1861.
32,239	Comfort	May 7, 1861.
33,415	Bollman	Oct. 1, 1861.
33,940	Grover	Dec. 17, 1861.
37,617	Dulaney	Feb. 10, 1863.
37,624	Hollowell	Feb. 10, 1863.
38,592	Mack	May 19, 1863.
*1,562	Parham	Nov. 3, 1863.
42,284	Grover	Apr. 12, 1864.
42,285	Grover	Apr. 12, 1864.
42,576	Grover	May 3, 1864.
43,285	Brown	June 28, 1864.
44,982	Smith *et al.*	Nov. 8, 1864.
45,059	Mack	Nov. 15, 1864.
45,528	Smith	Dec. 20, 1864.
49,023	Zuckerman	July 25, 1865.
52,847	Harlow	Feb. 27, 1866.
56,805	Schwalbach	July 31, 1866.
58,366	Andrews	Oct. 2, 1866.
60,433	Singer	Dec. 11, 1866.
61,270	Singer	Jan. 15, 1867.
76,807	Pepper	Apr. 14, 1868.
76,950	Sherwood	Apr. 21, 1868.
77,715	Chabot	May 12, 1868.
80,907	Byrkit	Aug. 11, 1868.
86,848	Macaulay	Feb. 9, 1869.
89,417	McArthur	Apr. 27, 1869.
93,065	Davis	July 27, 1869.
96,713	Lyon	Nov. 9, 1869.
96,886	Clever	Nov. 16, 1869.
99,067	Davis	Jan. 25, 1870.
99,283	Black	Feb. 1, 1870.
*3,825	Dulaney	Feb. 8, 1870.
101,140	Lawyer *et al.*	Mar. 22, 1870.
101,887	Kendall	Apr. 12, 1870.
102,366	Brown	Apr. 26, 1870.
105,123	Pepper	July 5, 1870.
106,032	Coon	Aug. 2, 1870.
106,249	Bennor	Aug. 9, 1870.
106,307	Barnes	Aug. 16, 1870.
107,041	Harlow	Sept. 6, 1870.
108,020	Harper	Oct. 4, 1870.
109,828	Macaulay	Dec. 6, 1870.
111,359	Mack	Jan. 31, 1871.
111,452	Higgins	Jan. 31, 1871.
112,033	Hancock	Feb. 21, 1871.
114,197	Rehfuss	Apr. 25, 1871.
117,002	Sherwood	July 11, 1871.
117,262	Crane	July 25, 1871.
120,815	Harper	Nov. 14, 1871.
121,186	Meriam	Nov. 21, 1871.
121,896	Rehfuss	Dec. 12, 1871.
123,493	Mack	Feb. 6, 1872.
123,892	Hall	Feb. 20, 1872.
128,640	Lamb	July 2, 1872.
130,715	Hoppe *et al.*	Aug. 20, 1872.
131,735	Brown	Oct. 1, 1872.
*5,046	Brown	Sept. 3, 1872.
132,332	St. John	Oct. 15, 1872.
133,814	Venner	Dec. 10, 1872.
135,194	Bingham	Jan. 28, 1873.
136,057	Gullman	Feb. 18, 1873.
136,616	Pickersgill	Mar. 11, 1873.
137,028	Rehfuss	Mar. 18, 1873.
137,199	Hoppe *et al.*	Mar. 25, 1873.
138,902	Lewis *et al.*	May 13, 1873.
140,787	Melone	July 15, 1873.
141,791	Hirons *et al.*	Aug. 12 1873.
144,864	Porter	Nov. 25, 1873.
145,215	Koch *et al.*	Dec. 2, 1873.
146,466	Moltz	Jan. 13, 1874.
146,644	Black	Jan. 20, 1874.
148,336	True	Mar. 10, 1874.

1. (b.) *Shuttles vibrate* (continued).

No.	Name.	Date.
148,902	Smith	Mar. 24, 1874.
149,565	Blake	Apr. 14, 1874.
149,862	Horr	Apr. 25, 1874.
150,532	Crane	May 5, 1874.
151,272	Buhr	May 26, 1874.
153,210	Weber	July 21, 1874.
155,120	St. John	Sept. 15, 1874.
155,798	Hazard	Oct. 13, 1874.
*6,118	Mack	Nov. 3, 1874.
159,006	Williamson	Jan. 19, 1875.

1. (c.) *Shuttles rotate.*

No.	Name.	Date.
6,766	Blodgett *et al.*	Oct. 2, 1849.
12,754	Smith	Apr. 17, 1855.
12,939	Bond	May 22, 1855.
13,727	Langdon	Oct. 30, 1855.
14,022	Slayton	Jan. 1, 1856.
15,469	Blodgett	Aug. 5, 1856.
15,470	Bond	Aug. 5, 1856.
16,914	Gibbs	Mar. 31, 1857.
18,359	Smith	Oct. 6, 1857.
18,605	Smith	Nov. 10, 1857.
20,730	Smith	June 29, 1858.
27,214	Gibbs	Feb. 21, 1860.
28,746	Giermann	June 19, 1860.
34,926	Thompson	Apr. 8, 1862.
36,255	McCurdy	Aug. 19, 1862.
42,687	Pickering	May 10, 1864.
49,421	Allen *et al.*	Aug. 15, 1865.
57,585	Shellenberger	Aug. 28, 1866.
58,925	Warth	Oct. 16, 1866.
60,021	Lenher	Nov. 27, 1866.
87,595	Rogan	Mar. 9, 1869.
92,068	Macpherson	June 29, 1869.
94,187	Davis	Aug. 31, 1869.
94,677	Warth	Sept. 7, 1869.
97,233	Rupertus *et al.*	Nov. 23, 1869.
104,247	Bartram	June 14, 1870.
114,294	House	May 2, 1871.
115,872	Lester	June 13, 1871.
127,430	Reece	June 4, 1872.
127,965	Heidenthal	June 11, 1872.
130,557	Bartram	Aug. 20, 1872.
135,536	Follett	Feb. 4, 1873.
137,321	Rogan	Apr. 1, 1873.
*5,388	Smith	Apr. 29, 1873.
139,245	Henderson *et al.*	May 27, 1873.
140,654	Smith	July 8, 1873.
159,183	Kappmeyer	Jan. 26, 1875.
159,956	O'Neil	Feb. 16, 1875.

1. (d.) *Stationary Shuttles.*

No.	Name.	Date.
12,015	Robertson	Nov. 28, 1854.
17,366	Ellithorpe	May 26, 1857.
19,662	Parker	Mar. 16, 1858.

1. (d.) *Stationary Shuttles* (continued).

No.	Name.	Date.
20,699	Comfort	June 29, 1858.
27,279	Dopp	Feb. 28, 1860.
34,988	Smith	Apr. 15, 1862.
56,020	Dulaney	July 3, 1866.
62,986	Willson	Mar. 19, 1867.
105,631	Bletcher	July 26, 1870.

2. *By revolving Hooks.* (a.) *Wheeler & Wilson Pattern.*

No.	Name.	Date.
8,296	Wilson	Aug. 12, 1851.
9,041	Wilson	June 15, 1852.
10,878	Crosby	May 9, 1854.
16,710	Belcher	Mar. 3, 1857.
22,961	March	Feb. 15, 1859.
24,455	Goodwyn	June 21, 1859.
24,881	Morton	July 26, 1859.
24,937	Hayden	Aug. 2, 1859.
25,043	Pratt	Aug. 9, 1859.
25,059	Tapley	Aug. 9, 1859.
25,223	Stoddard	Aug. 23, 1859.
26,948	Johnson	Jan. 24, 1860.
*913	Wilson	Feb. 28, 1860.
*914	Wilson	Feb. 28, 1860.
30,615	Collins	Nov. 13, 1860.
33,341	Folger	Sept. 24, 1861.
36,591	Wilkins	Sept. 30, 1862.
38,076	Wilkins	Mar. 31, 1863.
40,000	Tracy *et al.*	Sept. 15, 1863.
40,589	Secor	Nov. 10, 1863.
41,527	Miller	Feb. 9, 1864.
41,572	Eames *et al.*	Feb. 16, 1864.
48,345	McCluskey	June 20, 1865.
56,224	House	July 10, 1866.
56,646	Warth	July 24, 1866.
63,615	Collier	Apr. 9, 1867.
88,808	Pollock *et al*	Apr. 13, 1869.
*3,430	Wilson	May 11, 1869.
95,353	Husnik	Sept. 28, 1869.
112,745	Sidenberg	Mar. 14, 1871.
121,460	Kernaul	Dec. 5, 1871.
124,360	House	Mar. 5, 1872.
136,314	Farrar	Feb. 25, 1873.
136,635	Aird	Mar. 11, 1873.
138,163	Kernaul	Apr. 22, 1873.
145,570	House	Dec. 16, 1873.
158,214	Huntington	Dec. 29, 1874.

2. (b.) *Commercial Spool for Under-Thread.*

No.	Name.	Date.
21,592	Hinkley	Sept. 21, 1858.
26,687	Leyden	Jan. 3, 1860.
27,577	Smalley	Mar. 20, 1860.
28,877	Leyden	June 26, 1860.
30,518	Fetter	Oct. 23, 1860.
31,644	Lathrop *et al.*	Mar. 5, 1861.

2. (b.) *Commercial Spool for Under-Thread* (continued).

No.	Name.	Date.
38,276	Baldwin	Apr. 28, 1863.
40,446	Lathrop *et al.*	Oct. 27, 1863.
42,449	Thompson	Apr. 19, 1864.
*1,704	Fetter	June 21, 1864.
43,404	Hall	July 5, 1864.
44,003	Lathrop	Aug. 30, 1864.
57,157	Leyden	Aug. 14, 1866.
66,440	Abbott	July 9, 1867.
90,130	Sleppy	Mar. 18, 1869.
93,588	Bond	Aug. 10, 1869.
128,684	Wardwell	July 2, 1872.
129,981	Parks	July 30, 1872.
141,245	Wardwell	July 29, 1873.
143,027	Noyes	Sept. 23, 1873.
148,339	Wardwell	Mar. 10, 1874.
152,589	Abbott	June 30, 1874.

2. (c.) *Hooks of various other Patterns making Chain and Lock Stitch.*

No.	Name.	Date.
21,465	Blodgett	Sept. 7, 1858.
21,592	Hinkley	Sept. 21, 1858.
21,800	Miller	Oct. 12, 1858.
24,081	Miller	May 17, 1859.
24,780	Parker	July 12, 1859.
25,231	Hinkley	Aug. 23, 1859.
25,331	Hardie	Sept. 6, 1859.
25,782	Woodward	Oct. 11, 1859.
25,885	Crosby	Oct. 25, 1859.
28,920	Toggenberger	Jan. 26, 1860.
29,867	Miller	Apr. 10, 1860.
35,191	Winchell	May 6, 1862.
38,447	Grote	May 5, 1863.
42,110	Redmond	Mar. 29, 1864.
42,117	Sibley	Mar. 29, 1864.
48,248	Sibley	June 13, 1864.
54,926	Leavens	May 22, 1866.
58,245	Fuller, H. W.	Sept. 25, 1866.
59,659	Rodier	Nov. 13, 1866.
60,682	Bruen	Jan. 1, 1867.
62,050	McCurdy	Feb. 12, 1867.
63,132	Armstrong	Mar. 26, 1867.
68,839	Bruen	Sept. 17, 1867.
89,023	Tittman	Apr. 20, 1869.
97,935	Lathrop	Dec. 14, 1869.
98,390	Lamb	Dec. 28, 1869.
101,137	Lamb	Mar. 22, 1870.
101,292	Mead	Mar. 29, 1870.
103,254	Stockwell	May 17, 1870.
110,250	Lathrop	Dec. 20, 1870.
112,308	Winter	Feb. 28, 1871.
118,728	Lamb	Sept. 5, 1871.
126,056	Howard	Apr. 23, 1872.
126,057	Howard	Apr. 23, 1872.
127,532	Weber	June 4, 1872.
133,939	House	Dec. 17, 1872.
134,961	Whitney	Jan. 14, 1873.
135,000	McLean *et al.*	Jan. 21, 1873.
139,067	Lathrop	May 20, 1873.
142,013	Gordes	Aug. 19, 1873.
145,823	Weber	Dec. 23, 1874.

Class C.— Sewing Leather.

1. *Machines.*

No.	Name.	Date.
9,679	Wickersham	Apr. 19, 1853.
10,615	Wickersham	Mar. 7, 1854.
11,240	Butterfield	July 4, 1854.
11,507	Swingle	Aug. 8, 1854.
11,571	Shaw	Aug. 22, 1854.
11,581	Shaw	Aug. 22, 1854.
11,588	Turner *et al.*	Aug. 22, 1854.
11,631	Turner	Aug. 29, 1854.
14,207	Swingle	Feb. 5, 1856.
*363	Turner	May 25, 1856.
15,396	Swingle	July 22, 1856.
*415	Swingle	Nov. 4, 1856.
28,144	Bean	May 8, 1860.
29,785	Haskell	Aug. 28, 1860.
34,915	Townsend	Apr. 8, 1862.
*1,600	Butterfield	Jan. 5, 1864.
42,292	Johnson	Apr. 12, 1864.
*1,962	Turner	May 16, 1865.
48,511	Bradford *et al.*	July 4, 1865.
50,117	Hale	Sept. 26, 1865.
50,642	Tewkesbury	Oct. 24, 1865.
50,917	Dawley *et al.*	Nov. 14, 1865.
50,995	Keats *et al.*	Nov. 14, 1865.
51,157	Dunham	Nov. 28, 1865.
51,383	Bean	Dec. 5, 1865.

1. *Machines* (continued).

No.	Name.	Date.
52,368	Reed	Jan. 30, 1866.
57,047	Reed	Aug. 7, 1866.
58,550	Langmaid	Oct. 2, 1866.
59,127	Halligan	Oct. 23, 1866.
67,906	Reed	Aug. 20, 1867.
67,965	Elmes	Aug. 20, 1867.
86,592	Reed	Feb. 2, 1869.
86,632	Bean	Feb. 9, 1869.
89,275	Bean	Apr. 27, 1869.
92,138	Adams	July 6, 1869.
97,330	Weeman	Nov. 30, 1869.
109,427	Landfear	Nov. 22, 1870.
109,655	Palmer	Nov. 29, 1870.
110,945	Woodward	Jan. 10, 1871.
*4,500	Woodward	Jan. 10, 1871.
111,752	Kimball	Feb. 14, 1871.
115,925	Baker	June 13, 1871.
116,893	Turner *et al.*	July 11, 1871.
*4,500	Woodward	Aug. 1, 1871.
*4,785	Wickersham	Mar. 5, 1872.
*4,786	Wickersham	Mar. 5, 1872.
125,374	Baker	Apr. 9, 1872.
128,172	Richardson	June 18, 1872.
128,313	Jordan	June 25, 1872.
128,919	Springer	July 9, 1872.

1. *Machines* (continued).

No.	Name.	Date.
130,555	Ashe	Aug. 20, 1872.
130,556	Ashe	Aug. 20, 1872.
132,326	Shaw	Oct. 15, 1872.
134,508	Bean	Jan. 7, 1873.
134,509	Bean	Jan. 7, 1873.
135,431	Johnson	Feb. 4, 1873.
136,792	Tittman	Mar. 11, 1873.
137,528	Bean	Apr. 8, 1873.
137,640	Walters	Apr. 8, 1873.
*5,423	Bean	May 27, 1873.
146,280	Reed	Jan. 6, 1874.
150,479	Page	May 5, 1874.
152,894	Brewer	July 14, 1874.
*5,965	Bean	July 14, 1874.
154,115	Bean	Aug. 18, 1874.
155,193	Landfear	Sept. 22, 1874.
159,144	Bean	Jan. 26, 1875.

2. *Waxing Devices.*

No.	Name.	Date.
21,361	Peppers	Aug. 31, 1858.
23,752	Brigham	Apr. 26, 1859.

2. *Waxing Devices* (continued).

No.	Name.	Date.
39,092	Drew	June 30, 1863.
40,484	Hyde	Nov. 3, 1863.
41,050	Banister	Jan. 5, 1864.
43,077	McKay *et al.*	June 7, 1864.
43,209	Holbrook	June 21, 1864.
*1,831	Holbrook	Dec. 6, 1864.
47,911	Aldrich	May 30, 1865.
47,912	Aldrich	May 30, 1865.
*2,567	Drew	Apr. 16, 1867.
67,300	Hayden	July 30, 1867.
67,881	Kendall	Aug. 20, 1867.
69,056	Wiggin	Sept. 11, 1867.
113,962	Aldrich	Apr. 25, 1871.
128,008	Bean	June 18, 1872.
131,786	Sargent *et al.*	Oct. 1, 1872.
134,606	Lewis	Jan. 7, 1873.

3. *Sewing Hose.*

No.	Name.	Date.
31,214	Rice	Jan. 22, 1861.
73,709	French	Jan. 28, 1868.
74,289	Blake	Feb. 11, 1868.
*5,045	Rice	Aug. 27, 1872.
146,948	Richardson	Jan. 27, 1874.

4. *Sole-Sewing.* (*a.*) *Curved Needle.*

No.	Name.	Date.
34,413	Destory	Feb. 18, 1862.
36,396	Dunham	Sept. 9, 1862.
*1,363	Dunham	Dec. 16, 1862.
47,666	Stein	May 9, 1865.

4. (*a.*) *Curved Needle* (continued).

No.	Name.	Date.
56,729	Destory	July 31, 1866.
59,715	Duchemin	Nov. 13, 1866.
81,926	Stein	Sept. 8, 1868.
87,331	Eldredge	Mar. 2, 1869.
*3,386	Dunham	Apr. 20, 1869.
91,101	Duchemin	June 8, 1869.
92,912	Vetler	July 20, 1869.
93,731	Mills	Aug. 17, 1869.
94,389	Brown	Aug. 31, 1869.
*3,635	Destory	Sept. 7, 1869.
95,571	Destory	Oct. 5, 1869.
95,944	Mills	Nov. 16, 1869.
97,951	Mills	Dec. 14, 1869.
111,197	Goodyear	Jan. 24, 1871.
112,802	Goodyear	Mar. 21, 1871.
113,593	Stein	Apr. 11, 1871.
116,947	Goodyear	July 11, 1871.
121,237	Duchemin	Nov. 28, 1871.
124,393	Stein	Mar. 5, 1872.
127,423	Mills	June 4, 1872.
131,084	Destory	Sept. 3, 1872.
135,032	Duchemin	Jan. 21, 1873.
135,787	Duchemin	Feb. 11, 1873.
*6,081	Dunham	Oct. 13, 1874.
*6,295	Dunham	Feb. 16, 1875.

4. (*b.*) *Straight Needle.*

No.	Name.	Date.
20,775	Blake, R.	July 6, 1858.
31,203	Ballou	Jan. 22, 1861.
33,677	Drew	Nov. 5, 1861.
36,163	McKay *et al.*	Aug. 12, 1862.
40,212	Holden	Oct. 6, 1863.
42,622	McKay *et al.*	May 3, 1864.

4. (*b.*) *Straight Needle* (continued).

No.	Name.	Date.
42,916	McKay *et al.*	May 24, 1864.
45,422	McKay *et al.*	Dec. 31, 1864.
59,265	Richardson	Oct. 30, 1866.
63,607	Brown	Apr. 8, 1867.
*2,578	Drew	Apr. 30, 1867.
*2,579	Drew	Apr. 30, 1867.
*2,580	Drew	Apr. 30, 1867.
*2,906	Ballou	Mar. 31, 1868.
89,357	Swartwout	Apr. 27, 1869.
90,507	Crosby	May 25, 1869.
94,134	Richardson	Aug. 24, 1869.
94,976	Reeve *et al.*	Sept. 21, 1869.
97,518	Keith	Dec. 7, 1869.
97,611	Cutlan	Dec. 7, 1869.
98,151	Crosby	Dec. 21, 1869.
106,012	Wickersham	Aug. 2, 1870.
107,155	Blake	Sept. 6, 1870.
108,132	Greely	Oct. 11, 1870.
114,862	Rosinskey	May 16, 1871.
117,207	Richardson	July 18, 1871.
117,596	Blake	Aug. 1, 1871.
117,709	Wickersham	Aug. 1, 1871.
124,293	Sheffield	Mar. 5, 1872.
124,337	Crosby	Mar. 5, 1872.
124,338	Crosby	Mar. 5, 1872.
126,238	Stein	Apr. 30, 1872.
127,662	Vrooman	July 4, 1872.
129,059	Rosinskey	July 16, 1872.
131,291	Mills	Sept. 10, 1872.
134,303	Mills	Dec. 24, 1872.
135,047	Sheffield	Jan. 21, 1873.
138,764	Ross *et al.*	May 13, 1873.
140,586	Miller	July 8, 1873.
145,687	Richardson	Dec. 16, 1873.
153,428	Duchemin	July 28, 1874.
155,932	Drake	Oct. 13, 1874.
158,883	Ballou	Jan. 19, 1875.

CLASS D. — FEEDING.

1. *Needle.*

No.	Name.	Date.
18,732	Chase	Dec. 1, 1857.
58,614	Davis	Oct. 9, 1866.
125,774	Weeks	Apr. 16, 1872.
146,505	Beckwith	Jan. 20, 1874.

2. *Wheel or Band.*

No.	Name.	Date.
11,680	Shaw	Sept. 12, 1854.
12,856	Chilcott *et al.*	Jan. 12, 1855.
13,065	Singer	Mar. 15, 1855.
16,518	Alexander	Feb. 3, 1857.
17,825	Bartholf	July 21, 1857.
23,823	Clark	May 3, 1859.
26,816	Dick	Jan. 10, 1860.
27,412	Paine	Mar. 6, 1860.
31,805	Hicks	Mar. 26, 1861.
32,517	Howell	June 11, 1861.
43,514	Mack	July 12, 1864.
43,705	Phelps	Aug. 2, 1864.
43,890	Auger *et al.*	Aug. 23, 1864.
48,204	Planer	June 13, 1865.
48,206	Planer	June 13, 1865.
55,847	Galleth	June 26, 1866.
56,730	Dewey	July 31, 1866.
57,116	Galleth	Aug. 14, 1866.
57,287	Chicken	Aug. 21, 1866.
64,184	Stannard	Apr. 23, 1867.
68,420	Doll	Sept. 3, 1867.
89,501	Pratt	Apr. 27, 1869.
91,149	Miller	June 8, 1869.
101,779	Spoehr	Apr. 12, 1870.
112,016	Carpenter	Feb. 21, 1871.
116,618	McDonald *et al.*	July 4, 1871.
116,779	West	July 4, 1871.
119,246	Smyth	Sept. 26, 1871.
120,614	Barth	Nov. 7, 1871.
129,487	Miller	July 16, 1872.
130,264	Woodward	Aug. 6, 1872.
130,324	Smyth	Aug. 6, 1872.
146,483	Scribner	Jan. 13, 1874.
147,152	Muir	Feb. 3, 1874.
147,153	Muir	Feb. 3, 1874.
150,492	Smyth *et al.*	May 5, 1874.
152,721	Blanchard	July 7, 1874.

3. *Reciprocating Surface above Cloth.*

No.	Name.	Date.
12,364	Singer	Feb. 6, 1855.

3. *Reciprocating Surface above Cloth* (continued).

No.	Name.	Date.
12,577	Robertson	Mar. 20, 1855.
*343	Robertson	Jan. 15, 1856.
16,850	Robertson	Mar. 17, 1857.
18,566	Andrews	Nov. 3, 1857.
19,171	Boyd	Jan. 19, 1858.
22,225	Berry	Dec. 7, 1858.
22,269	Tyler	Dec. 7, 1858.
*1,073	Tyler	Nov. 13, 1861.
48,007	Wittneben	May 30, 1865.
50,297	Ballou	Oct. 3, 1865.
83,398	Meyers	Oct. 27, 1868.
96,017	Lomax	Oct. 19, 1869.
107,677	Godown	Sept 27, 1870.
117,203	Pitt	July 18, 1871.
140,603	Westmoreland	July 8, 1873.
145,025	St. Armant	Nov. 25, 1873.
157,017	Mason	Nov. 17, 1874.
159,006	Williamson	Jan. 19, 1875.
159,975	Hirons *et al.*	Feb. 9, 1875.

4. *Reciprocating Surface below Cloth.*

No.	Name.	Date.
12,116	Wilson	Dec. 19, 1854.
13,362	Singer	July 31, 1855.
14,141	O'Neil	Jan. 22, 1856.
*346	Wilson	Jan. 22, 1856.
20,557	Herron	June 15, 1858.
21,310	Andrus	Aug. 31, 1858.
22,273	Atwood	Dec. 14, 1858.
24,216	Irving	May 13, 1859.
41,164	McCurdy	Jan. 5, 1864.
41,444	Polluck *et al.*	Feb. 2, 1864.
42,036	Willcox	Mar. 22, 1864.
44,491	Willcox	Sept. 27, 1864.
45,628	Pepper *et al.*	Dec. 27, 1864.
48,205	Planer	June 13, 1865.
49,967	Bolton *et al.*	Sept. 19, 1865.
52,932	Rehfuss	Feb. 27, 1866.
53,514	Williams	Mar. 27, 1866.
60,769	Merriam	Jan. 1, 1867.
60,888	Hanlon	Jan. 1, 1867.
63,149	Fairfield	Mar. 25, 1867.
66,505	Littlefield	July 9, 1867.
67,652	House	Aug. 13, 1867.
67,752	Hadley	Aug. 13, 1867.
67,803	Robinson	Aug. 13, 1867.
67,815	Stanton	Aug. 13, 1867.
76,340	Minor	Apr. 7, 1868.
82,183	Vanduzer	Sept. 13, 1868.

4. *Reciprocating Surface below Cloth* (continued).

No.	Name.	Date.
83,133	Cole	Oct. 20, 1868.
83,596	Benedict	Nov. 3, 1868.
84,389	Smith	Nov. 24, 1868.
93,553	Plummer	Aug. 10, 1869.
98,452	Whitney	Dec. 28, 1869.
98,771	House	Jan. 11, 1870.
*3,795	Willcox	Jan. 11, 1870.
99,962	Smith	Feb. 15, 1870.
100,764	House	Mar. 15, 1870.
101,265	Hirschbuhl	Mar. 29, 1870.
101,926	Sawyer	Apr. 12, 1870.
102,226	Cooney	Apr. 26, 1870.
102,700	Rehfuss	May 3, 1870.
103,444	Garaghty	May 24, 1870.
106,228	Stocker	Aug. 9, 1870.
107,019	Fairfield	Sept. 6, 1870.
112,531	Berry	Mar. 14, 1871.
115,036	Diehl *et al.*	May 23, 1871.
115,151	Bates	May 23, 1871.
115,155	Bentel	May 23, 1871.
116,783	Willcox *et al.*	July 4, 1871.
117,459	Ramsey	July 25, 1871.
117,526	Eldridge	Aug. 1, 1871.
118,631	Moltz	Aug. 29, 1871.
119,690	Blees	Oct. 10, 1871.
122,401	Perkins	Jan. 2, 1872.
122,673	Smyth	Jan. 9, 1872.
123,114	Leavitt	Jan. 30, 1872.
126,844	Smyth	May 24, 1872.
126,845	Smyth	May 24, 1872.
127,867	Gullman	June 11, 1872.
130,325	Smyth	Aug. 6, 1872.
*5,177	Cole	Dec. 10, 1872.
135,579	Parham	Feb. 4, 1873.
135,930	Moore	Feb. 18, 1873.
139,040	Beebe	May 20, 1873.
141,088	Smyth	July 22, 1873.
151,320	Steinbach	May 26, 1874.
151,801	Smyth	June 9, 1874.
158,596	McCune	Jan. 12, 1875.

5. *By Movement of Table.*

No.	Name.	Date.
61,101	Rehfuss	Jan. 8, 1867.

6. *By Pressure against Thread.*

No.	Name.	Date.
13,850	Stedman	Nov. 27, 1855.

Class E. — Button-Hole.

1. *One Thread.*

No.	Name.	Date.
24,863	Goodes *et al.*	July 26, 1859.
31,628	Rose	Mar. 5, 1861.
32,023	Burr	Apr. 9, 1861.
33,029	Case	Aug. 13, 1861.
*1,616	Goodes *et al.*	Feb. 9, 1864.
41,923	Jackson	Mar. 15, 1864.
50,989	Emerson	Nov. 14, 1864.
79,393	Reynolds	June 30, 1868.
110,739	Cleminshaw	Jan. 3, 1871.
111,059	Helwig	Jan. 17, 1871.
128,363	Cleminshaw	June 25, 1872.
139,745	Tobey	June 10, 1873.
139,770	Cleminshaw	June 10, 1873.

2. *Two Thread.*

No.	Name.	Date.
10,609	Miller	Mar. 7, 1854.
13,353	Harrison	July 31, 1855.
25,692	Vogel	Oct. 4, 1859.
28,788	Steiner	June 19, 1860.
28,814	Rose	June 19, 1860.
33,619	Weitling	Oct. 29, 1861.
34,748	Deroquigny *et al.*	Mar. 25, 1862.
36,617	Humphrey	Oct. 7, 1862.
36,932	House	Nov. 11, 1862.
37,931	Weitling	Mar. 17, 1863.
39,442	House	Aug. 4, 1863.
39,443	House	Aug. 4, 1863.
39,444	House	Aug. 4, 1863.
39,445	House	Aug. 4, 1863.
40,311	Rehfuss	Oct. 13, 1863.
42,502	Parham	Apr. 26, 1864
43,742	Rehfuss	Aug. 2, 1864.
44,217	Parham	Sept. 13, 1864.
*1,805	Vogel	Nov. 1, 1864.
45,777	Weitling	Jan. 3, 1865.
47,905	Rehfuss	May 23, 1865.

2. *Two Thread* (continued).

No.	Name.	Date.
49,627	Humphrey	Aug. 29, 1865.
49,745	Frey	Sept. 5, 1865.
49,803	Tarbox	Sept. 5, 1865.
50,253	Humphrey	Oct. 3, 1865.
50,299	Cajar	Oct. 3, 1865.
50,870	Bartram	Nov. 7, 1865.
51,086	Rehfuss	Nov. 21, 1865.
54,671	Bartram	May 15, 1866.
*2,245	Bartram	May 15, 1866.
55,688	McCloskey	June 19, 1866.
55,863	House	June 26, 1866.
55,864	House	June 26, 1866.
55,865	House	June 26, 1866.
55,866	House	June 26, 1866.
57,451	Clements	Aug. 21, 1866.
61,533	Goodes *et al.*	Jan. 29, 1867.
61,711	Cajar	Feb. 5, 1867.
62,520	Bartram	Mar. 5, 1867.
76,323	Gritzner	Apr. 7, 1868.
78,821	Peabody	June 9, 1868.
80,520	Vogel	July 28, 1868.
87,338	House	Mar. 2, 1869.
87,409	Harrison	Mar. 2, 1869.
88,282	Dunbar	Mar. 30, 1869.
90,528	Gutman	May 25, 1869.
97,014	Woodruff *et al.*	Nov. 16, 1869.
104,590	Henrickson	June 21, 1870.
104,630	Nasch	June 21, 1870.
107,001	Chicken	Sept. 6, 1870.
110,669	Moreau	Jan. 3, 1871.
110,790	Robinson	Jan. 3, 1871.
111,447	Garrick	Jan. 31, 1871.
115,163	Chicken	May 23, 1871.
115,857	Humphrey	June 13, 1871.
120,855	Chicken *et al.*	Nov. 14, 1871.
123,348	Humphrey	Feb. 6, 1872.
124,252	Chicken	Mar. 5, 1872.
125,394	Humphrey	Apr. 9, 1872.
127,675	Braunbeck	June 11, 1872.

2. *Two Thread* (continued).

No.	Name.	Date.
132,968	Langmaid	Nov. 12, 1872.
134,558	Moreau	Jan. 7, 1873.
*5,260	Rehfuss	Jan. 28, 1873.
136,702	Chicken	Mar. 11, 1873.
136,718	Goodes	Mar. 11, 1873.
137,689	Kallmeyer	Apr. 8, 1873.
141,987	Blanchard	Apr. 19, 1873.
147,387	Goodes	Feb. 10, 1874.
151,380	Graff	May 26, 1874.
152,055	Wensley	June 16, 1874.
152,231	Humphrey	June 23, 1874.
159,740	Baird	Feb. 16, 1875.

3. *Attachments for ordinary Sewing-Machine.*

No.	Name.	Date.
69,671	Howard *et al.*	Oct. 8, 1867.
84,589	Sprague *et al.*	Dec. 1, 1868.
92,165	Harroun	July 27, 1869.
94,212	Howard *et al.*	Aug. 31, 1869.
95,320	Carpenter	Sept. 28, 1869.
97,856	Baird	Dec. 14, 1869.
103,745	Howard *et al.*	May 31, 1870.
117,364	Baird	July 25, 1871.
121,328	Burnam	Nov. 28, 1871.
121,477	Wilkins	Dec. 5, 1871.
123,742	Tait	Feb. 13, 1872.
*4,794	Baird	Mar. 12, 1872.
134,345	Baird	Dec. 31, 1872.
134,346	Baird	Dec. 31, 1872.
134,347	Baird	Dec. 31, 1872.
*5,306	Howard *et al.*	Mar. 4, 1873.
*5,336	Howard *et al.*	Mar. 25, 1873.
144,672	Hansen *et al.*	Nov. 18, 1873.
146,000	Haskins	Dec. 30, 1873.
*5,728	Howard *et al.*	Jan. 13, 1874.
156,048	Vogel	Oct. 20, 1874.

Class F. — Miscellaneous Parts.

1. *Bobbin-Winders.*

No.	Name.	Date.
36,899	Finkle	Nov. 11, 1862.
39,236	Lewis *et al.*	July 14, 1863.
80,908	Callen	Aug. 11, 1868.
110,267	Moffitt	Dec. 20, 1870.
114,442	Jenks	May 2, 1871.
115,124	Smith	May 23, 1871.
*4,571	Palmer	Oct. 3, 1871.
122,858	Shelden	Jan. 16, 1872.
123,625	Fish	Feb. 13, 1872.
123,852	Young	Feb. 20, 1872.
124,667	Day *et al.*	Mar. 19, 1872.
125,869	Wilder	Apr. 16, 1872.
126,829	Newton	May 14, 1872.
126,925	Brady	May 21, 1872.
127,155	Demarest	May 28, 1872.
128,518	Wilkins	July 2, 1872.
137,048	Bary	Mar. 25, 1873.
141,663	Pedden	Aug. 12, 1873.
148,110	Cook	Mar. 3, 1874.

2. *Cloth and Slide Plates.*

No.	Name.	Date.
44,889	Preis	Nov. 1, 1864.
62,186	Craig	Feb. 19, 1867.
67,635	Craig	Aug. 13, 1867.
91,484	Rehfuss	June 15, 1869.
131,907	Sahnders	Oct. 1, 1872.
133,733	West	Dec. 10, 1872.
134,209	Lawler	Dec. 24, 1872.
142,404	Leech	Sept. 2, 1873.
154,084	Rehfuss	Aug. 11, 1873.

3. *Cutting and Trimming Fabrics on Machine.*

No.	Name.	Date.
18,511	Marsh	Oct. 27, 1857.
*809	Marsh	Sept. 6, 1859.

3. *Cutting and Trimming Fabrics on Machine* (continued).

No.	Name.	Date.
42,976	Wales	May 31, 1864.
50,451	Chilcott	Oct. 17, 1865.
109,662	Ball *et al.*	Nov. 29, 1870.
113,498	Chase	Apr. 11, 1871.
123,242	Coles	Jan. 30, 1872.
139,350	Allen	May 27, 1873.
139,525	Wiggin	June 3, 1873.
140,159	Perrine	June 24, 1873.
142,290	Springer	Aug. 26, 1873.
144,480	Sample	Nov. 11, 1873.
147,441	Springer	Feb. 10, 1874.
148,765	Shorey	Mar. 17, 1874.
153,504	Tobey *et al.*	July 28, 1874.
155,334	Parsons	Sept. 22, 1874.
*6,088	Springer	Oct. 13, 1874.
156,267	Barber	Oct. 27, 1874.
*6,142	Springer	Nov. 17, 1874.
157,322	Graham	Dec. 1, 1874.
158,574	Craig	Jan. 12, 1875.
158,813	Springer	Jan. 19, 1875.

4. *Lifting Presser-Foot.*

No.	Name.	Date.
21,671	Grover	Oct. 5, 1858.
24,939	Kelsey	Aug. 2, 1859.
28,452	Chamberlin	May 29, 1860.
117,708	West	Aug. 1, 1871.
122,256	Kennedy	Dec. 26, 1871.
128,770	West	July 9, 1872.
129,974	Manning	July 30, 1872.
130,116	Fairfield *et al.*	Aug. 6, 1872.
130,674	West	Aug. 20, 1872.
130,675	West	Aug. 20, 1872.
133,757	Chandler	Dec. 10, 1872.
136,976	Dinsmore	Mar. 18, 1873.
139,368	Chandler	May 27, 1873.
141,332	Cushman	July 29, 1873.
142,442	Cushman	Sept. 2, 1873.
145,515	Manning	Dec. 16, 1873.
153,718	Manning	Aug. 4, 1874.

5. *Mounting Machines on Table.*

No.	Name.	Date.
27,926	Perkins	Apr. 17, 1860.
41,393	Pilbeam	Jan. 26, 1864.
47,560	Niederpruem	May 2, 1865.
97,481	Cowgill	Dec. 7, 1869.
105,548	Chase	July 19, 1870.
119,784	Parham	Oct. 10, 1871.
152,829	Coles	July 7, 1874.

6. *Needles.*

No.	Name.	Date.
17,272	Garvey	May 12, 1857.
24,892	Singer	July 26, 1859.
27,409	Horn	Mar. 6, 1860.
29,448	Willcox	July 31, 1860.
29,648	Drake	Aug. 14, 1860.
31,757	Willcox	Mar. 19, 1861.
34,571	Grover	Mar. 4, 1862.
37,996	Ambler	Mar. 24, 1863.
38,282	Brown	Apr. 28, 1863.
55,927	Stannard	June 26, 1866.
67,536	Harris	Aug. 6, 1867.
79,983	Isbell	July 14, 1868.
88,665	Parham *et al.*	Apr. 16, 1869.
91,684	Stackpole	June 22, 1869.
93,460	Macaulay	Aug. 10, 1869.
94,384	Blanchard	Aug. 31, 1869.
94,924	Suplee	Sept. 14, 1869.
99,158	Carpenter	Jan. 25, 1870.
*3,818	Suplee	Feb. 1, 1870.
*3,819	Suplee	Feb. 1, 1870.
99,782	Moscheowitz	Feb. 15, 1870.
100,112	Boone	Feb. 22, 1870.
100,909	Macaulay	Mar. 15, 1870.
103,549	Blanchard	May 31, 1870.
*4,002	Carpenter	May 31, 1870.
104,660	Strain	June 21, 1870.
105,433	Curtis	July 19, 1870.
106,092	Strain	Aug. 2, 1870.
109,753	Palmer	Nov. 29, 1870.
110,480	Lloyd	Dec. 27, 1870.

6. *Needles* (continued).

No.	Name.	Date.
112,576	Frary	Mar. 14, 1871.
112,744	Sibley	Mar. 14, 1871.
112,980	Strain	Mar. 21, 1871.
113,010	Blanchard	Mar. 28, 1871.
*4,663	Willcox	Dec. 5, 1871.
121,967	Secor	Dec. 19, 1871.
123,576	Mathues	Feb. 13, 1872.
125,270	Casselberry	Apr. 2, 1872.
151,558	Blanchard	June 2, 1874.
156,603	Spalding	Nov. 3, 1874.

7. *Needle-Sharpener.*

No.	Name.	Date.
114,265	Clark	May 2, 1871.

8. *Needle Threaders and Setters.*

No.	Name.	Date.
27,762	Stevens	Apr. 3, 1860.
32,624	Hardie	June 25, 1861.
34,407	Conrad	Feb. 18, 1862.
34,807	Bartlett	Apr. 1, 1862.
60,353	Foote	Dec. 11, 1866.
69,463	Michener	Oct. 1, 1867.
88,699	Dopp	Apr. 6, 1869.
89,256	Thrilpape	Apr. 20, 1869.
89,618	Barber *et al.*	May 4, 1869.
92,446	Headley	July 13, 1869.
102,795	Field	May 10, 1870.
104,030	Hendricks	June 7, 1870.
104,260	Brown	June 14, 1870.
110,144	Karr	Dec. 13, 1870.
110,855	Karr	Jan. 10, 1871.
113,542	Martine	Apr. 11, 1871.
119,217	Boersche	Sept. 26, 1871.
122,490	Raenchle	Jan. 2, 1872.
127,646	Schlarbaum	June 4, 1872.
128,341	Vittum	June 25, 1872.
132,110	Stanley	Oct. 8, 1872.
135,479	Johnston	Feb. 4, 1873.
139,990	Albert	June 17, 1873.
140,262	Farmer	June 24, 1873.
140,983	Williams	July 15, 1873.
142,430	Beardsley	Sept. 2, 1873.
143,098	Schofield	Sept. 23, 1873.
144,974	Gaspary	Nov. 25, 1873.
148,192	Doolittle *et al.*	Mar. 3, 1874.
149,580	Elliott	Apr. 14, 1874.
149,764	Lilley	Apr. 14, 1874.
150,167	Lilley	Apr. 28, 1874.
150,542	Dixie	May 5, 1874.
154,291	Smith	Aug. 18, 1874.
156,604	Stamp	Nov. 3, 1874.
157,745	Ellis	Dec. 15, 1874.
158,167	Fairfield	Dec. 29, 1874.

9. *Oil-Can Holder.*

No.	Name.	Date.
96,527	Wilmot	Nov. 2, 1869.
112,537	Brick	Mar. 14, 1871.
128,517	Wilkins	July 2, 1872.
136,327	Leslie	Feb. 25, 1873.

10. *Oiling Thread.*

No.	Name.	Date.
10,975	Singer	May 30, 1854.
12,336	Wilder	Jan. 30, 1855.
21,361	Pepper	Aug. 31, 1858.

See also Class C.

11. *Presser-Foot.*

No.	Name.	Date.
31,604	Hyde	Mar. 5, 1861.
31,646	Moulson	Mar. 5, 1861.
40,209	Bolton	Oct. 6, 1863.
57,010	Tewksbury	Aug. 7, 1866.
89,957	Tutton	May 11, 1869.
114,823	Hudson	May 16, 1871.
123,393	Goodrich	Feb. 6, 1872.
131,256	Decker	Sept. 10, 1872.
133,201	Chabot *et al.*	Nov. 19, 1872.
133,411	Coles	Nov. 26, 1872.
138,637	Goodrich	May 6, 1873.
139,700	Allerton *et al.*	June 10, 1873.
149,714	Brewster	Apr. 14, 1874.
150,668	Allerton *et al.*	May 12, 1874.
158,565	Barnes	Jan. 12, 1875.
158,744	Schneider	Jan. 12, 1875.

12. *Quilting.*

No.	Name.	Date.
130,701	Damron	Aug. 20, 1872.
131,443	Hoover *et al.*	Sept. 17, 1872.
138,399	Heffley	Apr. 29, 1873.
143,092	Null	Sept. 23, 1873.
150,003	Dewey	Apr. 21, 1874.
155,885	Null	Oct. 13, 1874.
155,886	Null	Oct. 13, 1874.
159,884	Beck	Feb. 16, 1875.

13. *Regulating Speed.*

No.	Name.	Date.
13,661	Singer	Oct. 9, 1855.
44,909	Zuckerman	Nov. 1, 1864.
51,012	Buchanan	Nov. 21, 1865.

14. *Running Stitch.*

No.	Name.	Date.
2,982	Bean	Mar. 4, 1843.
3,672	Rogers	July 22, 1844.
7,296	Smith	Apr. 16, 1850.
14,393	David	Mar. 11, 1856.
35,252	Palmer	May 13, 1862.
38,246	Shaw *et al.*	Apr. 21, 1863.
38,658	Dale	May 26, 1863.
38,837	Palmer	June 9, 1863.
38,927	Cook	June 16, 1863.
40,853	Pratt	Dec. 8, 1863.
44,686	Dale	Oct. 11, 1864.
127,579	Cussen	June 4, 1872.
157,598	Hahn	Dec. 8, 1874.

15. *Sewing Hats.*

No.	Name.	Date.
24,183	Tyler	May 24, 1859.
25,078	Eickemeyer	Aug. 9, 1859.
34,330	Hendrickson	Feb. 4, 1862.
37,957	Eickemeyer	Mar. 24, 1863.
42,158	Blackham	Apr. 5, 1864.
52,698	Eickemeyer	Feb. 20, 1866.
53,927	Sanford *et al*	Apr. 10, 1866.
54,844	Bodwell	May 22, 1866.
68,828	Judson	Sept. 10, 1867.
113,201	Parmenter	Mar. 28, 1871.
113,391	Bracher	Apr. 4, 1871.
117,867	Coles	Aug. 8, 1871.
*4,639	Judson	Nov. 21, 1871.
141,397	Stewart	July 29, 1873.
155,253	Morehouse	Sept. 22, 1874.
*6,311	Eickemeyer	Mar. 2, 1875.

16. *Sewing on Buttons.*

No.	Name.	Date.
130,581	Keith	Aug. 20, 1872.

17. *Sewing Straw-Braid.*

No.	Name.	Date.
79,856	Plummer	July 14, 1868.
94,046	Turner	Aug. 24, 1869.
122,555	Bosworth	Jan. 9, 1872.
*4,840	Plummer	Apr. 2, 1872.
131,739	Carpenter	Oct. 1, 1872.
133,553	Turner	Dec. 3, 1872.
138,806	Bosworth	June 9, 1873.
138,807	Bosworth	June 9, 1873.
141,303	Whiting, W. M.	July 29, 1873.
145,814	Palmer	Dec. 23, 1873.
146,970	Wright	Jan. 27, 1874.
151,351	Bosworth	May 26, 1874.
152,260	Turner	June 23, 1874.

18. *Sewing Knitted Goods.*

No.	Name.	Date.
59,746	Kilburn	Nov. 20, 1866.
77,611	Haslam	May 5, 1868.
137,997	Bevan	Apr. 22, 1873.

19. *Sewing Umbrellas.*

No.	Name.	Date.
105,862	Tate	July 26, 1870.

20. *Short Thread.*

No.	Name.	Date.
2,466	Greenough	Feb. 21, 1842.
3,389	Corliss	Dec. 27, 1843.
7,824	Robinson	Dec. 10, 1850.
9,380	Bradeen	Nov. 2, 1852.
12,247	Smith	Jan. 16, 1855.
12,402	Forbush	Feb. 20, 1855
13,178	Molliere	July 3, 1855.
*352	Greenough	Feb. 12, 1856.
16,026	Roper	Nov. 4, 1856.
16,436	Howe	Jan. 20, 1857.
17,400	Wells	May 26, 1857.
18,522	Roper	Oct. 27, 1857.
21,745	Crosby	Oct. 12, 1858.
24,324	Moody	June 7, 1859.
*4,305	Crosby	Mar. 21, 1871.
156,418	Garland	Nov. 3, 1874.
159,317	Garland *et al.*	Feb. 2, 1875.
159,812	Garland	Feb. 16, 1875.

21. *Shuttles.*

No.	Name.	Date.
10,728	Aikins	Apr. 4, 1854.
39,567	Halligan	Aug. 18, 1863.
57,514	Ingraham	Aug. 28, 1866.
65,052	Booth *et al.*	May 28, 1867.
111,678	Pratt	Feb. 7, 1871.
116,113	Strange	June 20, 1871.
120,277	Hervey	Oct. 24, 1871.
120,731	Fairfield	Nov. 7, 1871.
123,990	Goodrich	Feb. 27, 1872.
125,956	Hockensmith	Apr. 23, 1872.
128,017	Churchill	June 18, 1872.
129,004	Cook	July 16, 1872.
132,108	Roberts *et al.*	Oct. 8, 1872.
136,311	Edwards *et al.*	Feb. 25, 1873.
*5,342	Edwards *et al.*	Apr. 1, 1873.
137,665	Ells	Apr. 8, 1873.
138,134	Cooney	Apr. 28, 1873.
139,421	Rehfuss	May 27, 1873.
*5,436	Edwards *et al.*	June 3, 1873.
140,041	Hockensmith	June 17, 1873.
141,894	Secor	Aug. 19, 1873.
143,104	Thayer	Sept. 23, 1873.
143,303	Schofield	Sept. 30, 1873.
144,395	Knox	Nov. 11, 1873.
145,348	Hunter	Dec. 9, 1873.
148,072	Knox	Mar. 3, 1874.
148,457	Hockensmith	Mar. 10, 1874.
150,533	Crane	May 5, 1874.
152,041	Loomis	June 16, 1874.
154,117	Blake	Aug. 18, 1874.
156,933	Mangus	Nov. 17, 1874.

22. *Spools and Bobbins.*

No.	Name.	Date.
126,332	Reeve	Apr. 30, 1872.
135,125	Juengst	Jan. 21, 1873.
136,282	Thayer	Feb. 25, 1873.

23. *Stitches.*

No.	Name.	Date.
16,120	Johnson	Nov. 25, 1856.
17,255	Bosworth	May 12, 1857.
23,984	McCurdy	May 10, 1859.
26,906	Johnson	Jan. 24, 1860.
27,620	Davis	Mar. 27, 1860.
27,999	McCurdy	Apr. 24, 1860.
34,454	Weitling	Feb. 18, 1862.
36,616	Humphrey	Oct. 7, 1862.
39,658	Jewett	Aug. 25, 1863.
46,133	Parham	Jan. 31, 1865.
49,837	Sibley	Sept. 5, 1865.
85,891	Reed	Jan. 12, 1869.
86,591	Reed	Feb. 2, 1869.
90,045	Harroun	May 11, 1869.

24. *Take-up.*

No.	Name.	Date.
16,382	Finkle	Jan. 13, 1857.
18,102	Phelps	Sept. 1, 1857.
22,050	Comfort	Nov. 9, 1858.
26,035	Hicks	Nov. 8, 1859.
27,593	Couch	Mar. 20, 1860.
32,064	Hicks	Apr. 16, 1861.
39,454	Perry	Aug. 4, 1863.
41,790	Scofield *et al.*	Mar. 1, 1864.
63,483	Darling *et al.*	Apr. 2, 1867.
67,179	Fairfield	July 30, 1867.
82,397	Fanning	Sept. 22, 1868.
84,099	Eldredge	Nov. 17, 1868.

24. *Take up* (continued).

No.	Name.	Date.
95,019	Hawkins	Sept. 21, 1869.
102,170	Smith *et al.*	Apr. 19, 1870.
103,949	Wendell	June 7, 1870.
105,741	True	July 26, 1870.
118,067	Stebbins	Aug. 15, 1871.
121,966	Secor	Dec. 19, 1871.
129,406	Hall	Feb. 25, 1872.
136,324	Jones	July 16, 1872.
*6,087	Eldredge	Oct. 13, 1874.

25. *Tension Devices.*

No.	Name.	Date.
*8,876	Singer	Apr. 13, 1852.
17,835	Hoagland	July 21, 1857.
18,072	Larkin	Aug. 25, 1857.
19,080	Douglass	Jan. 12, 1858.
19,141	Harris	Jan. 19, 1858.
21,398	Rogers	Aug. 31, 1858.
22,045	Wheeler	Nov. 9, 1858.
24,000	Bartholf	May 17, 1859.
26,537	Pratt	Dec. 20, 1859.
27,948	Cross	Apr. 7, 1860.
29,138	Churchill	July 17, 1860.
31,351	Hook	Feb. 5, 1861.
31,423	Williams	Feb. 12, 1861.
35,126	Pratt	Apr. 29, 1862.
35,542	Pryibil	June 10, 1862.
37,580	Jones	Feb. 3, 1863.
41,272	Bland	Jan. 19, 1864.
42,801	Sleppy	May 17, 1864.
43,819	Willcox	Aug. 9, 1864.
44,720	Gritzner	Oct. 18, 1864.
47,462	Schenkl	Apr. 25, 1865.
51,346	Otis	Dec. 5, 1865.
51,514	Bodwell	Dec. 19, 1865.
53,527	Evans	Mar. 27, 1866.
53,783	Goodrich *et al.*	Apr. 10, 1866.
54,715	Girandins	May 15, 1866.
55,417	Hawkins	June 3, 1866.
60,456	Zinck	Dec. 11, 1866.
64,051	Wheaton	Apr. 23, 1867.
67,524	Froelich	Aug. 6, 1867.
81,080	Goodrich	Aug. 18, 1868.
87,810	Wheelock	Mar. 16, 1869.
93,459	Macaulay	Aug. 10, 1869.
98,409	Pratt *et al.*	Dec. 28, 1869.
99,122	Warner	Jan. 25, 1870.
102,787	Dulaney	May 10, 1870.
103,609	Hawkins	May 31, 1870.

25. *Tension Devices* (continued).

No.	Name.	Date.
103,643	Mooney	May 31, 1870.
110,424	Bennett	Dec. 27, 1870.
113,027	Crumb	Mar. 28, 1871.
115,756	McCarthy	June 6, 1871.
117,644	Kimball	Aug. 1, 1871.
119,589	Estabrooke	Oct. 3, 1871.
123,038	Newcomb	Jan. 23, 1872.
123,054	Spear	Jan. 23, 1872.
125,535	Bromley	Apr. 9, 1872.
127,982	Merrick	June 18, 1872.
129,195	Williams	July 16, 1872.
129,761	Stackpole	July 23, 1872.
130,288	Fairfield	Aug. 6, 1872.
136,626	Tiffany	Mar. 11, 1873.
138,381	Coles	Apr. 29, 1873.
148,773	Stetson	Mar. 17, 1874.
149,566	Blake	Apr. 14, 1874.
*5,859	Evans	May 5, 1874.
154,084	Rehfuss	Aug. 11, 1874.

26. *Thread-Cutters.*

No.	Name.	Date.
16,713	Burnham	Mar. 3, 1857.
52,398	Dennis *et al.*	Feb. 6, 1866.
67,531	Sawyer	Aug. 6, 1867.
90,554	Neale *et al.*	June 8, 1869.
104,561	Crowe	June 27, 1870.
106,526	Wood	Aug. 16, 1870.
118,467	Lord	Aug. 29, 1871.
123,772	Dimond	Feb. 20, 1872.
126,860	Wolcott	May 14, 1872.
127,053	Harris	May 21, 1872.
134,518	Collins	Jan. 7, 1873.
134,660	Henry *et al.*	Jan. 7, 1873.
137,947	Oburg	Apr. 15, 1873.
138,153	Henry *et al.*	Apr. 22, 1873.
138,412	Leslie	Apr. 29, 1873.
142,042	Rayor *et al.*	Aug. 19, 1873.
143,046	Webber	Sept. 23, 1873.
143,726	Slack	Oct. 14, 1873.
144,326	Evinger	Nov. 4, 1873.
146,561	West	Jan. 20, 1874.

27. *Miscellaneous.*

No.	Name.	Date.
12,984	Caperon	May 29, 1855.
16,315	Johnson *et al.*	Dec. 23, 1856.

27. *Miscellaneous* (continued).

No.	Name.	Date.
18,817	Lazelle	Dec. 8, 1857.
20,006	Steen	Apr. 20, 1858.
20,984	Donovan	July 27, 1858.
21,669	Grover	Oct. 5, 1858.
22,264	First	Dec. 7, 1858.
22,833	Wade	Feb. 1, 1859.
28,642	Alexander	June 12, 1860.
29,035	First	July 3, 1860.
31,263	Smith	Jan. 29, 1861.
31,477	Ruggles	Feb. 19, 1861.
31,642	Earle	Mar. 5, 1861.
37,925	Smith	Mar. 17, 1863.
42,149	Stain	Mar. 29, 1864.
42,318	Stoops	Apr. 12, 1864.
44,465	Smith	Sept. 27, 1864.
44,490	Willcox	Sept. 27, 1864.
48,840	Rodier	July 18, 1865.
51,890	Bean	Jan. 2, 1866.
67,544	Hobb	Aug. 6, 1867.
67,674	Preston	Aug. 13, 1867.
76,986	Brown	Apr. 21, 1868.
91,318	Ferren	June 15, 1869.
92,972	Huckans *et al.*	July 27, 1869.
97,892	Dewey	Dec. 14, 1869.
99,380	Welty	Feb. 1, 1870.
114,071	Whiteside	Apr. 25, 1871.
117,357	Wilder	July 25, 1871.
118,671	Antrim	Sept. 5, 1871.
121,043	Demarest	Nov. 21, 1871.
126,199	Gibbs	Apr. 30, 1872.
126,488	Pratt	May 7, 1872.
127,114	Speirs	May 21, 1872.
128,850	Butterfield	July 9, 1872.
131,166	Hinds	Sept. 10, 1872.
131,324	Barton	Sept. 17, 1872.
132,081	Hopkins	Oct. 8, 1872.
135,445	Roggenburger	Feb. 4, 1873.
137,007	Lincoln *et al.*	Mar. 18, 1873.
139,962	Keith	June 17, 1873.
140,438	Smith	July 1, 1873.
140,584	Lincoln *et al.*	July 8, 1873.
146,628	Woodruff	Jan. 20, 1874.
150,787	Powell	May 12, 1874.
151,406	Lomax	May 26, 1874.
152,374	Henry	June 23, 1874.
152,829	Coles	July 7, 1874.
154,385	Frame	Aug. 25, 1874.
155,783	Wooster *et al.*	Oct. 6, 1874.
156,728	Groubman	Nov. 10, 1874.
156,863	Waterhouse	Nov. 17, 1874.
156,913	Cooley	Nov. 17, 1874.
157,059	Bean	Nov. 24, 1874.

Class G. — Attachments.

1. *Binders.*

No.	Name.	Date.
10,344	Sweet	Dec. 20, 1853.
11,615	Nichols	Aug. 29, 1854.
12,322	Nichols	Jan. 30, 1855.
14,322	McCurdy	Feb. 26, 1856.
15,020	Singer	June 3, 1856.
21,659	Douglas	Oct. 5, 1858.
22,987	Snyder	Feb. 15, 1859.
28,774	Price	June 19, 1860.
32,037	Alford	Apr. 16, 1861.
40,127	Smith	Sept. 29, 1863.
42,615	Wissler *et al.*	May 3, 1864.
42,989	Cochran	May 31, 1864.
46,722	Steyner	Mar. 7, 1865.
49,036	Marsh	July 25, 1865.
52,387	Chaplin	Feb. 6, 1866.
59,879	Vincent	Nov. 20, 1866.
83,742	Stoddard	Nov. 3, 1868.
93,147	Wendell	July 27, 1869.
93,202	Hotchkiss	Aug. 3, 1869.
95,409	Angell	Oct. 5, 1869.
100,904	Kasson	Mar. 15, 1870.
102,273	Kellog	Apr. 26, 1870.
103,538	Anderson	May 31, 1870.
105,577	Kasson	July 19, 1870
106,730	Sawyer	Aug. 23, 1870.
109,366	Martin	Nov. 15, 1870.
110,740	Cole	Jan. 3, 1871.
110,810	White	Jan. 3, 1871.
112,019	Cole	Feb. 21, 1871.
112,223	Cole	Feb. 28, 1871.
114,387	Allebaugh *et al.*	May 2, 1871.
*4,376	Martin	May 9, 1871.
115,197	Harris	May 23, 1871.
116,195	Judd *et al.*	June 20, 1871.
116,570	Dalton	July 4, 1871.
116,761	Secor	July 4, 1871.

1. *Binders* (continued).

No.	Name.	Date.
119,555	Bartlett	Oct. 3, 1871.
120,513	Hall	Oct. 31, 1871.
120,969	Harris	Nov. 14, 1871.
121,014	Smith	Nov. 15, 1871.
121,356	Goldsmith	Nov. 28, 1871.
121,516	Harris	Dec. 5, 1871.
124,206	Goodrich *et al.*	Mar. 5, 1872.
124,968	Moschowitz	Mar. 26, 1872.
125,590	Martin	Apr. 9, 1872.
125,674	Grosfeld	Apr. 16, 1872.
127,158	Dalton	May 28, 1872.
128,216	Dulaney	June 25, 1872.
130,021	Comings	July 30, 1872.
130,914	Grosfeld	Aug. 27, 1872.
131,583	White	Sept. 24, 1872.
*5,180	Douglas	Dec. 10, 1872.
135,381	Stoll	Jan. 28, 1873.
138,306	Wood	Apr. 29, 1873.
138,772	West	May 13, 1873.
139,378	Earle	May 27, 1873.
140,233	Alexander	June 24, 1873.
144,706	Sexauer	Nov. 18, 1873.
147,970	Peacock	Feb. 24, 1874.
148,933	Comings	May 24, 1874.
156,624	Young	Nov. 3, 1874.

2. *Braiders.*

No.	Name.	Date.
12,014	Boynton	Nov. 28, 1854.
26,205	Robertson	Nov 22, 1859.
36,847	Maddock	Nov. 4, 1862.
43,355	Wagener	June 28, 1864.
44,339	Ramsey	Sept. 20, 1864.

2. *Braiders* (continued).

No.	Name.	Date.
47,171	Planer	Apr. 4, 1865.
50,157	Planer	Sept. 26, 1865.
51,247	Warth	Nov. 28, 1865.
54,670	Bartram	May 15, 1866.
63,117	Thomas	Mar. 19, 1867.
81,138	Carpenter	Aug. 18, 1868.
89,915	Chester	May 11, 1869.
93,193	Gillam	Aug. 3, 1869.
94,812	Contessa	Sept. 14, 1869.
98,985	Lyon	Jan. 18, 1870.
99,054	Bouscay	Jan. 25, 1870.
100,796	Pettee	Mar. 15, 1870.
108,033	Komp	Oct. 4, 1870.
110,374	Komp	Dec. 20, 1870.
117,344	Spout	July 25, 1871.
123,167	Goodrich	Jan. 30, 1872.
125,498	Steward	Apr. 9, 1872.
125,986	Price	Apr. 23, 1872.
126,382	Ellicott *et al.*	May 7, 1872.
128,825	Thomas	July 9, 1872.
136,354	Alexander	Mar. 4, 1873.
136,355	Alexander	Mar. 4, 1873.
140,012	Chaffee	June 17, 1873.
150,059	Lapham	Apr. 21, 1874.
152,662	Manning	June 30, 1874.
154,173	Davis	Aug. 18, 1874.
156,154	Gullmann	Oct. 20, 1874.
156,892	Rickart *et al.*	Nov. 17, 1874.

3. *Corders.*

No.	Name.	Date.
12,858	Dickinson	May 15, 1855.
25,255	Golay	Aug. 30, 1859.

3. *Corders* (continued).

No.	Name.	Date.
26,561	Brady	Dec. 27, 1859.
28,776	Rankin	June 19, 1860.
31,494	Taylor	Feb. 19, 1861.
39,336	Benedict	July 28, 1863.
42,657	Henry	May 10, 1864.
49,968	Brady	Sept. 19, 1865.
91,285	Sulgrove	June 15, 1869.
114,254	Barnum	May 2, 1871.
115,048	Fowler *et al.*	May 23, 1871.
121,775	Goodrich	Dec. 12, 1871.
123,991	Goodrich	Feb. 27, 1872.
126,050	Hall	Apr. 23, 1872.
127,103	Price *et al.*	May 21, 1872.
*4,909	Horn	May 21, 1872.
130,763	Sullivan	Aug. 20, 1872.
131,027	Rodier	Sept. 3, 1872.
143,589	Powell	Oct. 14, 1873.
146,736	Wilson	Jan. 20, 1874.

4. *Embroidering.*

No.	Name.	Date.
13,682	Singer	Oct. 9, 1855.
31,864	Boyd	Apr. 2, 1861.
33,556	Mann	Oct. 22, 1861.
42,770	Horne	May 17, 1864.
43,289	Crittenden	June 28, 1864.
51,239	Stevens	Nov. 28, 1865.
52,374	Boyd	Jan. 30, 1866.
65,768	Rose	June 11, 1867.
87,633	Carpenter	Mar. 9, 1869.
89,446	Thomas	Apr. 27, 1869.
91,708	Boyd	June 22, 1869.
91,898	Bartram	June 29, 1869.
93,093	Johnson	July 27, 1869.
93,266	Young	Aug. 3, 1869.
93,480	Rose	Aug. 10, 1869.
103,578	Cubley	May 31, 1870.
103,664	Rose	May 31, 1870.
103,984	Cobb	June 7, 1870.
104,017	Goodrich	June 7, 1870.
105,087	Johnson	July 5, 1870.
108,150	Johnson	Oct. 11, 1870.
111,071	Mack	Jan. 17, 1871.
112,601	Johnson	Mar. 14, 1871.
130,317	Rose	Aug. 6, 1872.
133,901	Stewart	Dec. 10, 1872.
136,098	Rose	Feb. 18, 1873.
142,478	Johnson	Sept. 2, 1873.
148,761	Rose	Mar. 17, 1874.
152,248	Palmer	June 23, 1874.
153,116	Rose	July 14, 1874.
153,117	Rose	July 14, 1874.
153,542	Cornely	July 28, 1874.
154,088	Rose	Aug. 11, 1874.
*6,005	Rose	Aug. 11, 1874.
161,632	Palmer	Apr. 6, 1875.

5. *Guides.*

No.	Name.	Date.
13,275	Robinson	July 17, 1855.
16,586	Hull	Feb. 10, 1857.
31,185	Munson	Jan. 22, 1861.
31,366	Barnum	Feb. 12, 1861.
38,705	Wagener	May 26, 1863.
40,464	Fish	Nov. 3, 1863.
42,184	Fowler	Apr. 5, 1864.
42,876	Robjohn	May 24, 1864.
42,877	Robjohn	May 24, 1864.
*1,760	Barnum	Sept. 13, 1864.
45,477	Conant	Dec. 20, 1864.
47,978	Peterson	May 30, 1865.
48,369	Clemons	June 27, 1865.
49,031	Huston	July 25, 1865.
49,558	Harrington	Aug. 22, 1865.
50,336	Smith	Oct. 10, 1865.
51,547	Brown	Dec. 19, 1865.
51,645	Zuchetti	Dec. 19, 1865.
*2,163	Barnum	Jan. 30, 1866.
52,870	McCurdy	Feb. 27, 1866.
54,367	Knight	May 1, 1866.
54,602	Robjohn	May 8, 1866.
56,527	Capewell	July 24, 1866.
56,714	Conant	July 31, 1866.
*2,323	Clemons	July 31, 1866.
59,997	Hall	Nov. 27, 1866.
60,360	Goodrich	Dec. 11, 1866.
61,103	Rehfuss	Jan. 8, 1867.
64,840	Clemons	May 21, 1867.
64,968	Garvie	May 21, 1867.
65,395	King	June 4, 1867.
67,590	Safford *et al.*	Aug. 6, 1867.
81,466	Benedict *et al.*	Aug. 25, 1868.
81,604	Cline	Sept. 1, 1868.
84,783	Wensley	Dec. 8, 1868.

5. *Guides* (continued).

No.	Name.	Date.
85,364	Carpenter	Dec. 29, 1868.
86,474	Van Vlean	Feb. 2, 1869.
86,594	Rodier	Feb. 2, 1869.
89,506	Rumpff	Apr. 27, 1869.
90,340	Clemons	May 25, 1869.
91,292	Wells	June 15, 1869.
91,922	Dinsmore	June 29, 1869.
93,010	Rogers	July 27, 1869.
93,540	Jones	Aug. 10, 1869.
94,175	Benster	Aug. 31, 1869.
95,362	Lewis	Sept. 28, 1869.
102,469	Alter	May 3, 1870.
103,159	Dodge	May 17, 1870.
103,318	Fisher	May 24, 1870.
109,612	Grimes	Nov. 29, 1870.
109,668	Rogers *et al.*	Nov. 29, 1870.
111,199	Grimes	Jan. 24, 1871.
112,245	Herterich	Feb. 28, 1871.
112,327	Dufour	Mar. 7, 1871.
113,669	Howard	Apr. 11, 1871.
116,056	Howard	June 20, 1871.
117,152	Colton *et al.*	July 18, 1871.
117,557	Moschcowitz	Aug. 1, 1871.
117,716	Alter	Aug. 8, 1871.
118,109	Cotton *et al.*	Aug. 15, 1871.
118,110	Cotton *et al.*	Aug. 15, 1871.
118,111	Cotton *et al.*	Aug. 15, 1871.
118,145	Palmer	Aug. 15, 1871.
118,412	Wells	Aug. 22, 1871.
118,913	Decker	Sept. 12, 1871.
119,102	Armstrong	Sept. 19, 1871.
*4,556	Alter	Sept. 19, 1871.
119,350	Hall	Sept. 26, 1871.
120,966	Halladay	Nov. 14, 1871.
121,293	Matterson	Nov. 28, 1871.
121,366	Hewitt	Nov. 28, 1871.
124,086	Roberts	Feb. 27, 1872.
124,493	Jensen	Mar. 12, 1872.
127,157	Dalton	May 28, 1872.
130,169	Willson	Aug. 6, 1872.
132,101	Perry	Oct. 8, 1872.
134,497	Vincent	Dec. 31, 1872.
134,826	Violet	Jan. 14, 1873.
136,859	Peaslee	Mar. 18, 1873.
140,406	Dupré	July 1, 1873.
142,812	Powell	Sept. 16, 1873.
142,819	Springer	Sept. 16, 1873.
143,955	Bond	Oct. 28, 1873.
143,969	De Waru	Oct. 28, 1873.
*5,689	Roberts	Dec. 16, 1873.
145,841	Buschmeier	Dec. 23, 1873.
148,047	Goodrich	Mar. 3, 1874.
148,048	Goodrich	Mar. 3, 1874.
150,787	Powell	May 12, 1874.
154,113	Baglin	Aug. 18, 1874.
154,485	Howard	Aug. 25, 1874.
158,231	Ballou	Dec. 29, 1874.
*6,306	Powell	Feb. 23, 1875.

6. *Hemmers.*

No.	Name.	Date.
10,386	Blodget	Jan. 3, 1854.
12,826	Odiorne	May 8, 1855.
14,283	Chapin	Feb. 19, 1856.
15,402	Boyes	July 22, 1856.
17,224	Marston	May 5, 1857.
20,245	Serrell	May 11, 1858.
20,695	Boyd	June 29, 1858.
21,355	Odiorne	Aug. 31, 1858.
23,079	Clemons	Mar. 1, 1859.
24,088	Barnum *et al.*	May 24, 1859.
25,715	Blake *et al.*	Oct. 11, 1859.
26,207	Serrell	Nov. 22, 1859.
27,805	Howell	Apr. 10, 1860.
28,889	Mitchell	June 26, 1860.
31,602	Howell	Mar. 5, 1861.
31,645	Marsh	Mar. 5, 1861.
31,878	Downer	Apr. 2, 1861.
32,035	Whitcomb	Apr. 9, 1861.
32,519	Jenks	June 11, 1861.
32,710	Paddock	July 23, 1861.
35,972	Ensign	July 22, 1862.
37,505	Henry	Jan. 27, 1863.
38,662	Downes	May 26, 1863.
39,160	Morrison	July 7, 1863.
*1,569	Blake *et al.*	Nov. 10, 1863.
43,657	Willcox	July 26, 1864.
46,790	Gaskill	Mar. 14, 1865.
47,629	Gaskill	May 9, 1865.
47,630	Gaskill *et al.*	May 9, 1865.
47,632	Goebel	May 9, 1865.
52,646	Overhiser	Feb. 13, 1866.
52,749	Rose	Feb. 20, 1866.
58,210	Browning *et al.*	Sept. 25, 1866.
58,670	Ogburn	Oct. 9, 1866.
67,753	Haggerty	Aug. 13, 1867.
69,095	Holcomb	Sept. 24, 1867.
76,720	Davis	Apr. 14, 1868.

6. *Hemmers* (continued).

No.	Name.	Date.
80,090	Rehfuss	July 21, 1868.
80,558	Morrison	Aug. 4, 1868.
84,454	Welder *et al.*	Nov. 24, 1868.
*3,402	Blodgett	Apr. 27, 1869.
92,692	Bartleson	July 20, 1869.
96,180	Yeutzer	Oct. 26, 1869.
96,809	Howell	Nov. 16, 1869.
96,901	Enlass	Nov. 16, 1869.
101,147	Morehouse	Mar. 22, 1870.
101,988	Eldridge	Apr. 19, 1870.
102,082	Boomer *et al.*	Apr. 19, 1870.
103,611	Hawkins	May 31, 1870.
106,155	Harris	Aug. 9, 1870.
106,489	Karr	Aug. 16, 1870.
107,650	Bartlett	Sept. 27, 1870.
107,889	Eldridge	Oct. 4, 1870.
109,585	Carleton	Nov. 29, 1870.
110,737	Carleton	Jan. 3, 1871.
113,903	Martin	Apr. 18, 1871.
115,282	Darby	May 30, 1871.
117,604	Colby	Aug. 1, 1871.
117,669	Ober	Aug. 1, 1871.
119,814	Blakemore	Oct. 10, 1871.
119,921	Ellis	Oct. 17, 1871.
120,868	Forrest	Nov. 14, 1871.
121,046	Ellis	Nov. 21, 1871.
121,944	Johnson	Dec. 19, 1871.
122,180	Lawrence	Dec. 26, 1871.
*4,693	Eldridge	Jan. 2, 1872.
122,819	Eldridge	Jan. 16, 1872.
124,809	Goodrich	Mar. 19, 1872.
125,833	Morehouse	Apr. 16, 1872.
126,139	Ellis	Apr. 30, 1872.
127,043	Gage	May 21, 1872.
127,732	Barnum	June 11, 1872.
128,876	Hall	July 9, 1872.
132,062	Darby	Oct. 8, 1872.
132,172	Morey	Oct. 15, 1872.
133,201	Chabot *et al.*	Nov. 19, 1872.
136,495	Ellis	Mar. 4, 1873.
136,651	Griest	Mar. 11, 1873.
138,064	Yeutzer	Apr. 22, 1873.
138,371	Booth	Apr. 29, 1873.
138,638	Goodrich *et al.*	May 6, 1873.
*5,414	Howell	May 20, 1873.
141,576	McMillan	Aug. 5, 1873.
141,933	Caswell	Aug. 19, 1873.
142,519	Shultz	Sept. 2, 1873.
142,689	Eldridge	Sept. 9, 1873.
143,160	Johnson	Sept. 23, 1873.
143,433	Brown	Oct. 7, 1873.
144,333	Griest	Nov. 4, 1873.
144,649	Apthorpe	Nov. 18, 1873.
144,736	Bryant *et al.*	Nov. 18, 1873.
146,185	Jones	Jan. 6, 1874.
146,684	Johnson	Jan. 20, 1874.
151,202	Davis	May 26, 1874.
151,807	Terry *et al.*	June 9, 1874.
153,179	Price	July 21, 1874.
153,301	Bean	July 21, 1874.
156,624	Young	Nov. 3, 1874.
159,391	Colby	Feb. 2, 1875.

7. *Rufflers and Tuckers.* (*a.*) *Tension-Plates.*

No.	Name.	Date.
14,475	Singer	Mar. 18, 1856.
28,139	Arnold	May 8, 1860.
30,112	Arnold	Sept 25, 1860.
42,043	Brown	Mar. 22, 1864.
50,164	Riggs	Sept. 26, 1865.
61,552	Miller	Jan. 29, 1867.
67,183	Fitch	July 30, 1867.
67,582	Reed	Aug. 6, 1867.
69,946	Stewart	Oct. 15, 1867.
80,371	Stewart	July 28, 1868.
83,592	Bartram	Nov. 3, 1868.
84,414	Crandell	Nov. 24, 1868.
84,676	Brooks *et al.*	Dec. 8, 1868.
89,415	Lowerree	Apr. 27, 1869.
94,299	Fairbairn	Aug. 31, 1869.
95,171	Vosburgh	Sept. 21, 1869.
95,469	Gunnerman	Oct. 5, 1869.
98,389	Kasson	Dec. 28, 1869.
100,161	Leslie	Feb. 22, 1870.
101,446	Eck	Apr. 5, 1870.
103,755	Leslie	May 31, 1870.
106,481	Hall	Aug. 16, 1870.
108,492	Leslie	Oct. 18, 1870.
108,787	Howard	Nov. 1, 1870.
116,715	Johnson	July 4, 1871.
123,168	Goodrich	Jan. 30, 1872.
124,853	Peterson	Mar. 19, 1872.
125,032	Dalton	Mar. 26, 1872.
125,608	Moore	Apr. 9, 1872.
126,467	Lawrence *et al.*	May 7, 1872.
129,352	Leslie	July 16, 1872.
131,857	Dalton	Oct. 1, 1872.
*6,159	Arnold	Dec. 1, 1874.

7. (*b.*) *Reciprocating Blades.*

No.	Name.	Date.
36,074	Crosby *et al.*	Aug. 5, 1862.
37,033	Crosby *et al.*	Dec. 2, 1862.
37,550	Pipo	Jan. 27, 1863.
46,424	Robjohn	Feb. 14, 1865.
50,225	Crosby	Oct. 3, 1865.
50,473	Hecht	Oct. 17, 1865.
58,376	Cary	Oct. 2, 1866.
89,085	Scharffe	Apr. 20, 1869.
93,063	Davis	July 27, 1869.
93,979	Everiss	Aug. 24, 1869.
106,788	Davis	Aug. 30, 1870.
108,486	Johnston	Oct. 1, 1870.
111,130	Mack	Jan. 24, 1871.
111,458	Johnston	Jan. 31, 1871.
112,882	Zay	Mar. 21, 1871.
118,759	Toof	Sept. 5, 1871.
120,173	Toof	Oct. 24, 1871.
120,722	Darby	Nov. 7, 1871.
120,817	Howard	Nov. 14, 1871.
122,268	Lyon	Dec. 26, 1871.
122,611	Johnston	Jan. 9, 1872.
123,115	Lyon	Jan. 30, 1872.
123,494	Mack	Feb. 6, 1872.
123,788	Moscheowitz	Feb. 20, 1872.
123,910	Johnston	Feb. 20, 1872.
123,995	Johnston	Feb. 27, 1872.
124,894	Gray *et al.*	Mar. 26, 1872.
125,230	Toof	Apr. 2, 1872.
125,231	Toof	Apr. 2, 1872.
125,424	Willcox *et al.*	Apr. 9, 1872.
126,139	Ellis	Apr. 30, 1872.
126,436	Barney *et al.*	May 7, 1872.
126,913	Toof	May 21, 1872.
*4,923	Scharffe	May 28, 1872.
129,087	Bishop	July 16, 1872.
129,351	Leslie	July 16, 1872.
130,189	Chamberlain	Aug. 6, 1872.
130,522	Moody	Aug. 13, 1872.
130,592	Perkins	Aug. 20, 1872.
131,012	Lyon	Sept. 3, 1872.
131,277	Johnston	Sept. 10, 1872.
131,300	Powell	Sept. 10, 1872.
*5,052	Johnston	Sept. 10, 1872.
*5,070	Johnston	Sept. 24, 1872.
*5,071	Johnston	Sept. 24, 1872.
*5,072	Johnston	Sept. 24, 1872.
134,744	Goodrich	Jan. 14, 1873.
135,122	Johnston	Jan. 21, 1873.
135,123	Johnston	Jan. 21, 1873.
135,359	Perkins	Jan. 28, 1873.
136,162	Hugg *et al.*	Feb. 25, 1873.
136,676	Stewart	Mar. 11, 1873.
137,002	Huntington	Mar. 18, 1873.
137,003	Huntington	Mar. 18, 1873.
137,342	Chamberlain	Apr. 1, 1873.
137,343	Chamberlain	Apr. 1, 1873.
137,686	Johnston	Apr. 8, 1873.
*5,368	Cary	Apr. 22, 1873.
139,064	Johnston	May 20, 1873.
139,089	Sievers	May 20, 1873.
139,657	Chamberlain	June 10, 1873.
139,883	Dalton	June 17, 1873.
*5,448	Crosby *et al.*	June 17, 1873.
140,285	Lewitt	June 24, 1873.
140,557	Stoll	July 1, 1873.
141,407	Walker	July 29, 1873.
141,610	Walker	Aug. 5, 1873.
142,543	Woolworth	Sept. 2, 1873.
143,049	Wise	Sept. 23, 1873.
143,259	Schullian	Sept. 30, 1873.
143,424	Rush	Oct. 7, 1873.
146,005	Johnston	Dec. 30, 1873.
146,482	Schultz	Jan. 13, 1874.
147,463	Woolworth	Feb. 10, 1874.
*5,793	Schultz	Mar. 17, 1874.
148,959	Johnston	Mar. 24, 1874.
149,110	Farmer	Mar. 31, 1874.
151,781	Irvine	June 9, 1874.
151,978	Hildebrand	June 16, 1874.
152,254	Sievers *et al.*	June 23, 1874.
154,497	Lewitt	Aug. 25, 1874.
156,119	Barney	Oct. 20, 1874.

7. (*b.*) *Reciprocating Blades* (continued).

No.	Name.	Date.
156,662	Darby	Nov. 10, 1874.
157,228	Schultz	Nov. 24, 1874.
157,462	Sievers	Dec. 8, 1874.
158,428	McCullough	Jan. 5, 1875.
158,834	Darby	Jan. 19, 1875.
159,020	Darby	Jan. 26, 1875.
159,261	Griest	Feb. 2, 1875.

8. *Tuck Creasers and Markers.*

No.	Name.	Date.
27,179	Wheeler	Feb. 14, 1860.
28,633	Fuller	June 5, 1860.
31,379	Fish	Feb. 12, 1861.
34,357	Fish	Feb. 11, 1861.
40,084	Rose	Sept. 22, 1863.
46,871	Bolton	Mar. 21, 1865.
50,271	Perrett	Oct. 3, 1865.
52,918	West	Feb. 27, 1866.
60,111	Yale	Nov. 27, 1866.
61,618	Goodrich	Jan. 29, 1867.
63,033	Fuller	Mar. 19, 1867.
64,404	Bostock	May 7, 1867.
65,141	Weissenborn	May 28, 1867.
66,185	St. John	June 25, 1867.
67,407	Brown	Aug. 6, 1867.
67,653	House	Aug. 13, 1867.
67,870	Goodrich	Aug. 20, 1867.
69,289	White	Sept. 24, 1867.
77,972	Fuller	May 19, 1868.
80,269	Bostock	July 28, 1868.
80,270	Bostock	July 28, 1868.
80,961	Ingle	Aug. 11, 1868.
81,160	Goodrich	Aug. 18, 1868.
83,950	Fuller	Nov. 10, 1868.
*3,218	Rose	Dec. 1, 1868.
85,856	Rogers	Jan. 12, 1869.
88,780	Fuller	Apr. 13, 1869.
89,842	Barnum	May 11, 1869.
*3,491	Weissenborn	June 8, 1869.
93,064	Davis	July 27, 1869.
93,743	Preiss	Aug. 17, 1869.
96,343	Page	Nov. 2, 1869.
97,435	Page	Nov. 30, 1869.
97,544	Mooney	Dec. 7, 1869.
101,272	Kellogg	Mar. 29, 1870.
103,342	Kellogg	May 24, 1870.
104,612	Martin	June 21, 1870.
105,402	Jones	July 12, 1870.
105,852	Safford	July 26, 1870.
106,151	Goodrich	Aug. 9, 1870.
106,789	Davis	Aug. 30, 1870.
107,109	Sibley	Sept. 6, 1870.
110,045	Jenson	Dec. 13, 1870.
*4,196	Bolton	Dec. 13, 1870.
112,050	Kellogg	Feb. 21, 1871.
112,578	Fuller	Mar. 14, 1871.
113,610	Yeutzer	Apr. 11, 1871.
114,276	Dulaney	May 2, 1871.
114,604	Robinson	May 9, 1871.
119,284	Shattuck	Sept. 26, 1871.
120,887	Lewitt	Nov. 14, 1871.
122,352	Barnum	Jan. 2, 1872.
122,613	Kasson	Jan. 9, 1872.
122,626	McFadden	Jan. 9, 1872.
123,989	Goodrich	Feb. 21, 1872.
124,025	Wiggins	Feb. 27, 1872.
125,782	Babcock	Apr. 16, 1872.
126,684	Doran	May 14, 1872.
127,023	Bush	May 21, 1872.
127,287	Yeutzer	May 28, 1872.
127,349	Hugg	May 28, 1872.
128,255	Smith	June 25, 1872.
128,942	Barnum	July 16, 1872.
129,128	Graff	July 16, 1872.
129,778	Babcock	July 23, 1872.
130,132	Hugg	Aug. 6, 1872.
130,365	Fuller	Aug. 13, 1872.
130,891	Bishop	Aug. 27, 1872.
131,206	Armstrong	Sept. 10, 1872.
132,018	Moore	Oct. 8, 1872.
132,148	Doran	Oct. 15, 1872.

8. *Tuck Creasers and Markers* (continued).

No.	Name.	Date.
134,966	Babcock	Jan. 21, 1873.
135,065	Barnum	Jan. 21, 1873.
135,078	Carpenter	Jan. 21, 1873.
135,919	Johnston	Feb. 18, 1873.
137,108	Stewart	Mar. 25, 1873.
138,635	Goodrich	May 6, 1873.
138,636	Goodrich	May 6, 1873.
139,249	Kane	May 27, 1873.
141,095	Tilestone	July 22, 1873.
143,741	Babcock	Oct. 21, 1873.
143,975	Faulkner	Oct. 28, 1873.
146,094	Powell	Dec. 30, 1873.
152,948	Henry	July 14, 1874.
154,052	Jones	Aug. 11, 1874.
157,649	Stewart	Dec. 8, 1874.
157,933	Sampson *et al.*	Dec. 22, 1874.
158,576	Detweiler	Jan. 12, 1875.
*6,316	Goodrich	Mar. 2, 1875.

9. *Tuckers and Plaiters.*

No.	Name.	Date.
16,429	Bishop	Jan. 20, 1857.
27,029	Allen	Feb. 7, 1860.
29,856	Brady	Sept. 4, 1860.
35,667	Blake	Jan. 24, 1862.
40,657	Bollman	Nov. 17, 1863.
57,374	Preiss	Aug. 21, 1866.
63,463	Brown	Apr. 2, 1867.
64,237	Mattison	Apr. 30, 1867.
69,461	McNeill	Oct. 1, 1867.
79,447	Cole	June 30, 1868.
80,243	Tucker	July 21, 1868.
80,653	Morehouse *et al.*	Aug. 4, 1868.
80,721	Gardner	Aug. 4, 1868.
83,219	St. John	Oct. 20, 1868.
94,628	Morehouse *et al.*	Sept. 7, 1869.
95,874	Bodwell	Oct. 19, 1869.
110,670	Morehouse	Jan. 3, 1871.
115,044	Farrand	May 23, 1871.
121,488	Bush	Dec. 5, 1871.
121,699	Woodbury	Dec. 5, 1871.
123,529	Wharton	Feb. 6, 1872.
127,080	Martin	May 21, 1872.
127,432	Russell	June 4, 1872.
128,181	Shepler	June 18, 1872.
128,229	Hunter	June 25, 1872.
128,475	Farrand	July 2, 1872.
128,476	Farrand	July 2, 1872.
129,987	Schmidt	July 30, 1872.
131,418	Bean	Sept. 17, 1872.
132,235	Bean	Oct. 15, 1872.
137,047	Barnum	Mar. 25, 1873.
137,232	Oakley	Mar. 25, 1873.
137,342	Chamberlain	Apr. 1, 1873.
138,730	Bouillon	May 13, 1873.
*5,427	Bean	May 27, 1873.
141,623	Bean	Aug. 12, 1873.
141,626	Brown	Aug. 12, 1873.
145,482	Bean	Dec. 16, 1873.
146,377	Brown	Jan. 13, 1874.
148,025	Bouillon	Mar. 3, 1874.
152,543	Bean	June 30, 1874.
154,646	Cleveland	Sept. 1, 1874.

10. *Welt-Guides.*

No.	Name.	Date.
33,817	Tucker	Nov. 26, 1861.
39,474	Folsom	Aug. 11, 1863.
42,810	Walker	May 17, 1864.
42,846	Folsom	May 24, 1864.
105,715	Moscheowitz	July 26, 1864.

11. *Variety of Work.*

No.	Name.	Date.
59,983	Duffy	Nov 27, 1866.
88,630	Hall	Apr. 6, 1869.
102,294	Mellen	Apr. 26, 1870.
118,145	Palmer	Aug. 15, 1871.
119,496	Bartlett	Oct. 3, 1871.
155,976	Robards	Oct. 13, 1874.

Class H. — Tables and Stands.

1. *Tables.*

No.	Name.	Date.
31,044	Ross *et al.*	Feb. 26, 1861.
41,393	Pilbeam	Jan. 26, 1864.
42,318	Stoops	Apr. 12, 1864.
88,121	Blake	Mar. 23, 1869.
*3,697	Blake	Nov. 2, 1869.
103,472	Kerigan	May 24, 1870.
106,109	Blake	Aug. 9, 1870.
106,110	Blake	Aug. 9, 1870.
108,000	Blake	Oct. 4, 1870.

1. *Tables* (continued).

No.	Name.	Date.
108,074	Wheat	Oct. 4, 1870.
108,812	Morgan	Nov. 1, 1870.
110,335	Bennor	Dec. 20, 1870.
113,741	Chesterman	Apr. 18, 1871.
116,809	Cochran	July 11, 1871.
118,655	Wagner	Aug. 29, 1871.
119,962	Breed	Oct. 17, 1871.
121,998	Dickinson	Dec. 19, 1871.
122,872	Wagner	Jan. 6, 1872.

1. *Tables* (continued).

No.	Name.	Date.
123,813	French	Feb. 20, 1872.
127,604	Hoyt	June 4, 1872.
132,027	Sargent	Oct. 8, 1872.
133,487	Rehfuss	Nov. 26, 1872.
134,904	Loth	Jan. 14, 1873.
135,392	Wilson	Jan. 28, 1873.
135,827	Loth	Feb. 11, 1873.
136,701	Cheney	Mar. 11, 1873.
136,798	Wheat	Mar. 11, 1873.

1. *Tables* (continued).

No.	Name.	Date.
136,903	Cuthbert	Mar. 18, 1873.
136,959	Bennor	Mar. 18, 1873.
137,983	Wauzer	Apr. 15, 1873.
139,805	Morrison	June 10, 1873.
140,874	Bennor	July 15, 1873.
140,927	Loth	July 15, 1873.
141,250	Wolfinger	July 29, 1873.
141,985	Bennor	Aug. 19, 1873.
142,024	Jeffery	Aug. 19, 1873.
143,742	Bennor	Oct. 21, 1873.
147,148	Marchand *et al.*	Feb. 3, 1874.
150,775	Murphy	May 12, 1874.
152,075	Clark	June 16, 1874.
153,438	Jones	July 28, 1874.
156,144	Draper	Oct. 20, 1874.
156,517	Whitworth	Nov. 3, 1874.
157,185	Adams	Nov. 24, 1874.

2. *Cases and Cabinets.*

No.	Name.	Date.
20,664	Ross *et al.*	June 22, 1858.
22,464	Uhlinger	Dec. 28, 1858.
114,435	Grove	May 2, 1871.
127,136	Alrich	May 28, 1872.
128,568	Uhlinger	July 2, 1872.
133,075	Alrich	Nov. 19, 1872.
133,361	Egley	Nov. 26, 1872.
134,905	Loth	Jan. 14, 1873.
136,525	Kirchner	Mar. 4, 1873.
136,543	Pusey	Mar. 4, 1873.
138,435	Range	Mar. 29, 1873.
140,324	Vetter	June 24, 1873.
147,572	Range	Feb. 17, 1874.
149,115	Hale	Mar. 31, 1874.
149,546	Tracey	Apr. 7, 1874.
149,767	Loomis	Apr. 14, 1874.
154,167	Anderson *et al.*	Aug. 18, 1874.

3. *Covers.*

No.	Name.	Date.
55,023	Thompson	May 22, 1866.
72,739	Johnson	Dec. 31, 1867.
93,444	Hunt	Aug. 10, 1869.
98,485	French	Jan. 4, 1870.
101,363	Hall	Mar. 29, 1870.
*3,961	Johnson	May 3, 1870.
103,863	French	June 7, 1870.
104,378	Uhlinger *et al.*	June 14, 1870.
107,398	Mooney	Sept. 3, 1870.
109,384	Chinn	Nov. 22, 1870.
110,507	Smith	Dec. 27, 1870.
110,711	Wolfinger	Jan. 3, 1871.
117,358	Wolfinger	July 25, 1871.

3. *Covers* (continued).

No.	Name.	Date.
*4,527	Wheat	Aug. 22, 1871.
120,085	Nauen	Oct. 17, 1871.
123,673	Browne	Feb. 13, 1872.
126,956	Heckel	May 21, 1872.
127,244	Junett	May 28, 1872.
128,833	Wheeler	July 9, 1872.
130,072	Reed	July 30, 1872.
131,101	Hughes	Sept. 3, 1872.
131,151	Cochran	Sept. 10, 1872.
133,846	Gardner	Dec. 10, 1872.
134,496	Better	Dec. 31, 1872.
134,756	McLure	Jan. 14, 1873.
135,121	Jeffery	Jan. 21, 1873.
136,506	Grover	Mar. 4, 1873.
136,762	Reed	Mar. 11, 1873.
138,324	French	Apr. 29, 1873.
140,875	Bennor	July 15, 1873.
140,876	Bennor	July 15, 1873.
140,877	Bennor	July 15, 1873.
141,169	Pusey	July 22, 1873.
141,561	Jensen	Aug. 5, 1873.
143,611	Boyer	Oct. 14, 1873.
*5,667	Bennor	Nov. 25, 1873.
145,612	Bennor	Dec. 16, 1873.
146,296	Wendell	Jan. 6, 1874.
147,469	Baird	Feb. 17, 1874.
149,155	Range	Mar. 31, 1874.
151,503	Morris	June 2, 1874.
154,311	Wolfinger	Aug. 18, 1874.
*6,056	Vetter	Sept. 22, 1874.
156,042	Salisbury	Oct. 20, 1874.

4. *Trays.*

No.	Name.	Date.
114,435	Grove	May 2, 1871.
127,136	Alrich	May 28, 1872.
136,525	Kirchner	Mar. 4, 1873.
146,298	Wendell	Jan. 6, 1874.

5. *Lamp-Brackets.*

No.	Name.	Date.
138,831	Wolf	May 13, 1873.

6. *Work-Holders.*

No.	Name.	Date.
115,288	Eddy	May 30, 1871.
146,110	Turner	Dec. 30, 1873.

7. *Aprons and Guards.*

No.	Name.	Date.
130,339	Tower	Aug. 6, 1872.
136,410	Browne	Mar. 4, 1873.

8. *Chairs.*

No.	Name.	Date.
140,362	Gray	July 1, 1873.

9. *Casters.*

No.	Name.	Date.
42,754	Dodge	May 17, 1864.
48,852	Stoops	July 18, 1865.
50,402	Stoops	Oct. 10, 1865.
52,257	Bartram	Jan. 30, 1866.
55,567	Wilkins	June 12, 1866.
75,755	Hathaway	Mar. 24, 1868.
79,571	Hewitt *et al.*	July 7, 1868.
81,454	Allen	Aug. 25, 1868.
88,558	Elliott	Apr. 6, 1869.
101,328	Veasey	Mar. 29, 1870.
101,843	Elliott	Apr. 12, 1870.
101,844	Elliott	Apr. 12, 1870.
101,924	Ryder	Apr. 12, 1870.
103,782	Sargeant	May 31, 1870.
107,666	Courts	Sept. 27, 1870.
112,740	Ryder	Mar. 14, 1871.
113,135	Bishop *et al.*	Mar. 28, 1871.
115,060	Jones	May 23, 1871.
115,779	Stafford *et al.*	June 6, 1871.
116,040	Fontayne	June 20, 1871.
118,117	Duncan	Aug. 15, 1871.
119,606	Hatch	Oct. 3, 1871.
120,098	Proctor	Oct. 17, 1871.
120,783	Skinner	Nov. 7, 1871.
124,106	Wright	Feb. 27, 1872.
127,571	Clark	June 4, 1872.
128,113	Chumock	June 18, 1872.
129,354	McAfferty	July 16, 1872.
129,629	Veasey	July 16, 1872.
132,285	Hiestand	Oct. 15, 1872.
137,141	Lincoln	Mar. 25, 1873.
139,606	Plank	June 3, 1873.
139,608	Proctor	June 3, 1873.
141,236	Robertson	July 29, 1873.
142,615	Clark	Sept. 9, 1873.
143,387	Smith	Sept. 30, 1873.
145,011	Proctor	Nov. 25, 1873.
146,289	Stansbury	Jan. 6, 1874.
146,997	Eddy	Feb. 3, 1874.
147,377	Eddy	Feb. 10, 1874.
147,574	Robinson	Feb. 17, 1874.
147,981	Sargeant	Feb. 24, 1874.
150,264	Strong	Apr. 27, 1874.
151,018	Gaar	May 19, 1874.
151,841	Cass	June 9, 1874.
152,241	Morton	June 23, 1874.
153,728	Sloan *et al.*	Aug. 4, 1874.
158,436	Plank	Jan. 5, 1875.
161,624	McEwen	Apr. 6, 1875.

Class I. — Motors.

1. *Hydraulic Engines and Water-Wheels.*

No.	Name.	Date.
120,975	Jennings	Nov. 14, 1871.
121,441	Welch	Nov. 28, 1871.
128,615	Greenleaf	July 2, 1872.
131,616	Hyde	Sept. 24, 1872.
136,452	Palmer	Mar. 4, 1873.
142,551	Atwell	Sept. 9, 1873.
146,120	Backus	Jan. 6, 1874.

2. *Steam, Air, and Gas Engines.*

See Gas-engine, pp. 947-949; Air-engine, pp. 35-45.

No.	Name.	Date.
114,429	Fontaine	May 2, 1871.
121,702	Buckman	Dec. 12, 1871.
121,891	Nicholson	Dec. 12, 1871.
121,626	Jeffrey	Dec. 5, 1871.
122,484	Nicholson	Jan. 2, 1872.
123,414	Nicholson	Feb. 6, 1872.
153,440	Laubereau	July 28, 1874.

3. *Springs in various Combinations.*

No.	Name.	Date.
36,084	Hall	Aug. 5, 1862.
*39,827	Parrot	Sept. 8, 1863.
67,730	Curdts	Aug. 13, 1867.
73,303	Cuppers	Jan. 14, 1868.
75,667	Crary	Mar. 17, 1868.
79,289	Monce	June 23, 1868.
79,296	Allis	June 30, 1868.
80,815	Enholm	Aug. 11, 1868.
81,219	Shiver	Aug. 18, 1868.
82,655	Stackpole	Sept. 29, 1868.
91,327	Garcin *et al.*	June 15, 1869.
93,214	Manson	Aug. 3, 1869.
95,069	Ayer	Sept. 21, 1869.
97,586	Ayer	Dec. 7, 1869.

3. *Springs in various Combinations* (continued).

No.	Name.	Date.
104,610	Manson	June 21, 1870.
111,276	Thornton *et al.*	Jan. 24, 1871.
115,379	Stearns	May 30, 1871.
115,436	Constable *et al.*	May 30, 1871.
120,654	Manson	Nov. 7, 1871.
121,532	Macauley	Dec. 5, 1871.
121,638	Manson *	Dec. 5, 1871.
121,745	Barnes	Dec. 12, 1871.
124,812	Greer	Mar. 19, 1872.
126,421	Squier	May 7, 1872.
126,441	Bouchard	May 7, 1872.
127,129	Wilcox	May 21, 1872.
129,998	Warren *et al.*	July 30, 1872.
131,614	Howell	Sept. 24, 1872.
133,760	Cleveland *et al.*	Dec. 10, 1872.
134,526	Dunton	Jan. 7, 1873.
141,367	Manson	July 29, 1873.
148,225	Manson	Mar. 3, 1874.
150,141	Fay	Apr. 28, 1874.
152,633	Herrinton	June 30, 1874.
156,161	Huntoon	Oct. 20, 1874.
160,876	Chambers	Mar. 16, 1875.

4. *Spring with Fusee.*

No.	Name.	Date.
72,607	Cuppers	Dec. 24, 1867.
*87,020	Tuckerman	Feb. 16, 1869.
140,607	Young	July 8, 1873.

5. *Spring with Governor or Fly.*

No.	Name.	Date.
16,315	Johnson *et al.*	Dec. 23, 1856.
48,467	Wells	June 27, 1865.
100,934	Shiver	Mar. 16, 1870.
127,189	Sage	May 28, 1872.

6. *Spring with Cone-Pulleys.*

No.	Name.	Date.
13,661	Singer	Oct. 9, 1855.
51,012	Buchanan	Nov. 2, 1865.
70,803	Chapman *et al.*	Nov. 12, 1867.

7. *Spring wound by Stirrups.*

No.	Name.	Date.
141,996	Chambers	Aug. 19, 1873.

8. *Weight.*

No.	Name.	Date.
44,909	Tuckerman	Nov. 1, 1864.
115,864	Johnson	June 13, 1871.
148,311	Lockwood	Mar. 10, 1874.

9. *Rocking Motion or Weight of the Operator.*

No.	Name.	Date.
75,666	Crary	Mar. 17, 1868.
85,504	Baird	Jan. 5, 1869.
85,505	Baird	Jan. 5, 1869.
104,608	Leyburn	June 21, 1870.
109,478	Whittemore	Nov. 22, 1870.
142,839	Cochran	Sept. 16, 1873.

10. *Pendulum.*

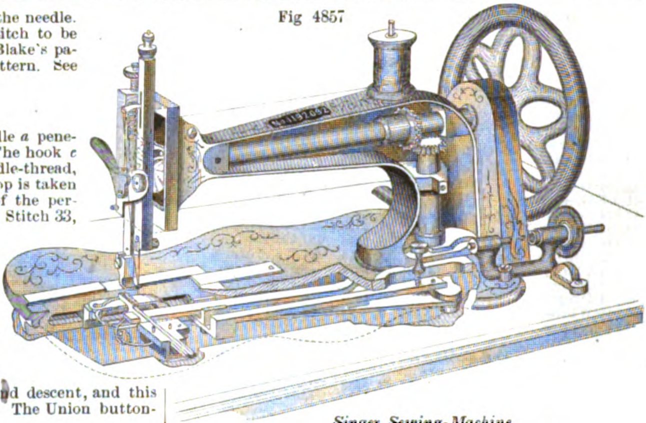
No.	Name.	Date.
77,167	Carter	Apr. 28, 1868.

11. *Wheel driven by Shot.*

No.	Name.	Date.
110,667	Mills	Jan. 3, 1871.

sole. A cast-off works in connection with the needle. The horn is so shaped as to allow the stitch to be formed near the shoe around the shoe. Blake's patent, July 6, 1858 McKay Association pattern. See SHOE-SEWING MACHINE, Plate LIX.

Fig 4857



Singer Sewing-Machine.

Button-hole Machines.

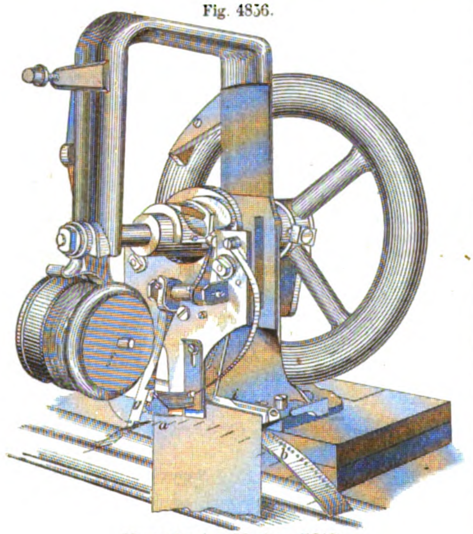
19. A single-thread machine. The needle *a* penetrates the fabric back from the edge. The hook *c* passes over the edge, takes the loop of needle-thread, draws it up over the edge, and then the loop is taken by the hook *b* and spread in the path of the perforating needle in its next descent. See Stitch 33, Plate LVII.

20. A two-thread machine. A hole is cut in the goods for the button-hole; the material is held in a clamp, which is moved under the needle, so that the latter makes a circuit of the button-hole a short distance from the edge. The needle descends alternately through the material back from the edge and then over the edge; the loop formed by the first descent is interlocked by the loop formed at the second descent, and this second loop is secured by a looper-thread. The Union button-hole machine of Boston.

Miscellaneous Parts.

21. A winder for shuttle-bobbins, which are held between the

Fig. 4856.



Howe Sewing-Machine (1846).

two heads and rotated by the contact of the friction wheel *a* with some rotating portion of the machine. *b* is an emery-wheel for sharpening needles.

22. A knife attached to the needle-bar to cut material parallel to the seam. In other instances a rotating cutter is attached to the cloth-plate.

23. A needle setter and threader. A device for placing the eye of the needle at the proper distance from the end of the needle-bar and for drawing the thread through the eye of the needle.

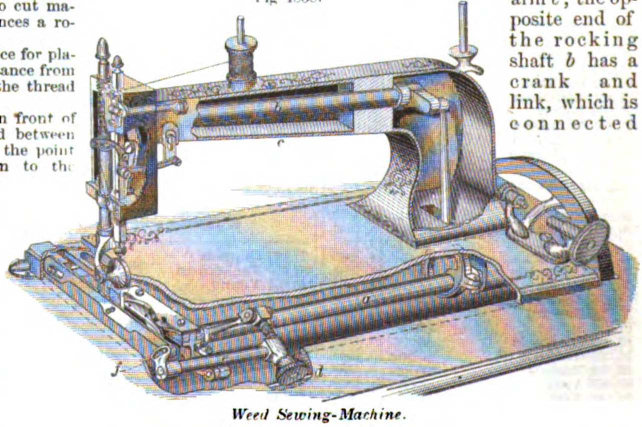
24. The material is raised and lowered in front of an ordinary sewing-needle, which is held between rollers that act to draw the material on to the point of the needle and off at the heel and on to the thread.

Fig. 4856 is the Howe sewing-machine, patented in 1846. It used a grooved and curved eye-pointed needle *a* carried by a vibrating arm *g*, the needle being supplied with thread from a spool *f*. The loops of needle-thread were locked by a thread carried by a shuttle *i*, moved through the loop by means of reciprocating drivers. The cloth was suspended in a vertical position, impaled on pins projecting from a baster-plate *b* moved intermittingly under the needle by means of a toothed wheel. The length of the seam depended upon the length of the baster-plate, and the seams were necessarily straight. On reaching the end of the length, the machine was stopped, the baster-plate returned to its original position, and the cloth again attached.

The Singer machine was patented in 1851 and subsequent years. The machine makes a lock-stitch by means of a straight eye-pointed needle and a longitudinally reciprocating shuttle. The needle-bar derives its motion from a pin on the end of the rotating horizontal shaft, the pin entering a heart-shaped groove in a block attached to the needle-bar. A bevel-wheel on the main shaft engages a bevel-wheel on the vertical shaft, provided at its lower end with a crank, connected by link with the shuttle driver or carrier. The four-motion feeding-dog is operated through the horizontal lever actuated from the vertical shaft. The feed is adjusted through a movable fulcrum, controlled by a set-screw. A take-up lever controls the thread between the tension device and the eye of the needle.

The Weed machine, as improved by G. A. Fairfield, and made under his patents, is shown in Fig. 4858. It makes a lock-stitch with a straight eye-pointed needle and reciprocating shuttle. The needle-bar is actuated from an eccentric on the main shaft *a*, which is connected by means of a link with a rocking shaft *b* in the goose-neck or overhanging arm *c*; the opposite end of the rocking shaft *b* has a crank and link, which is connected

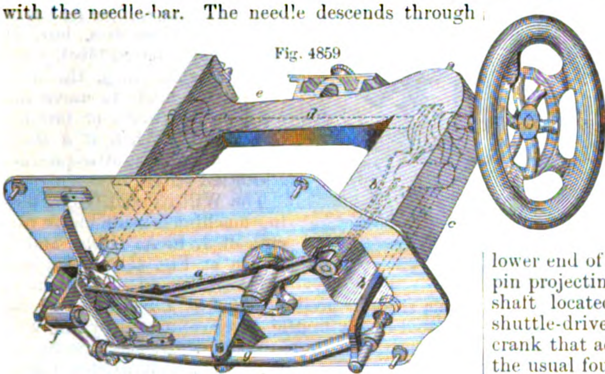
Fig 4858.



Weed Sewing-Machine.

with the needle-bar. The needle descends through

Fig. 4859



"*Domestic*" *Sewing-Machine.*

the cloth, rises sufficiently to form a loop to receive the point of the shuttle, then descends to slightly slacken the thread, and when the shuttle has passed completely through the loop, the needle rises to complete the stitch; a vibrating take-up, carried by the needle-bar and actuated through links, as shown, assists in tightening the stitch. A second eccentric on the main shaft is connected by means of a link with the shuttle-carrier, and another eccentric on the same shaft operates the feeding device.

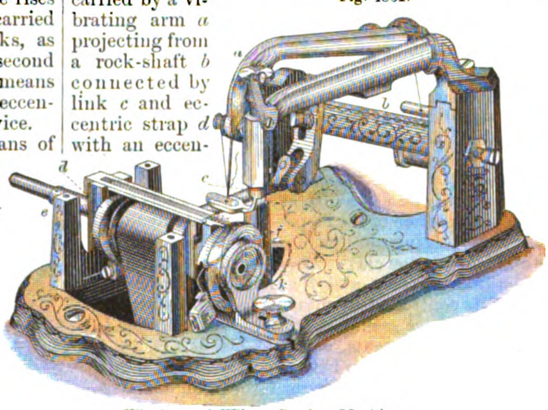
The length of the stitch is varied by means of the thumb-nut *d*, shaft *e*, and slotted cam *f*.

The "Domestic" sewing-machine, made under Mack's patents, is shown in Fig. 4859. It makes a lock-stitch with a reciprocating straight needle and a shuttle supported at the end of a horizontally vibrating shuttle-lever *a*, forked at one end to receive the ball-like end of a vertical lever *b* pivoted to the standard *c*, and forked at its upper end, so as to embrace a cam or eccentric on the main horizontal rotating shaft *d*, supported in bearings in the overhanging arm *e*, the shaft *d* having at its outer end a crank-pin to enter a curved slot in a block attached to the needle-bar, the pin and block reciprocating the needle-bar. The feed is of the four-motion class, deriving its motion from a bell-crank *f*, actuated by a horizontal lever *g*, moved by a vertically reciprocating connecting-rod *h*, driven by an eccentric on the main shaft *d*.

The Wilson sewing-machine (Fig. 4860) makes a stitch by a vertically reciprocating straight needle and a longitudinally reciprocating shuttle. The needle is moved by the action of a vibrating arm *a* pivoted to an upright *b* rising from the bed-plate. The lower end of the bent arm is slotted, and receives a pin projecting from a crank or disk on a short cross-shaft located directly under the upright *b*. The shuttle-driver is connected by link with the disk or crank that actuates the needle-arm. The feed is of the usual four-motion class, and the take-up *c* is a slotted arm actuated by means of a pin projecting from the needle-bar.

The Wheeler and Wilson sewing-machine (Fig. 4861) makes a lock-stitch by means of a curved eye-pointed needle carried by a vibrating arm *a* projecting from a rock-shaft *b* connected by link *c* and eccentric strap *d* with an eccen-

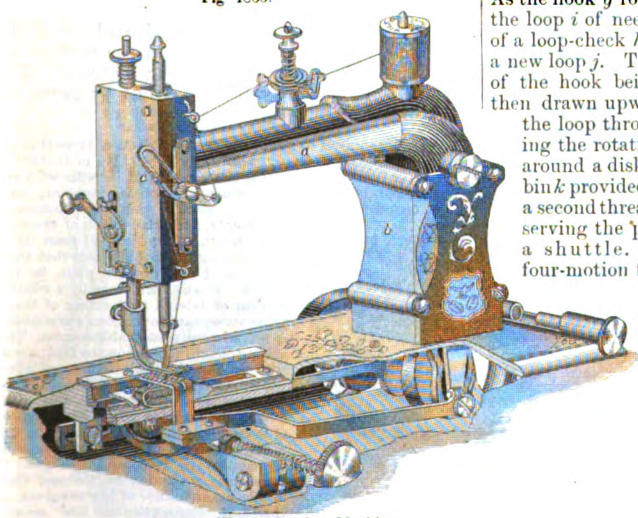
Fig. 4861.



Wheeler and Wilson Sewing-Machine.

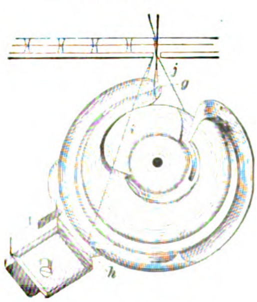
tric on the rotating hook-shaft *e*, this shaft having at its outer end the hook *f*, provided with a point *g* (see Fig. 4862) adapted to enter the loop of needle-thread. As the hook *g* rotates, it passes into and draws down the loop *i* of needle-thread, which is held by means of a loop-check *h*, while the point of the hook enters a new loop *j*. Then the old loop *i* is cast off, the face of the hook being beveled for that purpose, and is then drawn upward by the action of the hook upon the loop through which it is then passing. During the rotation of the hook each loop is passed around a disk-bobbin *k* provided with a second thread and serving the part of a shuttle. The four-motion feed is

Fig 4860.



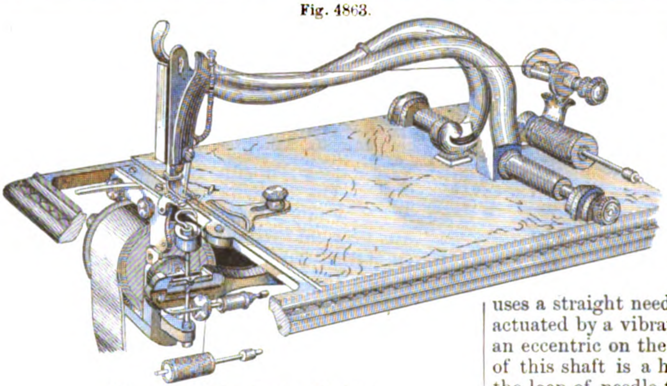
Wilson Sewing-Machine.

Fig. 4862.



Wheeler and Wilson Hook.

Fig. 4863.



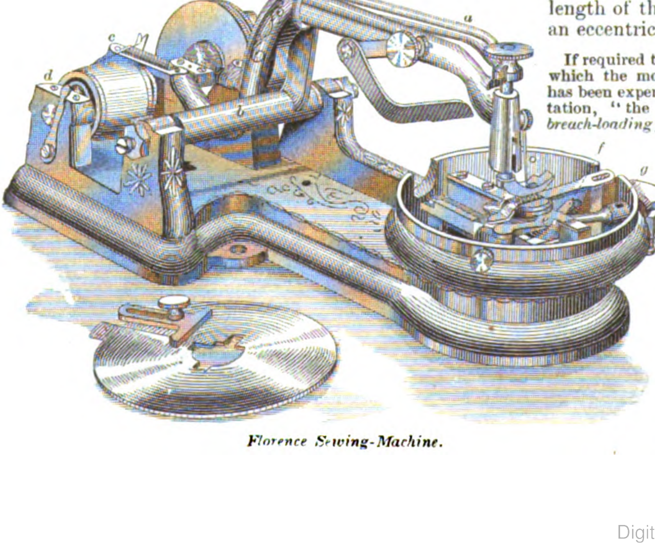
Grover and Baker Sewing-Machine.

the invention of A. B. Wilson, and is actuated in this machine by means of cams on the hook-shaft *e*. See also TAILORING-MACHINE.

The Grover and Baker machine (shown at Fig. 4863) makes the double-loop stitch (see Plate LVII.). It uses a curved eye-pointed needle and a rotary reciprocating curved thread-carrying looper *g*. The needle is carried at the upper end of a ⊃-shaped arm, slotted at its lower forward end, to receive an actuating pin upon a disk connected with the main shaft. The vertical looper-shaft has a spiral portion embraced by a slotted plate at the end of the ⊃-shaped arm, and as the latter vibrates it acts upon the spiral portion of the looper-shaft, and imparts to it a reciprocating rotary motion. The feed is of the usual four-motion class. The threads are contained on ordinary spools, and the slack of the needle-thread is controlled by means of a spiral spring.

The Florence sewing-machine is made under L. W. Langdon's patents, and is shown at Fig. 4864. It makes a lock-stitch by means of a curved needle carried by a vibrating arm or lever *a*, on a shaft *b*, which has a backward extension-yoke *c*, embracing an eccentric on the main shaft *d*. The shuttle-driver is actuated by the shaft *d* by means of a link. The needle and shuttle have constant motion, not having periods of rest, as in other machines. The slack of the shuttle-thread during the backward movement of the shuttle is taken up by means of a vibrating arm *e*. The feed is of the four-motion class, but, by means of a grooved block *f* and an adjustable pin *g*, the feed-bar may be made to move forward or backward, or brought to a stand. When at a stand the needle and shuttle produce a knotted stitch.

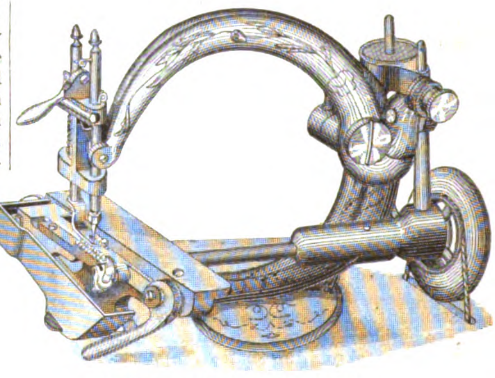
Fig. 4864.



Florence Sewing-Machine.

The Willcox and Gibbs sewing-machine is made under patents of J. E. A. Gibbs, and is shown at Fig. 4865. The machine makes a chain-stitch; uses a straight needle carried by a reciprocating bar actuated by a vibrating lever connected by link with an eccentric on the main shaft. At the forward end of this shaft is a hook, which, as it rotates, carries the loop of needle-thread, distends and holds it expanded while the feed moves the cloth, and until the needle at the next stroke descends through the loop so held. When the needle descends through the first loop, the point of the hook is again in position to catch the second loop, at which time the first loop is cast off and the second loop is drawn through it, the first loop being drawn up against the lower edge of the cloth, forming a chain.

Fig. 4865.



Willcox and Gibbs Sewing-Machine.

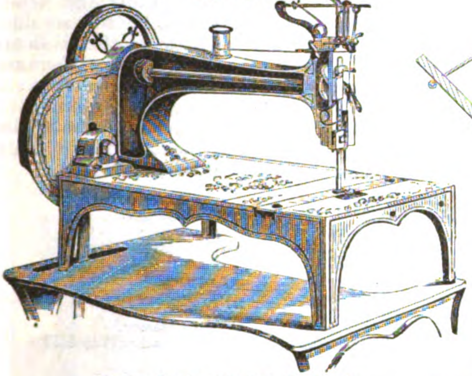
An eccentric on the main shaft, back of the rotating hook, enters a slot in the feeding-bar and gives it the usual four motions. The length of the stitch is governed by means of an eccentric lever.

If required to name the three subjects of invention on which the most extraordinary versatility of invention has been expended, the answer should be without hesitation, "the *sewing-machine*, *reaping-machine*, and *breach-loading fire-arm*." Each of these has thousands of patents, and, while each of them is the growth of the last 40 years, it is only during the last 25 years that they have filled any notable place in the world. It was then only by a combination of talents that either of these three important inventions was enabled to achieve any remarkable success. The sewing-machine previous to 1851, made without the admirable division of labor which is a feature in all well-conducted factories, was hard to make, and comparatively hard to run. The system of *assembling* — first introduced in the artillery service of France by General Gribeauval in 1765, and brought to proximate perfection by Colonel Colt in the manufacture of his revolver at Hartford, Connecticut — has economized material and time, and improved

the quality as well as cheapened the product. There is to-day, and in fact has been for some years, more actual invention in the special machines for making sewing-machines than in the machines themselves. The effect of this will be, when the adventitious aids of exclusive patents shall terminate, to give the larger and better equipped concerns a great advantage over smaller competitors.

What is true of one of the classes of invention named is true of the others, as well as of some not mentioned, — the American watch, for instance. The *assembling* system — that is, making the component parts of an article in distinct pieces to pattern, so as to be interchangeable, and then putting them together — is the only system of order. How else should the Providence Tool Company execute their order for 600,000 rifles for the

Fig. 4866.



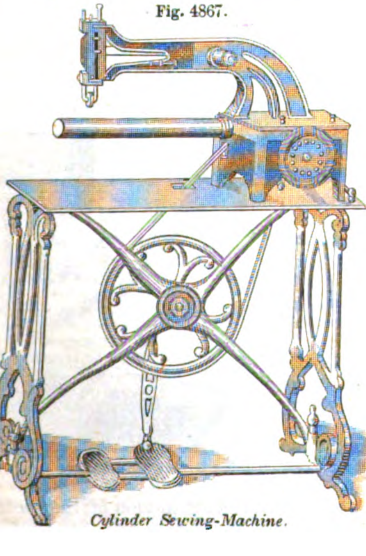
Singer Sewing-Machine for Leather.

Turkish government? How otherwise could the "Champion" Harvesting-Machine Companies of Springfield, Ohio, turn out an equipped machine every four minutes each working day of ten hours? Or, to draw the illustration from the subject in hand, how by any other than the nicest arrangement of detail can the Singer Sewing-Machine Company make 6,000 machines per week in their works at Elizabethport, New Jersey?

The data for showing the rate of increase of the sales of sewing-machines since the year 1851, is not accessible to the writer, even if it be obtainable at all. The sales have, however, largely exceeded half a million a year for four years past, and the following table is given as showing the sales of fifteen companies for the year 1874, but two of the numbers being estimated: —

	Machines.
The Singer Manufacturing Co.	241,679
Wheeler and Wilson Manufacturing Co.	92,827
Howe Sewing-Machine Co. (estimated)	35,000
Domestic Sewing-Machine Co.	22,700
Weed Sewing-Machine Co.	20,495
Grover and Baker Sewing-Machine Co. (estimated)	20,000
Remington Empire Sewing-Machine Co.	17,608
Wilson Sewing-Machine Co.	17,525
Gold Medal Sewing-Machine Co.	15,214
Willcox and Gibbs Sewing-Machine Co.	13,710
American Buttonhole Sewing-Machine Co.	13,529
Victor Sewing-Machine Co.	6,292
Florence Sewing-Machine Co.	5,517
Secor Sewing-Machine Co.	4,541
J. E Braunsdorf & Co., "Ætna"	1,866

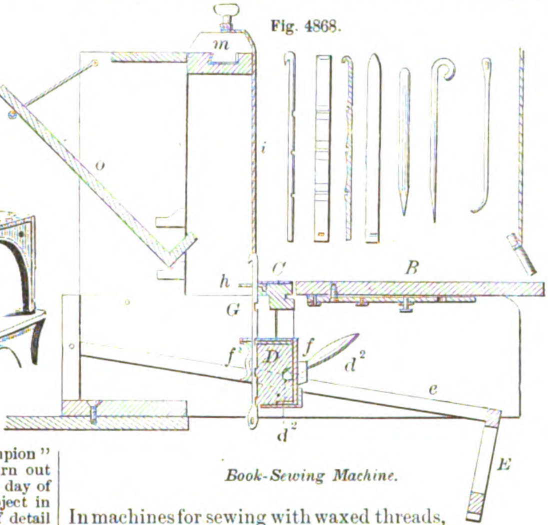
Fig. 4867.



Cylinder Sewing-Machine.

2. The sewing-machine for leather is similar to the ordinary straight-needle machine, but is stronger.

Fig. 4868.



Book-Sewing Machine.

In machines for sewing with waxed threads, a lamp warms the wax and thread. See also SHOE-SEWING MACHINE and Plate LIX.

The cylinder sewing-machine has a cylindrical work-holder for sewing seams on sleeves, trousers, water-hose, boot-legs, leathern buckets, and other tubular works.

3. The sewing-machine for books is shown in Fig. 4868.

The folded sheets are placed on the table *B*, which is capable of a sliding movement, and are compressed between it and a removable press (not shown), while slots are cut in their backs to receive the thread.

The sheets are then transferred to the inclined table *o*, the table *B* is slid up to the needle-guide *C*, and the sheets are one by one transferred to the table *B* and opened. A thread unwound from a spool at one side of the machine is inserted within the fold of the sheet behind the needles *G*, which are so adjusted as to pass into the slots previously made in the paper, and have their hooked upper ends turned backwardly. By depressing the treadle *E e* the needles are drawn downward, carrying the thread with them through the openings in the back; the sheet is then turned over, a second sheet placed upon it, opened, the needles again passed through by the upward movement of the treadle, a turn of the thread is taken around one of the end needles, forming a loop, and it is then passed beneath the hooks of the other needles as before. In sewing the next sheet, the same process is followed, a turn being taken around the needle at the opposite end, and so on until the whole are completed. In special cases this method is departed from, and needles of various forms, seen at the foot of the cut, are employed. Sometimes cords *i* are used instead of the end needles. The lower ends of these are secured to plates on the guide-bar *C*, their upper ends being tightened by a pin *m* around which they are passed. *D* is the needle-holder bar; it has a series of slotted plates *f*, through which the needles pass; a plate beneath these engages in one of the notches of the needles, which are there held by springs f^2 until firmly secured by a movement of the lever d^2 operating an eccentric which clamps the needle-holders firmly against the needles. As the pile of sheets grows higher, the needles are raised by turning the lever d^2, permitting them to be lifted until a lower notch engages with the locking-plate, when they are again clamped. *C* is the guide-bar provided with a series of slotted plates *h*, through which the needles pass.

The lower figures illustrate differently shaped needles employed in various kinds of work.

Patent No. 150,495, Thompson and Parkhurst, May 5, 1874, preserves the general features of the *sewing-table*. The signature is notched, placed upon the needles, the lacing-thread is passed, and the signature folded. The lifters are then thrown forward by means of levers, a cam operating the frame, thus holding the sewed signatures firmly in position. At the same movement of the lever the cam operates upon a slide, which is kept tightly pressed against the cam by the pressure of the right-angle lever upon a bearing-bar by means of a spring. The movement of the right-angle lever by this means operates the bar and throws pivoted hooks around the needles, holding them firmly in position for the operation of the thread-carrier. A backward movement of the lever withdraws the hook from around the needles and the lifters from over the signatures, and permits the addition to the partly sewed book of another signature. See also No. 151,507, Parkhurst and Thompson, June 2, 1874; No. 36,428, Tanner, September 9, 1862; No. 74,948, Smyth, February 25, 1868; No 91,175, Smyth, June 8, 1869.

Adaptations to book-sewing of the ordinary Sewing-Machine. No. 124,694, Palmer, March 19, 1872, machine for sewing pamphlets. No. 135,662, Palmer, February 11, 1873, book-sewing-machine. The signature, held between two slotted clamping-plates, is moved by them through shafts, connecting-levers, and the Geneva stop-motion intermittingly under the needle of an ordinary sewing-machine, the upper plate, upon the completion of the sewing, being released from cam-pressure and raised by a spring; a presser-foot operated by suitable cam holding it in contact with bed of machine during return movement of clamps. Two signatures can be alternately sewed (upon the forward and backward movements of the clamps), being separated by guides, one of which has a knife-edge to cut the thread, said clamps being moved longitudinally to place them into the path of the needle

See also Patent, No. 105,329, Hall, July 12, 1870.

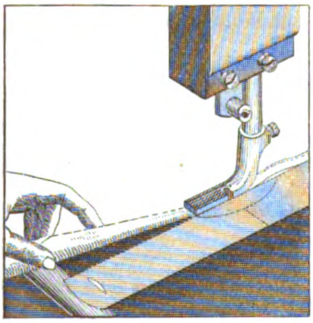
Stabbing-Machines. No. 114,286, Glass, May 2, 1871; No. 116,757, Reynolds, July 4, 1871.

Sew′ing-ma-chine′ At-tach′ment. The term is held to include those devices which are attached to a machine to enable it to do some special duty other than plain sewing.

They are enumerated in the following list, and some of the principal ones are shown in Figs. 4869–4876. It may be mentioned that the cuts are illustrative of the work, and but little variation is shown in the mode of attaching to the machine. There are, however, many modes of attaching the devices; to the table, to the head of the machine, making it a part of the presser-foot, attaching it to the needle-bar, etc. See the articles in the following list under their respective heads in the body of the work.

Basting-machine.
Binder (Fig. 4875).
Bobbin.
Bobbin-winder.
Braider (Fig. 4877).
Button-hole marker.
Cloth-plate.
Corder (Fig. 4876).
Creaser.
Embroiderer (Fig. 4877).
Embroidering-machine.
Feeder (see page 2122).
Feller (Fig. 4871).
Gage (see page 2122).
Gatherer (Fig. 4874).
Guide.
Hemming-guide.
Hemmer (Figs 4869, 4870).
Marker.
Needle.
Needle-setter.
Needle-sharpener.
Needle-threader.
Plaiter.
Presser-foot.
Quilter (Fig. 4873).
Ruffler (Fig. 4874).
Sewing-machine gage.
Sewing-machine needle.
Shuttle.
Spool-holder.
Stitch.
Stitching-machine.
Thread-cutter.
Threader.
Thread-guide.
Thread-waxer.
Tuck-creaser.
Tuck-marker (Fig. 4872).
Waxer.

Fig. 4869.

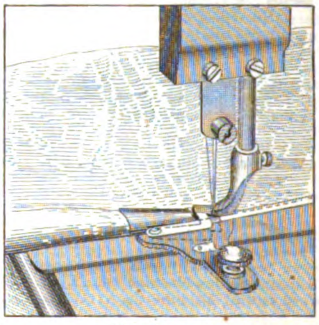


Narrow Hemmer.

Fig. 4869 is for turning and sewing narrow hems. It is, in the case illustrated, made a part of the presser-foot. It is a curved tongue, narrowing toward the needle-hole, turning the raw edge and the hem at the same time that the feed draws the goods to the needle.

Fig. 4870 is a device adapted to make broader hems. It is shown as attached to the bed-plate, and acts in a manner similar to the former.

Fig. 4870.

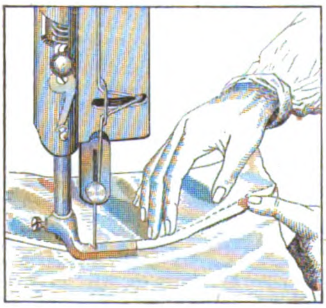


Wide Hemmer.

Fig. 4871 is a *feller*. It turns over the two raw edges at the same time, ready for the needle, which stitches them down.

Fig. 4872 is a *tuck-marker*. It has a guide attached to the cloth-plate of the machine, and attached to the side of the bed is an arm that gages the distance between the tucks, and also carries the under marker. The cloth is folded over this arm. The upper marker is attached to the needle-bar, and one tuck is marked while the needle is sewing the former one.

Fig. 4871.

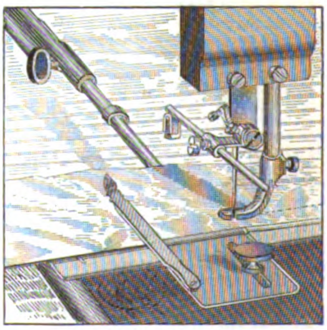


Feller.

Fig. 4873 is a *quilter*. An arm fastened to the head of the machine carries an adjustable guide, which runs in the seam last made.

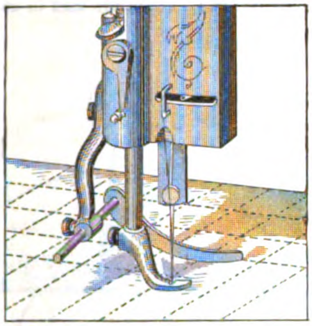
Fig. 4874 is a *gatherer* and *ruffler*. It has two blades, between which the strip to be ruffled is passed, while the cloth to which it is to be sewed is run beneath the lower blade. These blades are attached to a vibrating cam-lever, which is pivoted to an arm on the presser-bar. The blades are advanced by the upward motion of the needle-arm carrying the gather past the needle-hole, and are retracted by the downward motion of the needle-arm slipping back over the goods, as the needle sews the gather. The unsewed full edge makes the ruffle.

Fig. 4872.



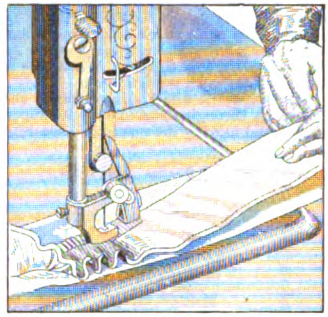
Tuck-Marker.

Fig. 4873.



Quilter.

Fig. 4874.

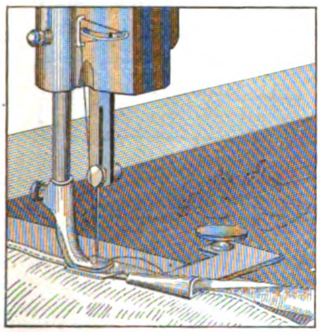


Gatherer and Ruffler

Fig. 4875 is a *binder*. It is a double tapering scroll, the upper part only of which is shown. The edge of the cloth is passed into the slit on the side of the scroll, and the binding entering at the large end follows the form of the scroll, and its edges, as they pass out of the scroll, lap against the goods; the decreasing size of the scroll also turns under the raw edge of the goods.

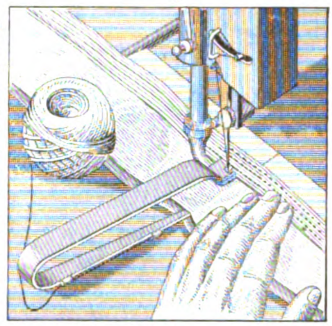
Fig. 4876 is a *corder*, attached to the presser-foot, which has grooves in the bottom running in the direction of the seam. The cord is passed from the ball through two eyes on the projecting arm of the corder, then at a right angle through another eye immediately in front of the groove in the presser-foot; as it passes through the groove a seam is run alongside it.

Fig. 4875.



Binder.

Fig. 4876.

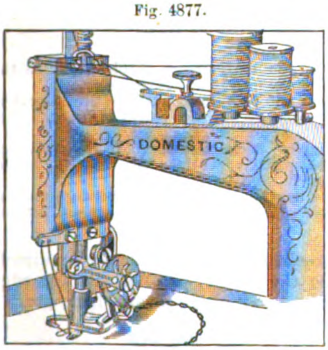


Corder.

Fig. 4877 is an *embroiderer*. The forked arm attached to the needle-bar carries a pawl that slides freely over the face of the ratchet on the downward movement of the needle, but engages and turns the rack as the needle ascends. In the back of the ratchet is a star-shaped cam-groove, which operates the upper end of the lever that reciprocates in the slots in the embroidering arms, causing them to cross the threads after each stitch, and the next descent of the needle stitches them thus.

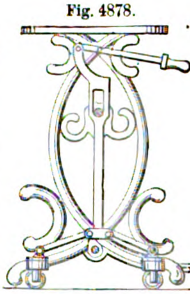
Sew'ing-ma-chine' Cast'er. Sewing-machine casters are so made as to be brought into use when the machine is to be rolled over the floor, and thrown out of use to give the machine steadiness when working.

Fig. 4877.



Embroiderer.

Fig. 4878.



Caster for Sewing-Machine.

In Fig. 4878, the casters have vertical movement, and are operated by levers actuated by cams on the treadle rock-shaft when the said shaft is raised by the hand-lever. The casters may be depressed in relation to the machine, so as to support it when it is to be moved.

In Fig. 4879, caster-wheels attached to supports passing through fixed guides attached to the legs of the frame are raised by cams operated by levers and connecting links to raise the frame from the floor. See also list, page 2115.

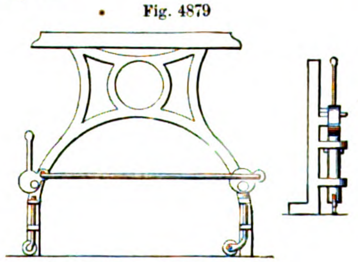
Sew'ing-ma-chine' Feed. The device or devices for moving the cloth or other material intermittingly forward or past the needle. They may be subdivided as follows, namely: —

Clamp. Two parallel bars or jaws, material confined between them, and moved by pawl or pinion engaging teeth or clamp. See patent to Greenough, February 21, 1842. Fig. 4848.

Baster, or Pin-plate. A flat, horizontally moving plate, with sharp pins projecting from one edge. Material crowded on these pins and carried by plate. See patent to Howe, September 10, 1846. In Fig. 4880, *A* shows this feed: the needle *a* vibrates in a vertical plane, carrying the upper thread *e*; *d* is one of the points projecting from the edge of the baster-plate, which traverses horizontally across the path of the needle, and carries the cloth *h*, which is suspended from the row of points *d*, one only of which is shown by this side elevation. *n* is the shuttle-mover. In both these cases a seam longer than the clamp or plate cannot be sewn without stopping the machine and readjusting the clamp or plate and cloth.

Pin-wheel, or Bolt. An annular ring, disk, or endless belt, moved intermittingly forward in one direction, and provided

Fig. 4879

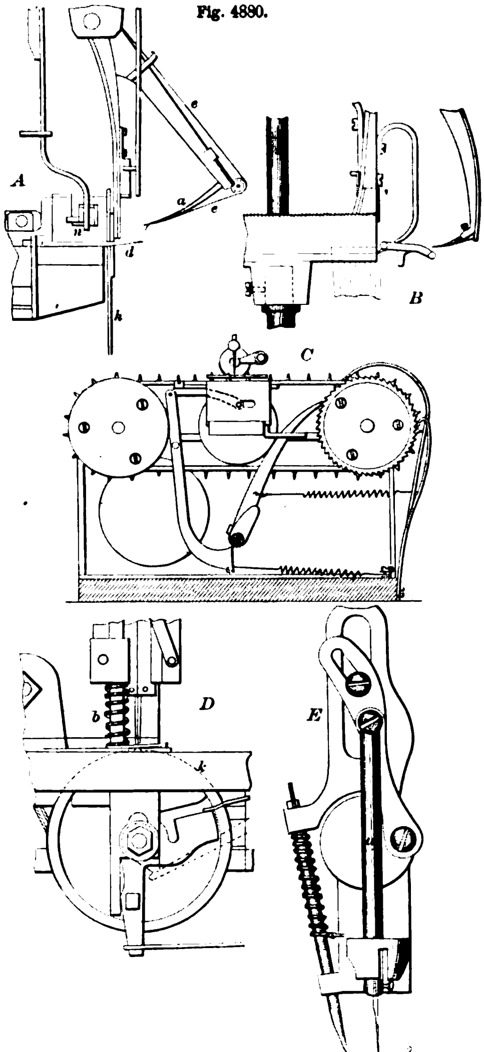


Sewing-Machine Caster.

with pins to enter and move the material for a seam of any desired length without stopping. The rotating-pin surface may move horizontally about a vertical axis and sustain and move material, as in patent to Blodgett and Lerow (*B*), October 2, 1849, or may move about a horizontal axis and carry the material over a horizontal cloth-supporting surface, as in patent to Bachelder (*C*), May 8, 1849. When pins are used it is difficult to sew other than a straight seam.

Wheel-feed. A wheel with periphery roughened or serrated, projecting through a slot in a cloth-supporting surface, and engaging and moving the material. See Singer, August 12, 1851.

Fig. 4880.



Sewing-Machine Feed.

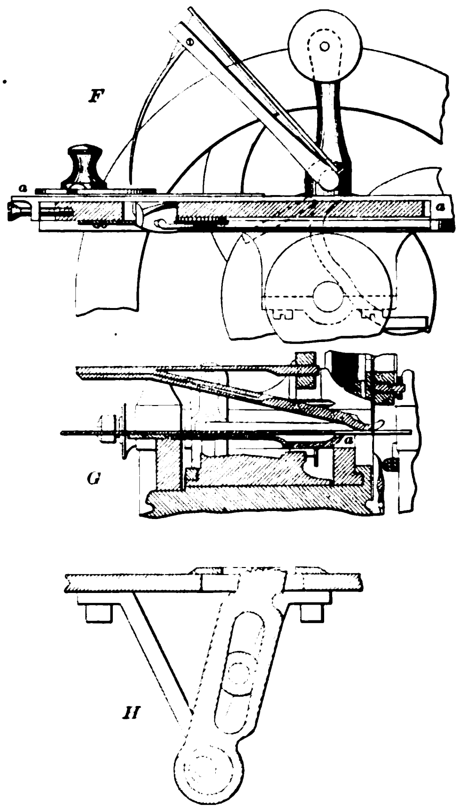
In *D* the rough-surfaced wheel is shown at *k*. The material is pinched between the wheel and the presser-foot *b*, and advanced by an intermittent motion in the intervals of the downward strokes of the needle.

Needle, or Awl. A reciprocating needle or awl, vibrated when in the material (see patent to Johnson, March 7, 1854), or moved horizontally through a horizontal movement of the block or head in which the needle or awl reciprocates. See patent to Townsend, April 8, 1862, or McLean, 1869, shown at *E*, in which the needle-bar *a* is oscillated.

Two-motioned. A horizontally reciprocating rough-surfaced dog or plate *a* engages the material at all times, carries it intermittingly to the needle, and while the needle is in the material moves back to take a new stroke. See Wilson, November 12, 1850, shown at *F*.

Four-motioned. A rough-surfaced dog or plate *a*, so moved as to rise against the material, move horizontally, fall from the material, and move back to its original position. See Wilson, June 15, 1852. See *G*, Fig. 4881. Commonly used in most

Fig. 4881.



Sewing-Machine Feed.

sewing-machines. *H* is a modification of this, in which the path of motion is elliptical instead of quadrangular.

Thread. A plate or arm pressing against the thread next to and moving the material forward. See patent to Stedman, November 27, 1855.

Upper feed. A feeding device located above the cloth-supporting surface and engaging upper side of material. See patent to Wickersham, April 19, 1853.

Each of the above has numerous minor subdivisions of detail, but the number of kinds of feed in actual use is quite limited.

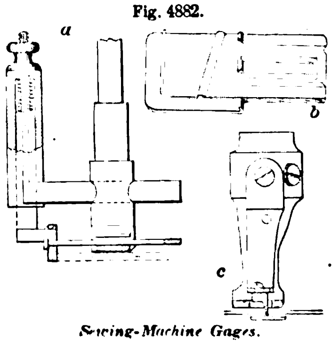
Sew'ing-ma-chine' Gage. A device for directing the goods to the needle, parallel with the edge of a selvage or edge, or with a previous hem, etc.

a is an edge-gage attached to the presser-foot and adjustable laterally.

b is attached to the cloth-plate in advance of the needle-hole.

c is a device to enter a seam to insure the parallelism of a second seam.

Fig. 4882.



Sewing-Machine Gages.

Sew'ing-ma-chine'

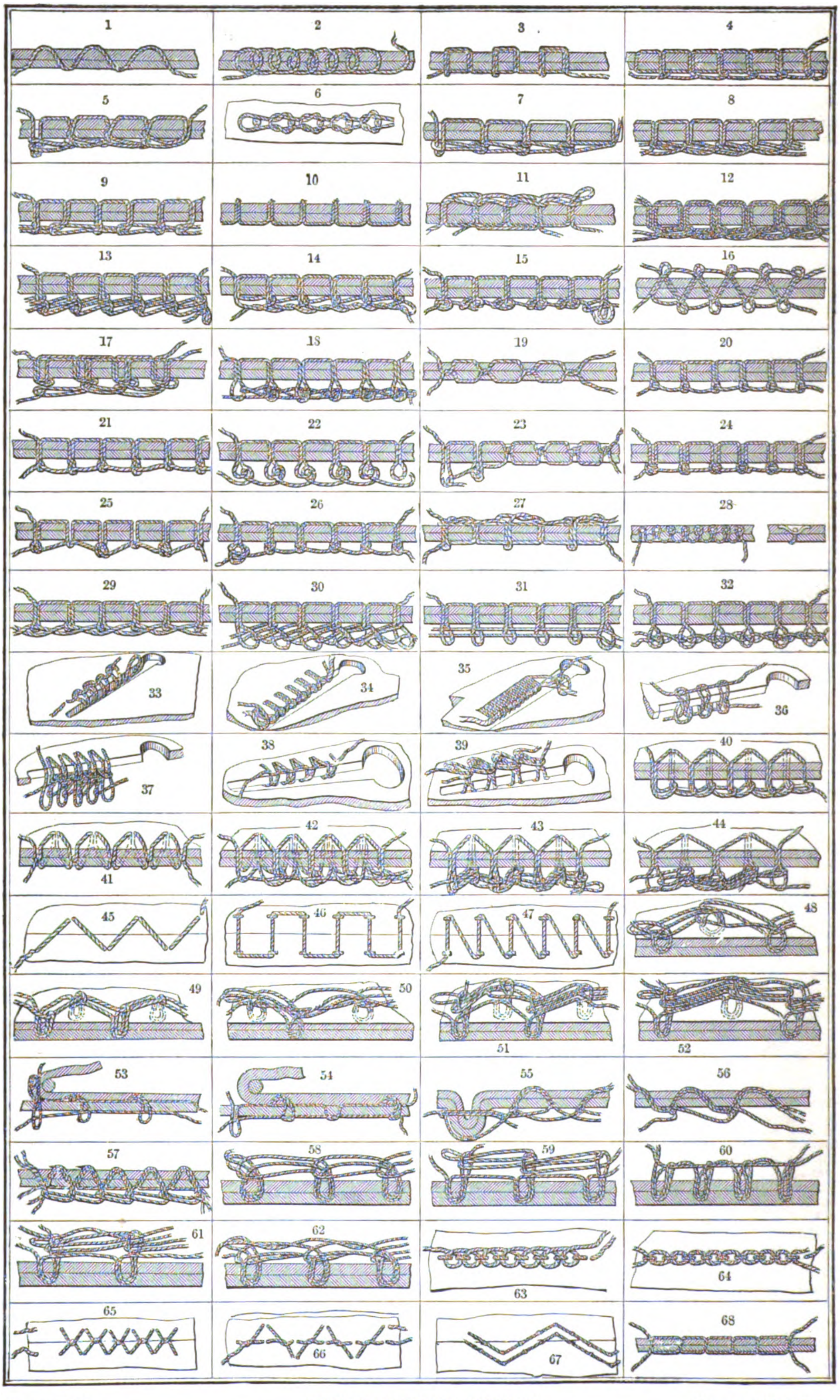
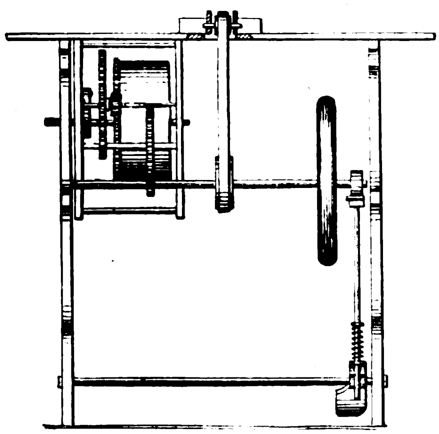


PLATE LVII. SEWING-MACHINE STITCHES. *See pages 2123, 2124.*

Hook. A rotating or reciprocating device beneath the table of a sewing-machine, to catch the needle-thread and open it while the succeeding stitch is made through the loop thus afforded. Or, which loops the needle-thread while the bobbin or shuttle containing the lower thread is passed through said loop. It is known as the *Wheeler and Wilson hook*. See Fig. 15, Plate LVI., and also Figs. 4861, 4862.

Sew′ing-ma-chine′ Mo′tor. A spring or engine attached to a sewing-machine as a driver. The example shows the application of a coil-spring as the moving power for ordinary domestic use. A friction-

Fig. 4883.



Spring Motor for Sewing-Machine.

roller and a brake, governed by a foot-lever, are employed to adapt the motion of the machine to the work.

There are many other modes, besides the one usual in factories, which consists of band connection with the usual shafting driven by an engine. See list, page 2115.

The electro-magnetic automotor of M. Cazal may be hidden under a footstool. Four of Bunsen's elements are sufficient for driving an ordinary sewing-machine at a stated cost of sixteen cents per day.

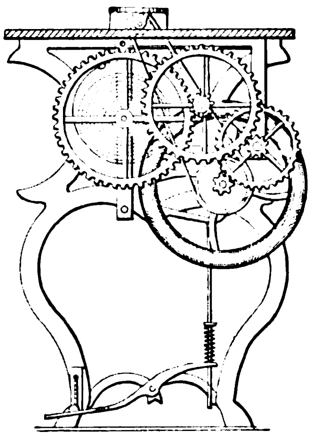
The apparatus itself has an iron pulley with an externally toothed rim, which revolves freely within a metallic ring, toothed similarly to the pulley, but on its internal surface, so that the points of the teeth of the pulley face and approximate to those of the outer circle. An insulated wire runs over the pulley, which thus becomes a magnet whenever an electrical current is run through it, and ceases to be so from the very instant that the current is interrupted.

While the current from the battery is active, each of the teeth of the pulley attracts its opposite on the rim; and if the current were to remain constant, each of these would remain *in situ*, and no motion would be imparted to the wheel; to avoid this, a commutator, which is set in motion by the motor itself, regulates the passage of the electrical current through the wire and renders it intermittent. As soon as the apexes of the teeth have placed themselves into opposition, the current ceases and the teeth on the pulley proceed onward, when a fresh current forces them into a second opposition with the next set on the rim, and so on indefinitely, producing a very satisfactory rotary motion. The power being symmetrically disposed around the axis and in each tooth, there is but little friction on the bearings and no noise produced. The speed can be varied at will, and pressure on a knob or button causes instant stoppage.

Sew′ing-ma-chine′ Nee′dle. These are straight or curved, and with an eye near the point. The straight needle is upon a bar which reciprocates in a straight path; the curved needle is upon an arm which oscillates on an axis. (See SEWING-MACHINE.) In one machine for making sewing-machine needles, the blank is grasped by one of a series of jaws and presented progressively to a cutter, a grooving tool, a similar tool to groove the opposite side, a punch, and a polishing-wheel. The jaws are upon sliding stocks, which are moved radially by a cam-groove, to cause the necessary rotation in the presentation of the blank to the tools.

In the usual method the blanks, in length from 1½ to 2 inches, are (1) cut from a coil of wire, and (2) a groove is simultaneously made on each side for the reception of the thread. Successive operators perfect the needle.

The first cuts out the eye with a punch operated by a treadle; the second straightens the blanks by tapping them on a steel block with a mallet; the third takes a dozen or so between the thumb and forefinger, and rounds them by a twirling motion while held against a rapidly moving emery belt; the fourth points them upon an emery wheel by a very similar manipulation; a fifth polishes out the grooves, using two rapidly rotating brushes, one of brass wire and the other of bristles; a sixth stamps the size or number on each needle.



A number are then placed in a muffle, the muffle in a furnace, and when heated to a cherry red, the needles are emptied into a vessel of whale-oil. This renders them extremely brittle; they are tempered by placing them on a heated copper plate and keeping them in continual motion until they turn to a light straw-color, when they are permitted to cool.

The revolving brushes are again used to remove the scale and impart a final polish. The eyes are then polished by drawing rapidly backward and forward over threads charged with polishing paste; in the case of straight needles, they are now ready for packing, after being straightened by a few blows of the hammer, but those for the Wheeler and Wilson, Grover and Baker, and other machines requiring curved needles, are bent to a curve of seven inches' radius before being packed.

Sew′ing-ma-chine′ Stitch. See the following, represented in Plate LVII.

Single Thread.

1. The ordinary *running*-stitch used in basting.
2. The *back* stitch.
3. The *fast* stitch.
4. *Chain*-stitch.
5. *Coiled*-loop chain-stitch.
6. *Knitted*-loop chain-stitch.
7. *Knotted*-loop chain-stitch.
8. Loop *enchained* by second alternate stitch.
9. Each loop locks and enchains alternate loops.
10. *Staple* stitch for waxed threads.

Two Threads.

11. *Double-needle* chain-stitch.
12. Double-thread chain; stitch two threads, one needle.
13. Double-looped stitch. Grover and Baker.
14. Chain with interlocking thread.
15. Under-thread through its own loop.
16. Two needles penetrate fabric from opposite sides.
17. Two needles working from the same side of the fabric.
18. Doubly interlocking loop.
19. *Lock*-stitch. Singer, Wheeler and Wilson, Weed, Wilson, Howe, Domestic, Florence.
20. Coil in needle-thread.
21. Double coil in needle-thread.
22. Coil in shuttle-thread.
23. Double coil in shuttle-thread.
24. Knot-stitch; every stitch knotted.
25. Knot-stitch; every other stitch knotted.
26. Knot-stitch (different knot).
27. Shuttle-thread drawn up to form embroidery.
28. *Wire*-lock; thread locked by wire.

Three Threads.

29. Two shuttles, each locking alternate loops.
30. Double loop with interlocking third thread.
31. Two shuttle-threads locking each loop.
32. Two shuttle-threads intertwining and locking each loop.

Button-hole Stitches.

33. Single thread. Loop of needle-thread drawn up over the edge and locked by needle at its next descent.
34. Two threads. Bights of needle-thread, above and below, extend to the edge of the fabric, and are locked by shuttle-thread.
35. Two threads. Needle penetrates back from edge, its loop passed to, and interlocked by, the needle at its next descent over the edge, and this second needle-loop locked by shuttle-thread.
36. Shuttle-thread drawn up over the edge of the fabric to the line of the needle-thread.
37. Needle-loop through the fabric locked by needle-loop over the edge, and second loop locked by second thread.
38. Two threads. Edge of fabric covered by shuttle-thread.
39. Third thread laid under the stitch at the edge of the fabric.

Fancy Stitches.

40 to 47. Various of above-described stitches made *zigzag*.
48 to 52. *Single-faced* or *straw-braid*, *zigzag*, or *herring-bone* stitches.
53 to 62. *Single-faced* or *straw-braid* stitches.
63 to 67. *Embroidering* stitches.
68. *Saddler's* stitch.

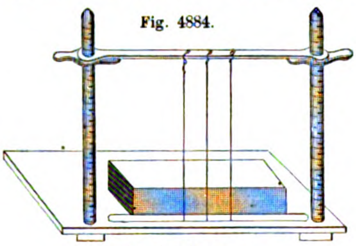
For the above selection of illustrations of stitches and the systematic description, the writer is indebted to Mr. G. W. Gregory, of Boston.

The *sampler* stitch is a hand stitch used in berlin work on canvas or perforated paper. One stitch crosses the other at right angles, forming a small cross.

Sew'ing-press. The frame with stretched vertical cords, against which the backs of the folded sheets of a book are consecutively laid and sewed.

Three or more grooves are sawed into the back of the pile of sheets, so that they shall fit to the inside of the same number of cords in the frame. The sewer takes a sheet, fits the grooves to the cords, and half opens the folded sheet in the middle. A stout thread,

Fig. 4884.

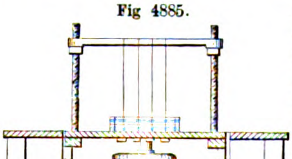


Sewing-Press.

its end first firmly fastened, is passed by means of a needle over the first cord, then along the inside of the fold of the sheet to the second cord, over that and along the fold to the next, where it is secured by a *hitch*; then another sheet is laid on, and the same operation is repeated in reverse order until a pile of sheets as high as the sewer can conveniently reach has thus been sewed to the cords. Such a pile will probably contain a dozen volumes. The cords are long enough to allow an inch or two at each end, when the volumes are separated; these serve to fasten the sheets into the covers. The sheets thus sewed together are now ready to receive their covers.

Sew'ing-ta'ble. A table or bench at which signatures of books are sewed to the cords or bands by which they are fastened together, and also secured in the cover. *Sewing-press.*

Fig 4885.



Bookbinder's Sewing-Table.

In the example, the bench is vertically adjustable on the supporting table, so as to be lowered by a screw as the pile of sheets rises; this maintains the top of the latter at a convenient hight for sewing.

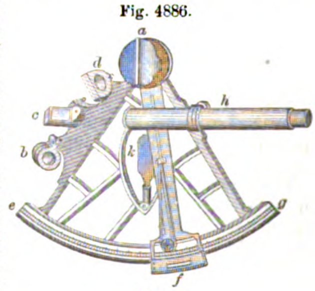
Sex'tant. *a.* An instrument for measuring angles; it resembles a quadrant, but has an arc of 60°. Arabian astronomers are said to have had a sextant of 59 feet 9 inches radius, about A. D. 995.

One of this kind was used by Tycho Brahe at his observatory in the island of Huen, A. D. 1550. These were supported vertically by a wall or pillar, were not reflecting instruments, and consequently were only capable of measuring angles up to 60°.

b. The reflecting sextant is particularly useful on shipboard, being conveniently held in the hand, and equally well adapted for measuring the altitudes of celestial objects in order to obtain the latitude and local time, or for lunar observations; that is, measuring the angular distance between the moon and the sun, or between the moon and a fixed star or planet, for the purpose of ascertaining the longitude. It is an improved form of the quadrant of reflection, invented by Newton in 1699 (see QUADRANT), and is capable of measuring angles of 120° or more. It consists of a frame, generally of metal, but sometimes of ebony, stiffened by cross-braces, and having an arc embracing about 65° of a circle. This is divided into double the number of degrees actually embraced between the two extreme graduations of the arc, as the fixed and movable glasses, owing to the double reflection, only form with each other an angle equal to half the angular distance between the two objects observed, one of which is seen directly and the other by reflection from the index-glass.

"Its flat surface is called the plane of the instrument. *e g* is the arc or limb, reading by the vernier attached to the movable radius *a f* to 30″, 20″, 15″, or 10″, as the case may be. *a* is the silvered index-glass, provided with screws for its adjustment. At *b* are the fore-shades or screens of colored glass. *c* is the horizon-glass, the lower half of which is silvered, and which also has screws for its adjustment. At *d* are the back-shades or screens of colored glass. *h* is the telescope, useful for obtaining accurate results, but not an essential feature of the instrument. *a f* is the movable radius, carrying at one end the index-glass, and at the other end a vernier. This is read by a microscope. Slow motion is imparted to the radius by a tangent-screw. *k* is the handle, attached to the back of the frame. The principle of the sextant depends on the practical application of the following theorem in optics: 'When a ray of light, proceeding in a plane at right angles to each of two plane mirrors which are inclined to each other at any angle whatever, is successively reflected at the plane surfaces of each of the mirrors, the total deviation of the ray is double the angle of inclination of the mirror.'" — G. CHAMBERS.

Fig. 4886.



Sextant.

When observing altitudes the instrument is held perpendicularly to the horizon, in observations in the plane of the line joining the two objects. On shore an ARTIFICIAL HORIZON (which see) is used; at sea the navigator is compelled to rely on the natural horizon.

In taking noon observations at sea to determine the latitude, the observer takes his place shortly before meridian, and turning down one or several of the shades to prevent his eye being injured by the glare, directs the telescope or sight-tube to the sun, moving the index so as to bring its reflected image to coincide with the sea horizon; as the sun rises, he gradually advances the limb, clamping it and using the tangent-screw for this purpose, as the sun's path becomes more nearly horizontal, and slightly rocking the instrument from side to side to insure that it is in a vertical plane at the moment when the sun attains his greatest hight. The reading of the limb at the moment when the sun begins to dip is noted, and a very simple calculation, adding his declination derived from the "Nautical Almanac" to the true zenith distance obtained by observation, gives the latitude.

Meridian altitudes of the moon, a planet, or a fixed star may also be employed for this purpose.

Observations for local time are taken when the sun or other object is rising or falling most rapidly; the calculations for this

are more complicated. When ascertained, it is compared with the time at Greenwich or other meridian, as indicated by a chronometer on board; the difference of time turned into arc at the rate of four minutes of time to one degree of arc, gives the longitude of the place of observation. Calculations for determining the latitude by double altitudes taken out of the meridian, and those for longitude by lunar observation, are still more complex, and observations of the latter frequently require the observer to assume a very inconvenient position.

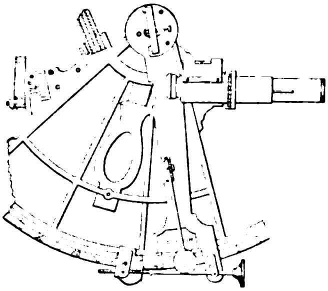
In observations on shore with the artificial horizon, the true altitude of the object is doubled by the reflection of its image from the mercurial surface; the apparent angle must therefore be divided by two.

Besides the uses of the sextant as specially adapted to the purposes of the astronomer and navigator, it is also used by the surveyor for measuring angles and for filling in the detail of a survey when the theodolite is used for the long lines, and laying out the larger triangles.

The Box-sextant (which see) is a small instrument specially contrived for this purpose.

The spirit-level sextant, invented by Mr. George Davidson, of the United States Coast Survey, is designed for observing the altitudes or depressions of celestial and other objects, dispensing with both the natural and artificial horizons. It consists of an observing tube, on top of which is a spirit-level, the bubble of which is viewed by reflection from a plane mirror just below it, forming an angle of 45° with the axis of the instrument. As the level is too near the eye for distant vision, a convex lens is inserted in the tube between the mirror and the eye. This is longitudinally adjustable, to adapt it to the vision of different observers. The mirror occupies but one half the tube, in order that the observed object may be seen direct, and for the same reason the lens embraces only a semicircle. In making observations the sextant is held in the usual manner, the object and the eye in the same vertical plane, and by moving the vernier arm the image of the object is brought into the same horizontal line with the image of the cross-wires in the tube at the same time that they bisect the image of the bubble. The reading on the graduated limb of the instrument shows the angle of elevation or depression of the object. For night observations the bubble must be illuminated. This may be done by means of a lamp, or by a vial filled with phosphorus in oil, which, when air is admitted by withdrawing the stopple, will afford light sufficient for the purpose.

Fig. 4887.



Sextant.

Sex'to. (*Bookbinding.*) A size of book made by folding the sheets into six leaves each.

Sex'to-dec'i-mo. (*Bookbinding.*) A size of book in which each signature is folded to contain sixteen leaves. *16mo.*

Shab'rack. (*Menage.*) (Fr. *shabraque*; Hungarian, *csabrág*; from Turkish, *tshâprâk.*) The cloth or housing of a military saddle.

Sgraf'fi-to. (*Fine Arts.*) A style of picture in which a white ground is chipped or worked away to expose a black sub-surface.

Shack'le. 1. (*Locksmithing.*) The hinged and curved bar (*a*) of a padlock by which it is hung to the staple.

2. (*Nautical.*) *a.* A link (*b*) in a chain-cable which may be opened to allow it to be connected to the ring of the anchor or divided into lengths, usually fifteen fathoms. It consists of a *clevis*, *bolt*, and *key*. Used for the chains also.

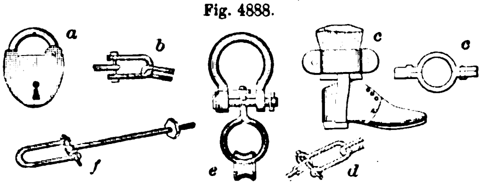
b. A ring on the port through which the port-bar is passed to close the port-hole effectually.

c. The clevis, secured by a pin and bolt to the shank of an anchor, and to which the cable is bent; used in place of the old-fashioned anchor-ring.

3. (*Railroading.*) A link for coupling railroad-cars, being engaged by the pin of the respective draw-heads. See Car-coupling.

4. A fetter or gyve (*c*) for the ankle of a prisoner, consisting of a ring riveted around the small of the leg and connected by a chain to a similar shackle on

Fig. 4888.



Shackles.

a, padlock-shackle.
b, chain-shackle.
d, rafter and tie-rod shackle.
e, swivel-shackle.
f, shackle-bolt.

the other leg, to a ring-bolt in the floor or wall of the cell, or otherwise.

5. (*Husbandry.*) The usual connection of the *double-tree* to the forward end of the plow-beam. A *clevis.*

6. (*Carriage.*) The iron by which the bed or body of a carriage is made to rest upon the spring-bar.

Shack'le-bar. (*Railway.*) A coupling bar or link of a railway-car.

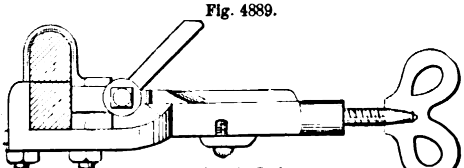
Shack'le-bolt. 1. A bolt having a shackle or clevis on the end (*f*, Fig. 4888).

2. One passing through the eyes of a clevis or shackle.

Shack'le-crow. (*Nautical.*) A bolt-extractor with a shackle instead of a claw.

Shack'le-jack. (*Vehicle.*) An implement for attaching the thills to the shackle on the axle where an anti-rattling box of india-rubber is used. The

Fig. 4889.



Shackle-Jack.

jack forces backward the eye of the thill-shackle, compressing the rubber sufficiently to bring into line the bolt-holes of the two parts of the shackle.

Shade. 1. A colored glass in a sextant or other optical instrument for solar observations.

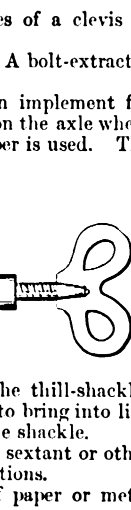
2. *a.* A hollow conic frustum of paper or metal surrounding the flame of a lamp, in order to confine the light within a given circular area.

b. A hollow globe of ground glass or other translucent material, used for diffusing the light of a lamp or burner. A clean glass globe obstructs about 12 per cent of the light; when ornamented with cut flowers or figures, about 24 per cent; a globe ground all over, about 40 per cent.

3. A device for protecting the eyes from the direct rays of the sun or artificial light.

4. A window-curtain to exclude light.

Fig. 4890.



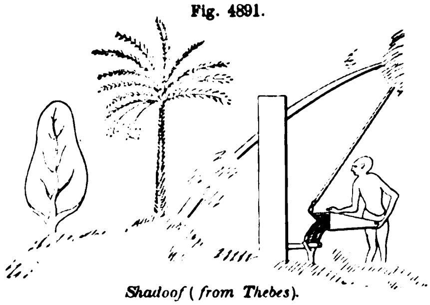
Curtain-Hook.

Shade-hook. A hook for holding a curtain-cord.

Sha-doof'. The *shadûf* (Arabic) is the oldest

known water-elevating machine, and is about equivalent to our swing-pole and bucket arrangement. It is found represented in monuments of as early date as 1432 B. C., and has been in use in Italy in all

Fig. 4891.

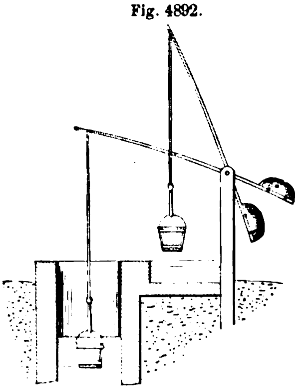


Shadoof (from Thebes).

times, ancient and modern. It is still very common along the Nile, being employed in raising water for irrigation. It has not been adopted for irrigating purposes in other countries to any great extent, though a few are to be found in Palestine.

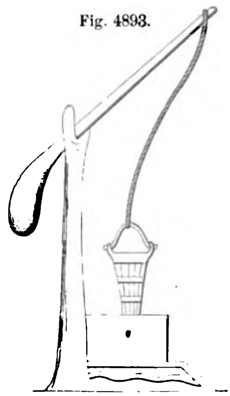
The Egyptian system was to divide the allotments of land into shallow beds, with a raised wall or ridge of soil around each. The water was then turned from the common ditch into the *squares* successively, the dividing wall of earth being scraped away by the foot.

Fig. 4892.



Modern Shadúf.

Fig. 4893.



Anglo-Saxon Draw-Well.

"For the land [Canaan], whither thou goest in to possess it, is not as the land of Egypt, from whence ye came out, where thou sowedst thy seed, and wateredst it with thy foot, as a garden of herbs; but the land, whither ye go to possess it, is a land of hills and valleys, and drinketh water of the rain of heaven."

Fig. 4892 is the modern Egyptian shadúf. A weight is tied on to the end of the raising-pole to counterbalance the full bucket. A simpler way, not unfrequently employed in this country, is to employ a sapling with a thick, heavy butt.

The *draw-well*, shown in Fig. 4893, is from a MS. of the fourteenth century in the Harleian MS., England, No 1,257.

Shaf-fer-oon'. (*Architecture.*) A form of molding. See CONGE.

Shaft. (*Mining.*) A perpendicular or slightly inclined pit. It is sunk by digging or blasting. In treacherous ground it is lined by curbs, called *tubbing* or *cribbing*. A longitudinal division is a *brattice*. It is used for access to the mine, for ventilation, for the pump-stocks, for the removal of ore or coal. Jutting ledges in the shaft are *scarcements*.

The term *sinking* is applied to a *shaft*; *driving*, to a *drift*, *adit*, or *gallery*.

The names of shafts refer to the specific uses; as,

Engine-shaft, that in which the hoisting apparatus works. Also known as the *winding*-shaft or *working*-shaft.

The *ventilating*-shaft (which may also be a working-shaft) is known as an *upcast* shaft, for ascent of air, or a *downcast* shaft for descent of fresh air. When these two are one shaft, they are divided by a *brattice*.

An *air*-shaft is a ventilating-shaft.

Pumping-shaft, for the pump-stocks and rods for drainage of the mine.

Ladder-shaft, by which the miners descend and ascend to and from the working.

Trial-shaft, an experimental boring to ascertain the presence of minerals or water, or the extent of a *field*.

The *timbering* or lining of a shaft is by means of *props*, *sills*, or *bars*, and *cleading*. The specific names depend upon position, and some of the terms apply to drifts and galleries.

The *props* are struts or posts, either vertical or raking, and are usually of round timber.

The *sills* or *bars* are horizontal timbers resting on the props.

The *cleading* are boards which form the casing, and for whose support the props and bars form a frame.

The square ends of the props abut upon the sills and bars, and are prevented from slipping by a peculiar form of spike, called a *brob*.

The depths of the shafts in Cornish mines are reckoned from the level of the *adit*.

Until lately the greatest depth yet attained was in the now abandoned Kuttenberg mine, in Bohemia. Some of the Newcastle mines are 1,800 feet deep.

The depth of a mine in a mountainous country, such as the Tyrol, Bohemia, or Mexico, being reckoned from the surface, gives no indication of actual depth in respect of sea-level.

The mine at Joachimsthal, in Bohemia, is 2,120 feet, but the surface of the ground at the mouth of the shaft is 2,388 feet, above sea-level.

The Valenciana mine in Mexico is 5,910 feet above the level of the sea, and its deepest workings are 4,274 feet above that level.

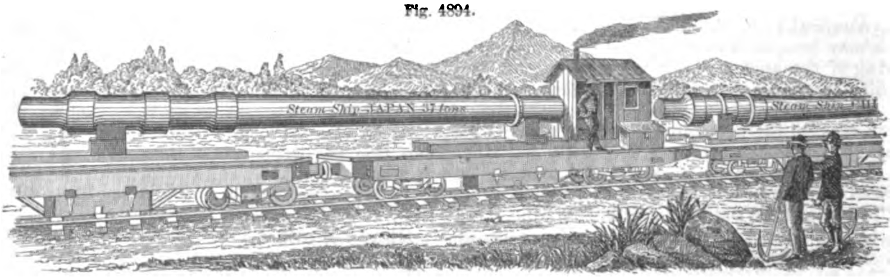
A boring at Minden is 2,231 feet deep, of which 1,993 feet are below the level of the sea.

These depths are much exceeded by some in the Comstock lode, Nevada.

2. (*Vehicle.*) One of the bars between a pair of which a horse is hitched to a vehicle. A *thill*.

The Egyptian chariots were always drawn by a pair of horses yoked to the end of a pole or tongue. The Lydians, it is said, attached several poles to their chariots, and placed a horse between each pair. This was using shafts. It is probable that

Fig. 4894.



Paddle-Shafts for Pacific Steamers (en route for San Francisco by Union Pacific Railway).

1,000 years before Alyattes shafts were used by the nomadic nations in moving camp. In its primitive form, we see it used by the North American Indians of the present day. A couple of poles are slung by girths and breast-straps, one on each side of a horse, and the load is placed on the trailing ends of the poles. Some time in the dim past an axle and a pair of low wheels was contrived, and this makes the modern dray. Perhaps a pair of gudgeons, driven into the end of a log, were made to support the shaft near their midlengths. The question of priority as between rollers and wheels must be decided in favor of the former on the ground of probabilities. The first we know of the civilized nations of antiquity, the dwellers upon the Nile and in the land of Mesopotamia, they had gorgeous chariots and other excellent appointments.

The Roman *cisium* was a kind of gig for rapid traveling, and was perhaps drawn by one horse between shafts. One old monument seems to represent it that way.

3. (*Machinery.*) *a.* That part of a machine to which motion is communicated by torsion, as the shaft of a fly-wheel, a paddle-shaft or screw-shaft of a steam-vessel, the crank-axle of a locomotive.

The shafts for the steamers "Japan" and "China," weighing respectively 78,520 and 68,400 pounds, were transported from Bridgewater, Mass., where they were manufactured, to San Francisco, by rail. Two trucks were required for each. Their arrangement is shown in Fig. 4894.

A *counter*-shaft is one between the main shafting and the machine.

b. A rod supported in hangers or bearings suspended from the ceiling or beneath the floor of a workshop, by which motion is communicated to various machines from the prime motor. See SHAFTING; HANGER.

4. *a.* The portion of a chimney above the roof. A *stack*.

b. The chimney of a furnace.

5. (*Architecture.*) The body of a column.

6. *a.* The handle of a weapon or tool. A *haft*.

b. The forward, straight part of a gun-stock.

7. The helve of a tilt-hammer.

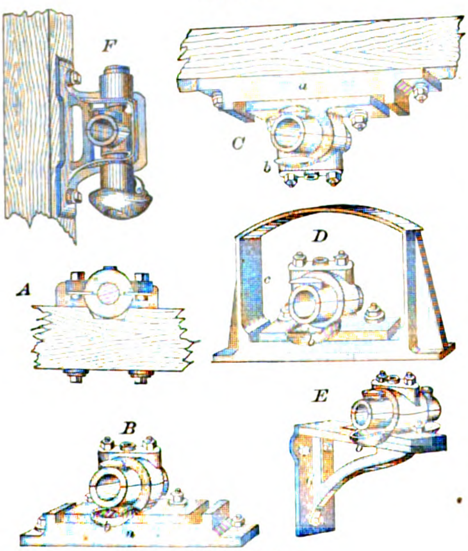
8. The interior space of a blast-furnace.

9. (*Weaving.*) A long lath at each end of the heddles of a loom.

10. An arrow.

Shaft-al′ley. (*Shipbuilding.*) A passageway between the after bulkhead of the engine-room and the *shaft-pipe*, around the propeller-shaft, and affording a means of access thereto.

Fig. 4895.



Pillow-Blocks.

Shaft-bear′ing. Fig. 4895, *A*, clamp-block.

B, pillow-block resting on cast-iron wall-plate *a* and provided with oil-dish *b*.

C, the same, inverted; used for carrying the head-shafts of long lines of shafting.

D, the same built into a wall and protected by an arched wall-box *c*.

E, pillow-block secured to a knee *d* attached to the face of a wall. *b*, Oil-dish.

F, post-hanger, fastened to an upright or pillar. See also STEP; SPINDLE.

Shaft-coup′ling. 1. A device for connecting together two or more lengths of a revolving shaft by shaping the ends into flat surfaces or bearings, which are held together by a strong iron bush or coupling-box.

A common but unyielding coupling (*a*, Fig. 4896) is formed by fitting and fastening the square ends of the sections of coupling into sockets in an iron block.

Another mode (*b*), which admits of some yielding when the shafting is not perfectly in line, consists of serrated disks on the adjacent ends of the sections of shafting. These have sufficient play to permit the joint to bend a little when the shafting is out of line.

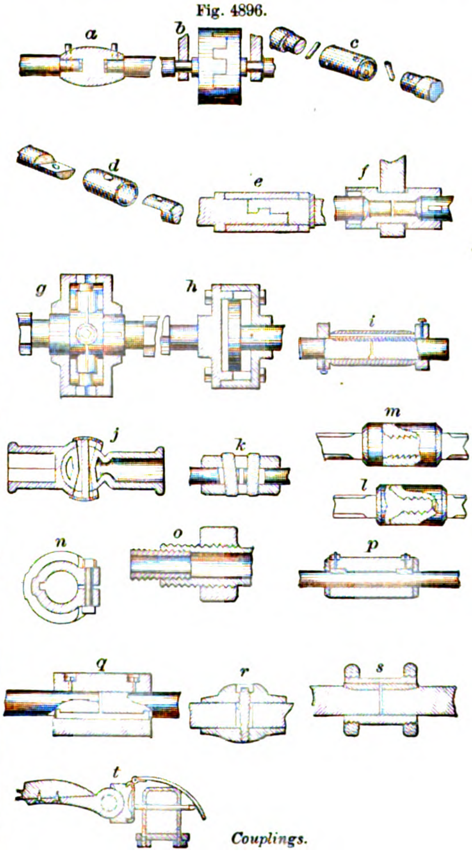
A form of coupling (*c*) consists of a cylindrical box with pins at right angle engaging the ends of the sections of shafting. By allowing a little play to the parts, this partakes in a degree of the principle of the *gimbal*.

The lap-joint coupling (*d*) is formed by reducing the ends of the shafting to a semi-cylindrical form, so as unitedly to form a cylinder, which is inclosed by a coupling-sleeve secured by a pin or key.

By scarfing the ends together (*e*), they are protected against longitudinal displacement, without depending on the strength of the pin.

Murray's coupling-box (*f*) rests in the hanger, and has sockets at the ends for the reception of the ends of the shafting and the

Fig. 4896.



Couplings.

keys, which are at right angles to each other. A slight play is allowed in the fitting of the parts.

In another form of coupling (*g*) a cross is interposed between the boxes, which are at the end of each section of the shaft. Each arm of the cross has a screw at its end; two of these receive motion from two projections on one box, while the other two bear against two similar projections on the other box, causing the two shaft-sections to turn together. This coupling performs to a limited extent the function of a universal joint, but requires a bearing at each end of every section.

One form of friction-coupling (*h*) consists of a pair of boxes, inclosing disks on the ends of the adjacent sections of shafting. Between the disks is a planchet of leather, which is compressed to such an extent, by screwing up the bolts, as to cause the motion of one shaft to be communicated to the other. If a violent strain occur beyond the coupling, greater than that for which the coupling is intended, one of the disks will slip on the leather.

Mattison's friction-coupling has caoutchouc on the abutting faces of the wheels on the respective sections of shafting. The frictional contact of the india-rubber, when the wheels are brought into contact, causes them to revolve together when motion is imparted to one of them.

i. Hawkins. T-headed keys occupy longitudinal slots in the abutting ends of the shafts, and are held in place by a sleeve.

j. Wheeler. A ball on one shaft enters a socket on the end of the other, and is held there by a key passing through a slot in the ball and retained in place by a cap, allowing a certain degree of rolling motion.

k. Fox. The ends of the shafts are made tapering, are inserted within the tubular coupling, and held by keys.

l. Lecky. The end of one shaft has a screw-threaded tenon of peculiar shape, which enters a correspondingly threaded cavity in the enlarged end of the other.

m. Lecky. Is similar in general to the foregoing, but the screw-threads are flat on the sides which have to resist a pulling force.

n. Briggs. This coupling has an opening on one side, permitting it to expand somewhat to readily receive the shafts, upon which it is compressed by bolts and nuts; a recess on the opposite side receives one half of a key, fitting counterpart slots in the ends of the two shafts to compel their simultaneous rotation.

o. Bolles. Is particularly designed for well or other tubular shafting. The ends of each tube are threaded both internally and externally; the former threading receives an internal thimble connecting the sections, and the latter an exterior nut which covers the joint.

p. Gray. Two or more pawls within a sleeve are, by means of binding-screws, pressed into nicks in the shafts so as to prevent their independent rotation.

q. Baum. A coupling-fin provided with studs enters slots in the two sections of the shaft, and is retained in place by a sleeve held to the sections by screws.

r. Ruggles. The coupling-box is in two parts, which are drawn together by a bolt having differential screw-threads adapted to corresponding internal threads in each half of the box between which the shaft is clamped.

s. Light. The ends of the shaft-sections are slotted to receive a key which is held by a split sleeve secured by a nut screwed on to each of its ends.

2. (*Vehicle.*) A device for securing the thills of a carriage to the axle-tree. One form is shown at *t*. A THILL-COUPLING (which see).

Shaft-coup'ling Jack. (*Vehicle.*) An implement for bringing the shaft-eye and axle-clip into

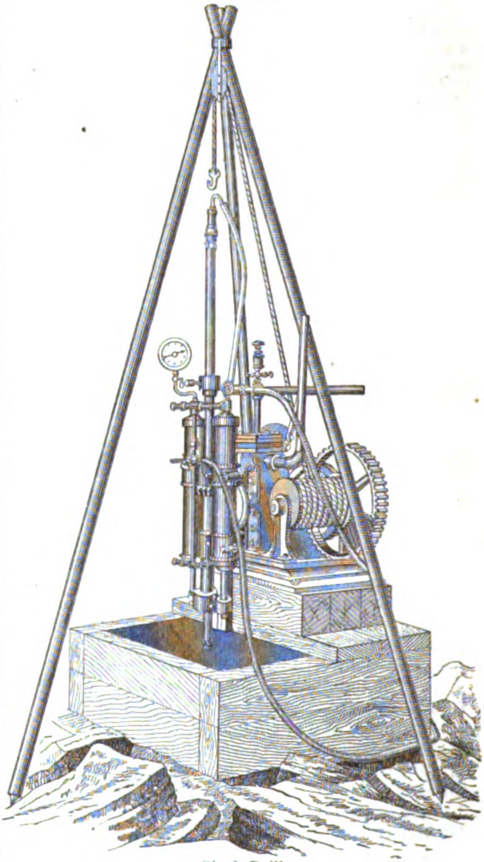
Fig. 4897.

Shaft-Coupling Jack.

apposition, so that the bolt will pass through the two portions. It is used where an anti-rattling block of caoutchouc is placed between shaft-eye and axle.

Shaft-drill. A rotary drilling-machine, armed with diamond-points, for boring vertical shafts. It is supported on a framing over the shaft, and the drill is rotated by bevel-gearing operated from two steam or compressed-air cylinders. The drill-holder may be lifted and lowered by a tackle suspended from shears when it is desired to substitute a shorter for a longer drill-rod. See page 697.

Fig. 4898.



Shaft-Drill.

Shaft-fur'nace. (*Metallurgy.*) One in which the ore, in a state of division, is dropped down a chimney through the flame. See ROASTING-FURNACE; SILVER-MILL. See also Fig. 3420, page 1571.

Shaft'ing. (*Machinery.*) The principal means in a machine-shop for the transmission of power. It serves to convey the force which is generated in the engine to the different working-machines, for which purpose it is provided with drums and belts, or else cog-wheels firmly keyed on.

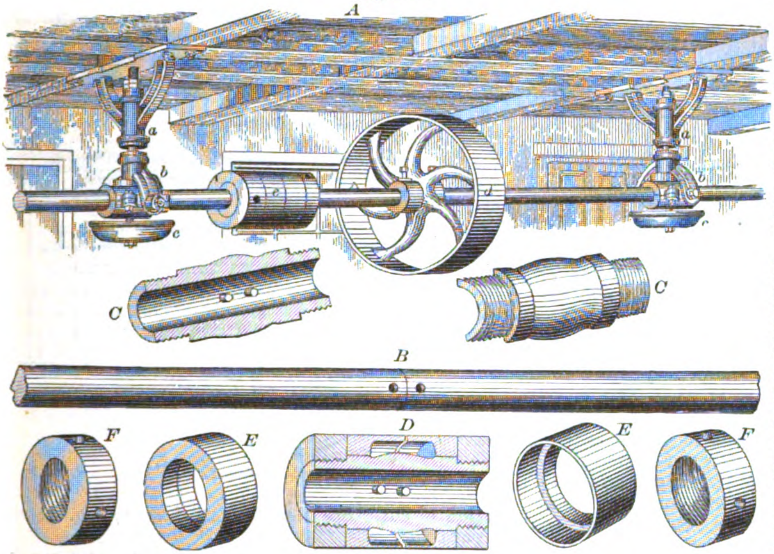
Horizontal shafts are known as *lying;* vertical, as *upright.*

Their *stiffness* resists *flexure* and *torsion;* their *strength* resists *fracture.* The *stress* is the power tending to break them.

A, Fig. 4899, represents a portion of a line of shafting attached to beams of a ceiling. The hangers *a* are secured to the beams by bolts, and are provided with swivel-boxes *b*, facilitating adjustment and keeping of the shafting in line. These are adjustable in hight by bolts and nuts. *c* are oil-drip cups, *d* a pulley, and *e* the coupling which unites two lengths of the shaft. These are shown in contact, but disconnected, at *B*. *C C* are inside and outside views of the coupling proper. *D*, one half of the coupling, with its appendages complete. *E E* are the *thimbles*, and *F F* the securing nuts. The cylindrical interior of the coupling is bored with a *shim* between the two sections, so as to allow something for compression or hug. These are placed over the butting ends of the shaft-sections, and secured thereto by pins, if desirable; the thimbles or cone-rings are slipped over them, and the nuts *F F* screwed on with a spanner, binding the whole together.

In Fig. 4900, *A* shows another pattern of shafting, with hangers and appurtenances. The journal-box *a* is held between two pintles or stems *b c*, the ends of which are concave, those of the

Fig. 4899.

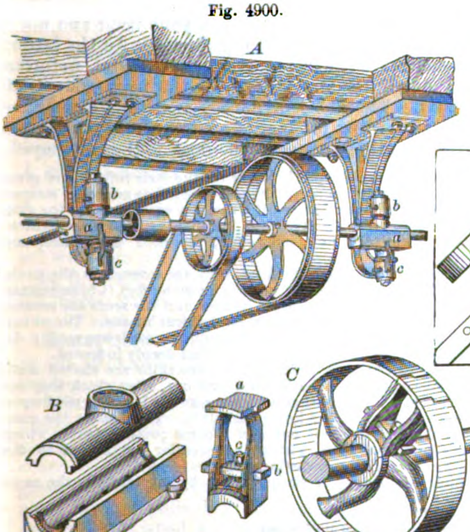


Shafting.

box bearing being convex, so as to form a species of ball and socket joint, and allow the box to adjust itself to the alignment of the shaft.

The box is self-lubricating; the oil, after being drawn up

Fig. 4900.

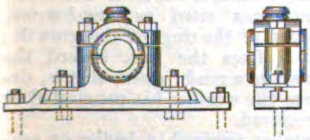


Shafting.

from a reservoir below by the rotation of the shaft, and performing its office, is again returned to the reservoir, the drip-cup being dispensed with.

Fig. 4901 is a cast-iron plummer-block; it is lined with gun-metal or Babbitt metal, and supported on a wall-plate having snugs between which the block fits, and is adjusted in line with the shaft by cotters driven between its ends and the snugs.

Fig. 4901.



Plummer-Block.

Fig. 4902 is a form of flexible shafting, avoiding the use of gearing. See also FLEXIBLE COUPLING, page 882.

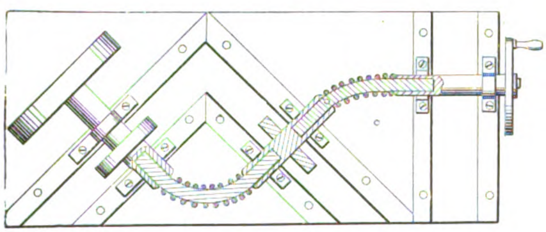
It sometimes becomes necessary to take down a section of shafting, drive out keys, and remove couplings, merely to slip on a pulley. To obviate this necessity, pulleys have been made in sections, to be keyed together on the shafting.

Preferable to this is an arrangement by which a small section of hub and rim are made removable.

In Wheeler's (*C*, Fig. 4900), one or more of the arms of the pulley are enlarged, or divided, admitting a piece shown at *a*, a casting separate from the pulley, and easily fitted to the latter by the file. This supplementary piece has a section of the hub embracing one half of the shaft. It engages with the rim of the pulley by a parallel cut, divided in the center at right angles. This form of division, however, is not material. The piece is held in place by a bar *b*, passing through the true arms of the pulley and the false arms of the segment, and held in place securely by a set-screw *c*. Instead of this arrangement the bar may be a single key without set-screw. There is no set-screw to mar the shaft, and no key in the hub of the pulley or key-way on the shaft to be cut. Most of the fitting required is at the rim, as the hub portion may be cast accurately enough and the key may be forged to fit.

Shaft'ing-box. An inclosed bearing for a shaft. In the example, the shaft has its bearing in a perforated box within an outer shell filled with oil.

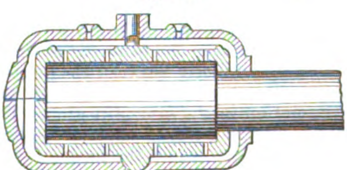
Fig. 4902.



Universal Shafting.

Shaft'ing-hang'er. A suspended bearing for a shaft. In the example, the body of the hanger is made hollow, and cores of different sizes are used in the space, so that one pattern may be used for several sizes of shafts. A self-oiling apparatus is com-

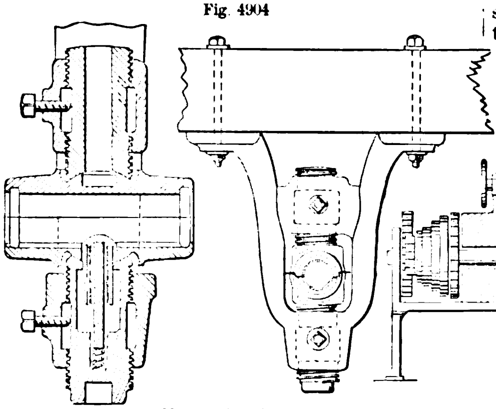
Fig. 4903.



Shafting-Box.

bined with a ball-and-socket hanger, so as to bring the reservoir of oil close to the lower side of the

Fig. 4904



Hanger for Shafting.

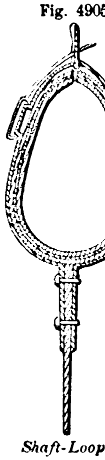
shaft and at the same time in the center of the bearing. See also HANGER, page 1059.

Shaft-jack. (*Vehicle.*) An iron attaching the shafts to the axle. See SHAFT-COUPLING JACK.

Shaft-loop. (*Harness.*) The ring of leather suspended from the gig-saddle to hold the thill or shaft.

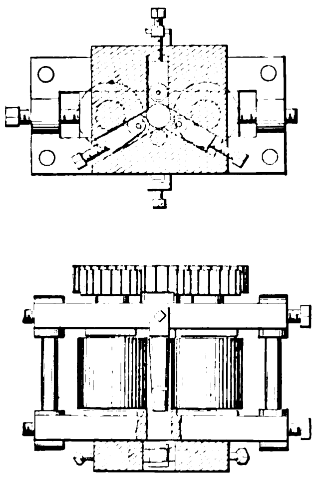
Shaft-pipe. (*Shipbuilding.*) The pipe or tube in the stern of a vessel through which the propeller-shaft passes in-board. In wooden vessels it occupies a hole bored through the *stern-post* and *dead-wood.* In iron vessels it passes through a hole in the stern-post and through frames with circular arcs, which form bearings.

Fig. 4905.



Shaft-Loop.

Fig. 4906.



Machine for straightening and rounding Shafting.

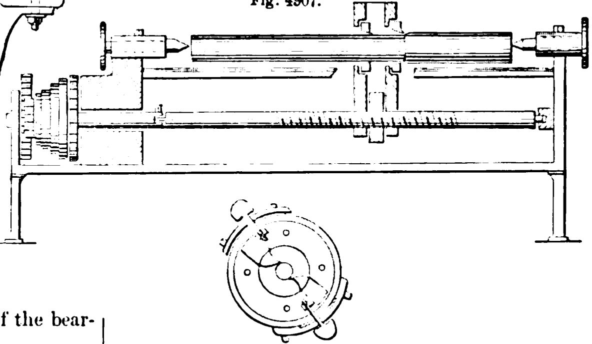
Shaft-straight'en-er. A machine for rolling rods for shafting to take the bend out of them. The shaft is fed longitudinally between the pressure-rollers *B B*, which are geared to a common wheel, so as to have rotation in the same direction. The feed-rollers are upon the ends of adjustable slides, and are placed obliquely to cause the feed.

A hydraulic press for this purpose is shown at *F*, Plate XXV.

Shaft-tug. (*Harness.*) The loop depending from the harness-saddle, and which holds up the shaft that passes through it.

Shaft-turn'er. A lathe for turning long rods for shafting. The shaft is held between two tail-centers and dressed off longitudinally by a series of annular cutters secured to a slide-rest. The shaft may be rotated, in which case the cutters in the annular holder will be modified to suit the direction of cut. See also DUPLEX LATHE, Fig. 1803, page 763.

Fig. 4907.



Shaft-Turning Lathe.

Shag. (*Fabric.*) *a.* A cloth with a coarse, rough nap.

b. Another name for *plush.* A shaggy pile-cloth of various materials.

c. The *pile* of velvet, fustian, plush, velveteen, etc.

Shag'ging. (*Knitting-machine.*) Giving a lateral motion.

Sha-green'. Shagreen is a parchment and not a leather, though it is usually classed with the latter. Its conception and production are Oriental, Astracan and Asiatic Russia being still the main sources of supply. The hides of horses, asses, and camels are concerned in its production, and it is said that only a strip from the crupper to the neck is thus employed.

The strips are steeped in water till the hair softens and gives readily, when it is removed by scraping; they are again steeped and worked by the flesher till all matter extraneous to the skin is separated, and the skin itself is reduced to the proper thickness. They are now moistened, mounted on frames, and stretched.

Being spread upon the floor, they are covered on the grain side with the seeds of the *alabuta* or goose-foot (Chenopodium album). A covering of felt is laid on, and the seeds are pressed into the skin by trampling or mechanical means. The skins, still bound in the frames, are dried till the seeds are readily detached. They are now dry, horny, and deeply indented.

Being placed on a padded horse, the skins are shaved until the indentations are shallow and uniform, after which they are steeped in hot water, then in a hot alkaline lye, and piled upon one another while in a hot, moist state. This causes the compressed parts to swell out and become protuberances, which form embossed balls, giving the peculiar appearance to the leather by which it is distinguished.

Shagreen is dyed of various colors by substantially the same means as morocco.

Red by cochineal.

Blue by the cold indigo vat.

Black by solution of tannin, followed by sulphate of iron.

Green by sal-ammonia and copper filings.

Imitation shagreen is made by passing the leather between rollers, in contact with a copper plate suitably indented.

Shake. 1. (*Coopering.*) A shook of staves and headings. See SHOOK.

2. *a.* A *wind-shake* is a crack in standing timber from exposure, strain of wind, or the like. The faults of timber are sometimes cited as ring-*hearted*, cracks in the direction of the rings of the growth; *wind-shaken*, cracked from the bark toward the pith, otherwise known as a rend; *doted*, that is, decayed in spots where the weather has penetrated or a wound has been received.

b. A crack in lumber received in drying or seasoning.

Shake-wil'ly. (*Cotton-manufacture.*) A *willy* or willowing-machine for cleaning cotton, preparatory to carding.

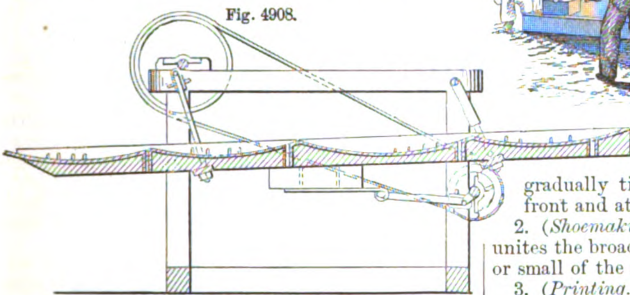
Shak'ing-frame. 1. A frame turned by a crank or otherwise, and having sieves arranged upon it; used in graining powder.

2. (*Metallurgy.*) A form of buddle or sieve used in sorting ores.

Shak'ing-ma-chine'. A shaking or rotating box in which articles are agitated, to grind or polish them by mutual attrition upon each other, with or without the aid of extraneous helps, such as sand, emery, or graphite. See TUMBLING-BOX.

Shak'ing-ta'ble. (*Metallurgy.*) A form of separator in which the slimes or comminuted ores are agitated in the presence of water. In the example, the rocking table has lateral concavities furnished with agitating pins and vertical discharge-openings. The table has longitudinal and vertical motion from cranks on two shafts having different speeds, and connected by a belt over pulleys on said shafts.

Fig. 4908.



Shaking-Table.

Shal'li. (*Fabric.*) A twilled cloth made from the hair of the Angora goat.

Shal-loon'. (*Fabric.*) From *Chalons*, in France. A kind of worsted stuff, formerly used.

"In *blue shalloon* shall Hannibal be glad."
SWIFT.

Shal'lop. (*Nautical.*) *a.* A light fishing-vessel with two masts and lug or fore-and-aft sails.

b. A *sloop*. A one-masted, undecked, fore-and-aft rigged vessel.

c. A boat for one or two rowers.

Sham'bles. (*Mining.*) Shelves, stages, or benches on to which the ore is thrown successively in raising.

Sham'my. Properly *chamois*. A kind of soft leather, originally prepared from the skin of the chamois goat; but that usually met with is made of common goat or sheep skins, prepared so as to give great pliability and softness. It is much used for cleaning and polishing carriages, silverware, glass, and fine varnished work. See CHAMOIS; TAWING.

Sha-moy'ing. (*Leather.*) A process in preparing skins. See CHAMOIS.

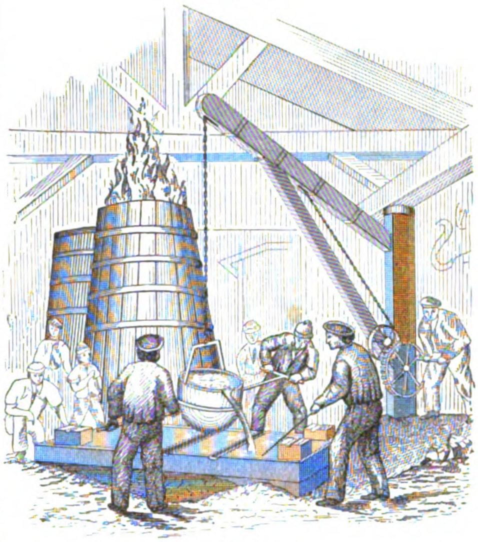
Sham-poo'ing Ap'pa-ra'tus. A barber's wash-basin and rose-syringe, for washing the hair and scalp.

Shank. 1. (*Founding.*) A large ladle to contain molten metals; it is managed by a straight bar at one end, and a cross-bar with handles, called the *crutch*, at the other end, by which it is tipped to pour out the metal.

They are made of various sizes, from those handled by two men to those containing several tons, and slung from a crane.

Nasmyth, of Manchester, England, has added to the pivot of the large crane-ladle a tangent-screw

Fig. 4909.



Shank.

and worm-wheel, by which it may be gradually tilted by a man standing directly in front and at any convenient distance.

2. (*Shoemaking.*) That part of the shoe which unites the broad sole and the heel; beneath the arch or small of the foot.

3. (*Printing.*) The body of a type.

4. (*Lock.*) The stem of a key, between the *bow* and the *bit*.

5. (*Nautical.*) The stem of an anchor, connecting the *arms* with the *stock*. See ANCHOR.

6. The straight portion of a hook.

7. The tang of a case-knife or chisel.

8. The part of a nail between the head and the taper of the point.

9. (*Tools.*) The part of a tool by which it is held or fastened, or to which the handle is attached.

10. The eye on (not through) a button.

11. (*Architecture.*) The space between two of the channels in the Doric triglyph.

Shank-cut'ter. (*Shoemaking.*) A machine or tool for cutting shanks for boots and shoes.

Shank-ir'on. (*Shoemaking.*) *a.* A former for the shank of a boot or shoe.

b. An iron plate placed between the leather portions of a boot-shank, to stiffen it.

Shank-last'er. (*Shoemaking.*) A tool for fitting the upper leather over the shank of the last. The edge of the leather is gripped by the jaw, by screwing down the handle, and a leverage obtained by the pivoted fulcrum on the surface of the last.

Fig. 4911 consists of two levers which are crossed and jointed together so as to form two jaws and two handles; the inner parts of the jaws are made of leather, the edges extending beyond the toothed or spurred ends of the same.

Shank-paint'er. (*Nautical.*) The chain or chain and rope which fastens the *shank* and *flukes* of an anchor to the side of a vessel, abaft the cathead, while the *ring* and *stock* are secured to the *cat-head* by the *cat-head stopper*.

Shanks. Flat pliers used by lens-makers, for *shanking* or *nibbling* the edges of pieces of glass, to reduce them to circular form before the grinding and polishing processes commence.

Fig. 4910.

Shank-Laster.

Fig. 4911.

Shank-Laster.

Shank-wheel. (*Shoemaking.*) A tool to ornament the shank of a boot or shoe.

Shape. 1. A matrix or mold.

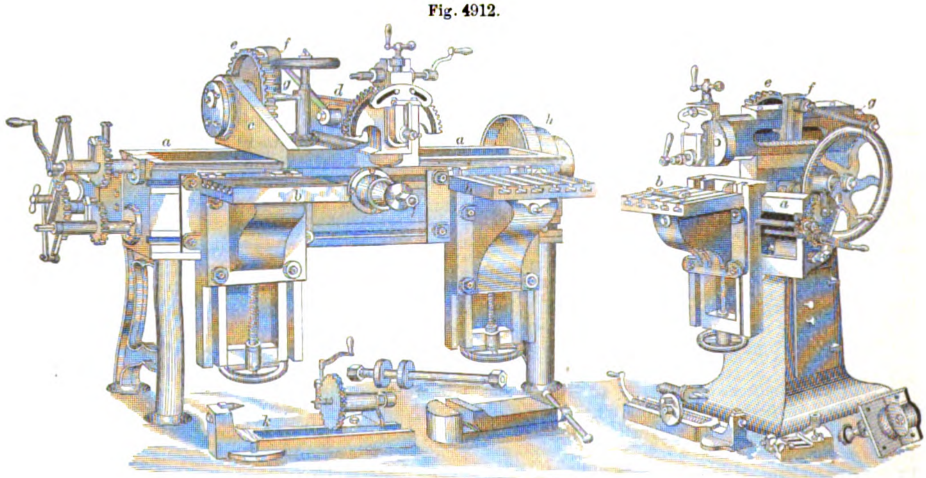
2. A piece of metal, roughed out as nearly as may be to the shape it will assume when finally forged and finished.

Shaped Fab'ric-loom. A loom for weaving corsets, skirts, etc.

Shap'er. 1. (*Metal-working.*) A form of planer in which the work is placed on a mandrel or dogged to a stationary bed, while the tool-stock is reciprocated. The machine has assumed many forms, and is one of the comparatively late additions to the machine tools of the shop.

Fig. 4912 shows two sizes of this machine-tool. The longer has 6 feet length of bed; length of stroke, 14½ inches; will plane a length of 5 feet, and weighs about 5,000 pounds. The smaller machine has a length of stroke of 9½ inches, and will plane a length of 16 inches. Each has quick-return motion and circular feed. The bed *a* is grooved on the front side, so as to afford hold for the tables *b b* for holding the work; the tables are adjustable vertically, horizontally, and independently. On the bed *a* is the tool-bed *c*, in which the tool-head *d* slides transversely of the bed by means of spur-wheel *e*, crank *f*, and pitman *g*, driven by gearing from the band-wheel *h*. The extent of this motion is variable, being determined by the distance of the crank-pin from the axis of the crank. *i* is an arbor upon which is shaped circular work. A hole is bored in the object, and it is then dogged on the arbor, which is slightly rotated between each reciprocation of the tool, thereby feeding the work to the cutter. The result is the planing of a surface curved in a plane at right angles to the motion of the tool. The machine is much used for shaping objects in which the circular form is not complete, and they cannot, therefore, be turned

Fig. 4912.



Shapers (Large and Small Sizes).

in a lathe. The motion of the tool is in a line parallel with the axis of the arbor.

k shows upon the floor a bed with a pair of heads having centers upon which small work may be mounted, and the whole placed upon one or both of the tables *b b*. The mandrel in the attachment *k* is at right angles to the motion of the tool. This enables other kinds of shapes to be reached.

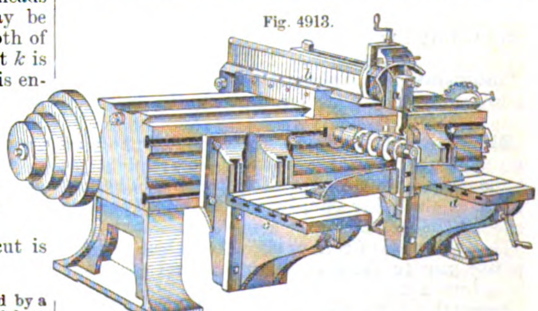
Adown the length of the bed *a* passes a feed-screw which moves the tool-bed *c* between strokes, when required. Depth of penetration of the tool and its angular presentation are obtained by rectilinear and circular adjustments of the tool-head.

The smaller machine on the right of the cut is similar in its mode of operation.

In the machine (Fig. 4913), the tool-holder *a* is carried by a sliding head *b*, to which reciprocating motion is imparted by a link arrangement. Plane work is placed on and adjusted by the tables *c d*; circular work is carried on the arbor *e*, the head *b* being kept stationary while the arbor is rotated.

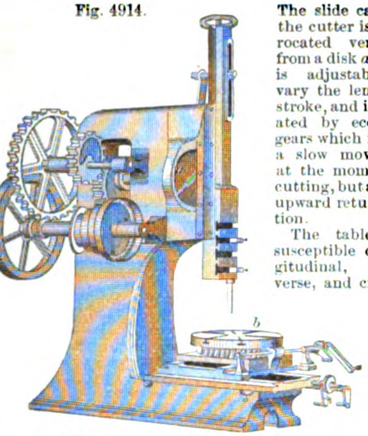
The machine (Fig. 4914) is used for paring, shaping, and slotting.

Fig. 4913.



Long-Bed Shaping-Machine.

Fig. 4914.



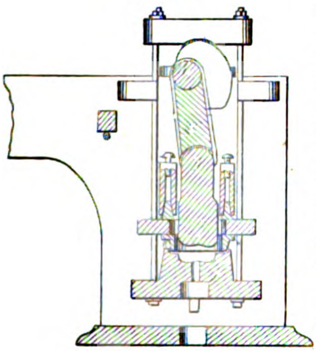
Shaping and Slotting Machine.

The slide carrying the cutter is reciprocated vertically from a disk *a* which is adjustable to vary the length of stroke, and is operated by eccentric gears which impart a slow movement at the moment of cutting, but a quick upward return motion.

The table *b* is susceptible of longitudinal, transverse, and circular horizontal motion to present the work, or to feed on any line of advance by combined movements of the rectilinear and tangent screws. See also ROUTING-MACHINE.

2. (*Sheet-metal Working.*) A striking or stamping machine for raising sheet-metal. In the example, the die and its bed-plate are raised against the clamp and plunger, the clamp being secured to a cross-plate which bears against adjustable springs. The die is secured to a cross-head, reciprocated by link attachment to a crank on the same shaft which carries the eccentrics giving the motion to the die. See STAMPING-MACHINE.

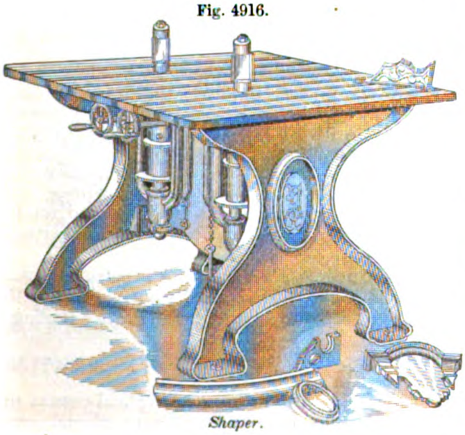
Fig. 4915.



Shaper for Sheet-Metal Ware.

3. (*Wood-working.*) A machine for cutting moldings and irregular forms. In that illustrated, the cutters are held by side and end pressure in cutter-heads at the top of vertical spindles. Various sized cutter-heads may be used. The spindle-bearings are connected, and are vertically adjustable by hand-wheels at the front of the machine. Safety-guards are provided over the cutters to prevent danger to the operator.

Fig. 4916.



Shaper.

Shap′ing. 1. (*Shipbuilding.*) As applied to the preparation of angle-plates for shipbuilding, *shaping* consists in *cutting* or *shearing* the angle-iron bars to the proper length (see SHEARS); *bending* them so as to give the proper figure to the molding edge (see BENDING; LEVELING-BLOCK; SWAGE); and *beveling* them (see BEVELING).

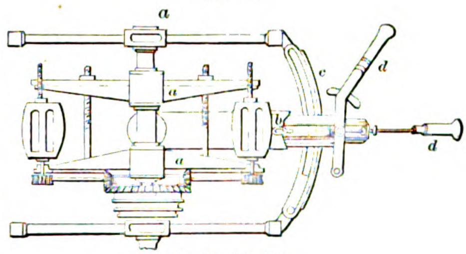
The shaping of plates consists in *cutting*, *planing* the edges, and *bending*.

Shap′ing-ma-chine′. 1. (*Metal-working.*) A machine-tool for working in metal. A planing-machine in which the object is dogged to a table with vertical and horizontal adjustment, or to a mandrel, and the tool above it has a reciprocating motion. See SHAPER.

2. (*Block-making.*) The shaping-machine *a*, Fig. 4917, turns the outside surface to form.

It consists of a large double wheel *a a* mounted on an axle, and having upon its rims 10 pairs of mandrels, by which 10 blocks are chucked. Of each pair, one mandrel forms a front center and chuck, by which the block is rotated, and the end of the other mandrel forms a back center on which the block turns. When the main wheel is rotated, the blocks revolve, each exposing the outside of one cheek to the action of the cutting-tool *b*, which traverses a segmental bar *c* by means of a slide-rest. The cutting-tool is moved by handles *d d* operated by the attendant.

Fig. 4917.

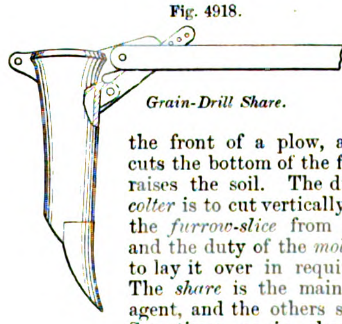


Shaping-Machine.

The outwardly exposed faces of the blocks having been dressed, the machine is stopped, and the whole series of blocks turned one quarter round by means of the central cog-wheel and the pinion connection to each of the mandrels. By resuming the rotation of the large wheel, the newly exposed face is dressed, and by a repetition of the process each of the four sides is brought to shape. *Shapes* are attached to the segmental guide, which control the form imparted to the faces of the blocks. One shape answers for the edges, and another for the cheeks. One handle keeps the tool to its work; the other has a roller, which runs against the shape and governs the curve.

Share. (*Husbandry.*) *a.* The sharp blade at the front of a plow, and which cuts the bottom of the furrow and raises the soil. The duty of the *colter* is to cut vertically to detach the *furrow-slice* from the *land*, and the duty of the *mold-board* is to lay it over in required order. The *share* is the main, effective agent, and the others subsidiary. Sometimes, as in shovel-plows,

Fig. 4918.



Grain-Drill Share.

the whole working portion is a share which cuts, lifts, and throws the furrow-slice.

Ransome, of Ipswich, England, patented the cast-iron share in 1785.

He patented the case-hardening of the upper edge in 1803, so that the share became self-sharpening.

b. The blade in a seeding-machine or drill, which opens the ground for the reception of the seed.

Sharp'en-er. See under the various heads: —

Knife-sharpener.	Scissors-sharpener.
Reaper-knife sharpener.	Steel.

Sharp'ie. (*Nautical.*) A long, sharp, flat-bottomed sail-boat.

Sharp-nail. A nail with a sharp forged point, used in some trades.

Sharps. The most pointed of the three grades of sewing-needles, — *blunts, betweens, sharps.*

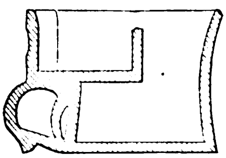
Shave. A drawing-knife. Sometimes a blade mounted in a stock, as a SPOKESHAVE, a DRAW-SHAVE (which see).

Shave-grass. A scouring-rush. A rough aquatic plant called the Dutch rush.

Shave-hook. A triangular plate of steel, with sharpened edges, used in scraping the surfaces of metal which are to be soldered. The object is to clean them from grease or soil, so that the solder may adhere. See SCRAPER.

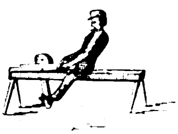
Shav'ing-cup. A cup with compartments for hot water and soap, for convenience in shaving.

Fig. 4919.



Shaving-Cup.

Fig. 4920.



Shaving-Horse.

Shav'ing-horse. (*Wood-working.*) A narrow bench or trestle on which the workman sits astride while shaving down work with the drawing-knife or spokeshave. It has a clamp, closed by pressure of the feet, for holding the work.

Shav'ing-mak'er. A machine for making wooden shavings for stuffing; also known as *excelsior.*

Shav'ings-con-duct'or. A device employed in wood-working establishments for removing the shavings, dust, etc., from the machines as fast as they are produced. It consists of a fan having tubes leading to each machine. The suction of the fan draws the refuse above referred to into a general delivery-tube, through which it may be forced to the furnace-room or deposited at any other suitable spot. See FAN-BLOWER, Fig. 1918.

Shav'ing-tub. (*Bookbinding.*) The box beneath the cutting-press to catch the shavings.

Shawl. An outer garment covering the upper part of the person; commonly used by ladies, but not unfrequently by men. In the latter case it represents the outer garment of the Scotch Highlanders, the plaid, which term in time has come to be applied to any kind of checkered goods similar in pattern to the tartan of which the Highlander's plaid was made.

Shawls are made of various materials, as wool, silk, crape, etc., plain or embroidered. The cheaper kinds are generally of wool, and are woven in the usual manner.

The English and French imitations of Cashmere or India shawls are sometimes made of pure Thibetian goats' wool, frequently of goats' wool and sheep's wool, and often wholly of the latter.

The manufacture of imitation Cashmere shawls was introduced into England about 1784 by a manufacturer of Norwich. He employed a warp of Piedmontese silk and a weft of worsted yarn, the design being afterward worked in by a process of hand darning. Norwich shawls were first produced entirely in the loom in 1805. Paisley then took up the manufacture and succeeded in producing successful imitation of Cashmere, using wool only, at very low prices.

In 1802 the manufacture was begun at Paris. The invention of Jacquard's loom, or at least its perfection by Jacquard, is said to have originated in this manufacture. The French imitations of India or Cashmere shawls still approach nearer the original than any others, and command a corresponding price. Those of Scotch manufacturers are, however, but little behind them, and are constantly improving. Great care is taken in the processes of scouring, dyeing, bleaching, and weaving. A Scotch shawl of the highest quality occupies a skillful weaver for a month or more, the weaving representing more than half the value of the shawl.

India or "camel's hair" shawls are made from the hair of a goat indigenous to the Himalayas and the highlands of Thibet, which has a fine curled wool beneath the coarse upper hair. In the spring, the goats are shorn, and the coarse hairs carefully picked out. The wool is washed in a solution of potash, and afterward in pure cold water, care being taken to avoid felting the fiber. It is spun by hand, a hard and wiry twisting of the fibers being avoided. For this purpose the spinners use for a spindle a ball of clay with an iron wire attached, and keep the finger and thumb smooth with soapstone powder. The wool is twice dyed, — before carding and after spinning.

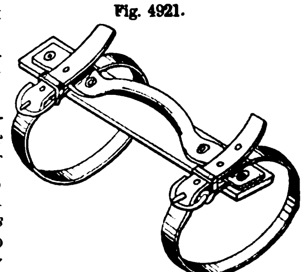
The pattern of an India shawl is worked in two very different ways. One method is to embroider it in a kind of needlework upon the material, and the other to work it into the web during the process of weaving. The latter method renders the shawl much more elegant and expensive. When this process is employed a number of skewers are used, sometimes of wood, but for the best work always of ivory, about the size of a common packing-needle. They are sharpened at both ends, and each skewer is covered with a different-colored thread. These are then worked according to a set pattern, stitch by stitch, into the web, as the weaving proceeds. As the process is very slow, no one person ever produces an entire shawl, the pattern being given out to the natives in patches or blocks, which are then by a similar method united in the common fabric. Of course but one surface of the product is presentable, the under side being a jumble of ends of threads without order or beauty.

The best are made in the vale of Cashmere, where the cost of a really fine shawl ranges from $250 to $500. Some of those which are worked for native princes are altogether too costly for export, being worth several thousand dollars.

Shawl-loom. A figure-weaving loom.

Shawl-strap. A traveler's pair of straps with handle to pack a shawl or blanket compactly.

Fig. 4921.



Shawl-Strap.

Shawm. (*Music.*) An ancient wind-instrument.

Sheaf. (*Husbandry.*) A bundle of wheat or other grain on the stalk, bound together. A number of *sheaves* standing together so as to be mutually supporting, forms a *shock* or *stook.*

Corn-fodder is sometimes bound in sheaves and mowed away, but more often the sheaves of two corn-shocks are stuck up together to form a fodder-shock.

Shear. A barbed fish-spear with several prongs.

Shear-grind'ing Ma-chine'. Fig. 4922 is a machine for grinding the blades of cotton and woolen shearing-machines. The spiral-knife cylinder *a* is mounted in bearings on the machine, and rotated against the grinding-roller *b*, renewing the sharpness of the knife-edges.

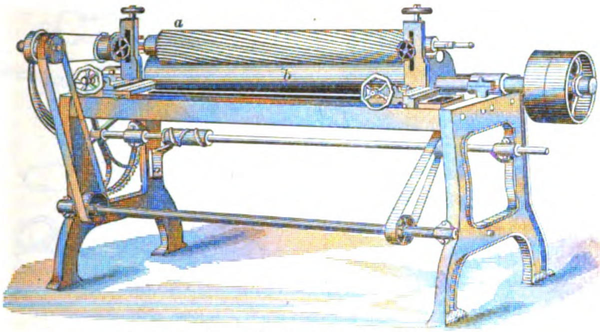
Shear-hook. (*Nautical.*) An instrument with prongs and hooks, placed at the extremities of the yards of fire-ships to entangle the enemy's rigging.

Shear-hulk. See SHEER-HULK.

Shear'ing. 1. The cutting of metallic plates and bars. See SHEARS.

2. (*Mining.*) The making of vertical cuts at the ends of a portion of an undercut seam of coal, serv-

Fig. 4922.



Shear-Grinding Machine (Curtis and Marble).

ing to destroy the continuity of the strata and facilitate the breaking down of the mass. The undercutting is called *holing.*

3. See SHEEP-SHEARS.

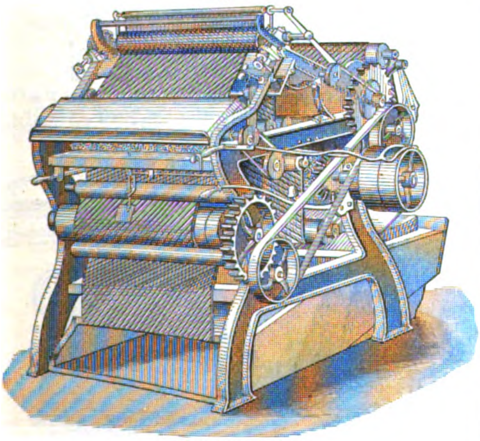
4. The cutting of the pile, nap, or fluff of cloth. See SHEARING-MACHINE.

Shear′ing-ma-chine′. 1. (*Woolen-manufacture.*) A machine through which cloth is passed after leaving the *gig-mill,* in order to shorten the nap and bring it to an even length so as to secure a smooth surface. This was formerly done by hand with a pair of shears. Machinery for the purpose was introduced, leading, of course, to riots, in England, at the beginning of this century. See CLOTH-SHEARING MACHINE, page 575.

One arrangement consists of a fixed semicircular rack, within or behind which is a cutting-edge, called a *ledger-blade,* and a large revolving wheel containing eight small cutting-disks, which, in contact with the ledger-blade, form a number of delicate cutting-shears; each cutting-disk is furnished with a toothed pinion working into the semicircular rack, so that as the large wheel revolves the disks acquire an independent rotary motion in addition to their motion with the large wheel. The machine may be made to travel over the cloth, or the cloth may be moved beneath the machine, which remains stationary.

In Curtis and Marble's machine (Fig. 4923), the cloth is wound from one roller on to another, passing over a fixed bar, which holds it up to the action of the

Fig. 4923.



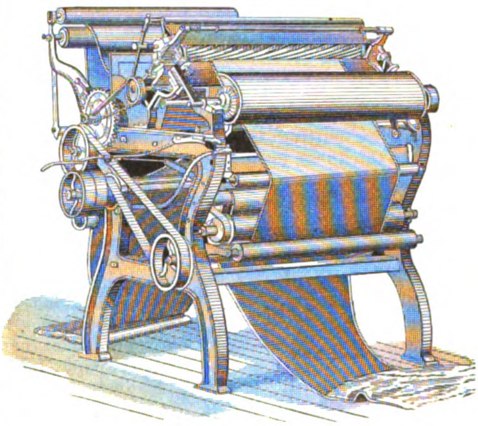
Shearing-Machine.

cutters; one of these is a continuous spiral cutting-edge upon the periphery of a roller, and the other a stationary blade; the nap is clipped between the two.

For removing the loose fibers from cotton cloth, it is passed over a hot plate or a row of gas-jets set closely together. See SINGEING-MACHINE.

Fig. 4924 is a view from another point of direction of a similar machine. It is intended for shearing brussels, axminster, tapestry, and ingrain carpets. The fabric is fed continuously through the machine, passing rollers which smooth it perfectly and pass it over a straight-edge. Here it is so sharply bent that the fibers are projected outward and caught between the spiral blades and a straight steel knife, between which the fluff is cut off or the pile reduced to a length, as the case may be.

Fig. 4924.



Shearing-Machine.

Fig. 4925 is a view of Curtis and Marble's mat-shearing machine. It has a revolving cylinder, with spiral knives cutting against a sharp straight knife known as a *ledger-blade.* It is constructed to cut five feet wide either in single mats or in strings.

The view shows a mat undergoing treatment.

Shearing-machines are made for shearing *crosscut, reversibly,* or *continuously.*

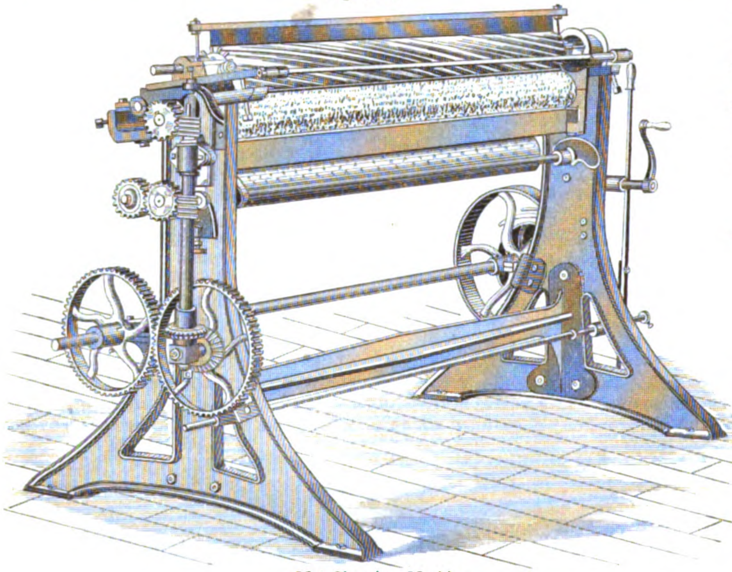
Shear′ing-ta′ble. (*Husbandry.*) A bench for holding sheep while being sheared. The table is tilted, the sheep backed upon it, and the table then restored to its horizontal position. The sheep is held by straps, and rests upon the curved block while under the operation of the shears. The spring-supporting rests sustain the leaves in the several positions they are made to assume in turning the sheep.

Shears. 1. A cutting instrument, operating like scissors, but on a larger scale and somewhat differently shaped. The edges of the blades are beveled, and the handles adapted for thumb and fingers respectively, instead of being duplicates. They are adapted for tailors' use.

Shears with two blades and a spring back were used in old Rome for clipping sheep, hair, and hedges.

Tinman's shears have relatively shorter jaws, and are either grasped in the hand or one leg placed in the vise while the other is worked by hand. They

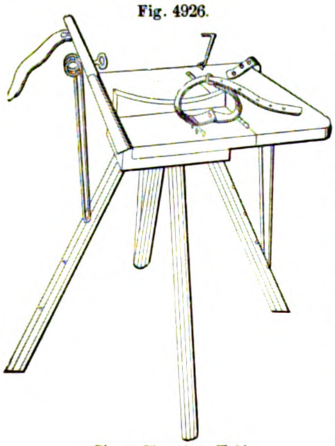
Fig. 4925.



Mat-Shearing Machine.

are used for cutting tin-plate and sheet-metal of moderate thickness, such as stove-pipe plate.

Fig. 4926.



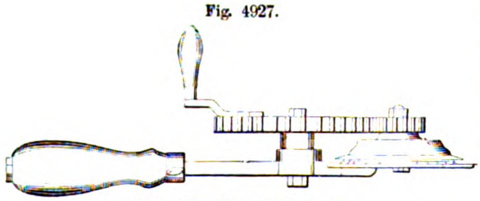
Sheep-Shearing Table.

Bench-shears have powerful blades with obtuse cutting-edges. The handles are made long in proportion to the blades, and the end of the lower one is bent downwardly at right angles, so that it may be inserted into a hole in the work-bench or table.

Hand-shears are used between the thumb and finger, in the same manner as cloth-shears, but have a stronger edge, being intended for cutting sheet-metal.

Fig. 4927 is a two-handed shears for clipping horses. One handle is for holding it to place, and

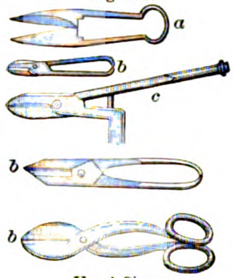
Fig. 4927.



Shears for Clipping Animals.

the other drives the circular cutter by means of a crank.

Fig. 4928.



Hand-Shears.

a, *sheep*-shears. See also SHEEP-SHEARS.

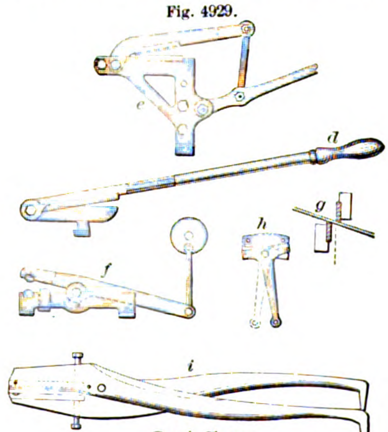
b, *hand*-shears or *snips*, used by sheet-metal workers.

c, *bench*-shears, used by tinmen and others. The blades are about one fifth of the total length, which is usually from 1½ to 4 feet; the square tang is to be inserted in a hole in the work-bench or a heavy wooden block. The handle is sometimes forged thicker at the end, to increase the cutting effect by its momentum when thrown down by a sudden jerk.

d, another form, in which the joint is at the extreme end, and the cutting-edge between it and the handle.

e, *purchase*-shears. These are worked by a lever united by a connecting-rod to the movable blade, and considerably increas-

Fig. 4929.



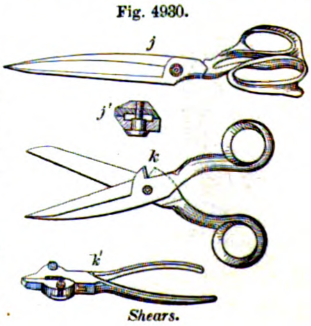
Bench-Shears.

ing the power; a spring is usually provided to press the two edges together, and a stop to determine the length or width of the pieces cut off. Were the edges of the blades not in contact, as seen at *g*, the effect would be to fold rather than cut the metal, and strain the shears.

f, *shears and squeezer*. The lower piece is firmly fixed; the cutting-edges are near the joint; and dies may be placed in the far end for swaging hot pieces of metal. The long arm of the cutting-lever is operated by a connecting-rod and eccentric driven by the engine.

h, *double* shears, used at the British Mint. The lower

Fig. 4930.



Shears.

piece has a cutter at each end, and acts by a rocking motion against the fixed upper piece.

i, bench-shears with a pivoted cutter, adjusted in each blade by means of a screw.

j. The blades are recessed at the pivot-hole *j'*, so that the metal, in cutting, is not compressed so much at that point, in order that it may remain soft after hammering, allowing the rivet-holes to be readily punched.

k. Two short, strong blades are formed on the sides of the large ones for cutting wire, whalebone, etc.

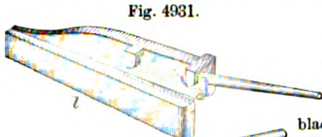
k'. Cutting-nippers having cutters which are held by screws, so as to be removable and replaceable, are also used for this purpose.

Shears are also made having a thin cutting-blade closing in between two opposite blades, which serve as guides for the cutting-blade.

Another description is provided with a series of removable cutters of different sizes, having triangular cutting-faces; these are secured in one jaw and cut into a suitable slot in the opposite jaw.

l. A stationary blade is fitted in the rabbeted face of the lower section, and a movable blade operated by a lever is hinged to the rabbeted face of the upper section; the faces of the sections give support to the blades.

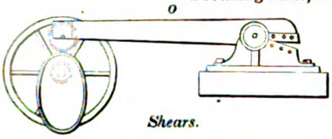
Fig. 4931.



m. For brush-makers. The wedge-shaped throat in the lower stationary blade holds the bristles while they are severed by the downward movement of the upper blade.

n. For cutting the bloom or mill bar as it comes from the roughing-rollers. The cutting-edges of hard steel are bolted to the lower stationary frame and to the upper movable jaw, which is operated by a connecting-rod from the fly-wheel shaft of the engine.

The bar-shears have usually one stationary and one oscillating jaw, and are used to cut bars of iron into pieces to be built into fagots for reheating and rerolling to form beams, nail-plates, or some peculiar grades of iron which owe their quality to repeated working. The moving jaw is operated by a cam on a rotating shaft, and makes its strokes in uniform time. See BAR-SHEAR, page 241.



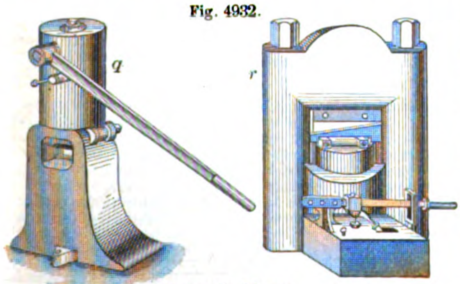
Shears.

o. Metal-shears. The cutters are attached and arranged as in the preceding case. The long lever of the upper jaw is operated by an eccentric on the fly-wheel shaft pressing against a roller pivoted in the end of the lever.

The machine for cutting to a length angle-iron for ships' frames consists of a fixed cutter in the form of a right-angled triangular notch, in which the angle-iron to be cut is laid with the angle downward; the movable cutter is a solid right-angled triangle, with the right angle pointing downward; it is fixed in the lower end of a block which slides between vertical guides, and has a reciprocating motion given to it by an eccentric on a rotating shaft, making twenty revolutions per minute or thereabout.

The effort required to shear a piece of iron is about 50,000 pounds per square inch of the area of the shorn surface. The work performed is about equal to that effort multiplied by half the thickness of the piece in the direction of shearing. For an equal area of steel, the effort is probably about double.

Fig. 4932.



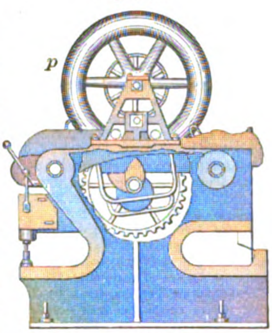
Hydraulic Shears.

The *shears* for cutting plates for the outside skin of a ship consist of a pair of straight cast-steel cutters: the lower one is fixed and horizontal; the upper or movable cutter has a slight slope to give it an oblique cut.

q r are forms of hydraulic shears. The movable cutter is attached to the ram of a hydraulic press, making in the former a downward and in the latter an upward stroke.

Fig. 4933, a combined shears and punch. The punch is connected with a lever making its effective stroke at one side of the machine, — the left in the illustration, — and operated by a yoke and a heart-cam: the movable shear-blade is attached to a lever making its stroke at the other side, and operated by a yoke and eccentric. The motions of both are derived from gear-connection with the fly-wheel *p*.

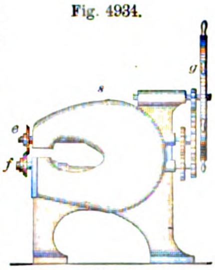
Fig. 4933.



Shears and Punch.

In Fig. 4934, the circular cutters *e f* are rotated in opposite directions by gears operated from the hand-wheel *g*. A number of these cutters may be arranged on each shaft, so as to cut a sheet of metal into a series of strips.

Fig. 4934.



Circular-Cutter Shears.

2. The *ways* or *track* of a lathe upon which the lathe-head, puppet-head, and rest are placed, and on which the latter is adjusted in the common lathe or slides in the traversing lathe.

3. For the hoisting device, see SHEERS.

See under the following heads: —

Bar-shears.	Hydraulic shears.
Bench-shears.	Lopping-shears.
Button-hole shears.	Pruning-shears.
Cattle-marking shears.	Punch and shears.
Clipping-shears.	Scissors.
Cutting-nippers.	Shear-grinding machine.
Edging-shears.	Shearing machine.
Garden-shears.	Shearing-table.
Grass-edging shears.	Sheep-shears.
Hair-clipping shears.	Sheet-metal shears.
Hand-shears.	Tailor's shears.
Hedging-shears.	Tinman's shears.

Shear-steel. Blister-steel, heated, rolled, and tilted to improve the quality.

Several bars are welded together and drawn out.

Shear-steel is named from its applicability to the manufacture of cutting instruments, shears, knives, scythes, etc.

The bar is sometimes cut, fagoted, reheated, and again tilted. This may be repeated. The terms *single shear* and *double shear* indicate the extent to which the process is carried.

Sheath. 1. A scabbard for a sword.

2. A case for a knife.

Sheath'ing. (*Shipbuilding.*) A covering, usually thin plates of copper or an alloy containing copper, to protect a wooden ship's bottom from worms. Lead was used for the purpose nearly as long ago as the Christian era.

The gradual oxidation of the copper has been prevented by the application of pieces of zinc or iron upon different parts of the surface. This renders the

copper electro-negative and preserves it, but at the expense of its cleanliness, as marine weeds and barnacles are more apt to adhere to it.

The order for the sheathing of the vessels of the English navy with copper-plate was given in 1783.

Sheathing-copper is laid on with a lap-joint, the lower and after edges of the sheet lapping upon the sheets below and abaft it. The grades are known by the number of ounces to the superficial foot, as 16-ounce, 18-ounce, 28-ounce, 32-ounce. The heaviest is put forward from the bows to the keel, and on the load-line and four strakes below it.

The sizes of these metallic sheets are as follows : —

Weight in ounces per square foot.....	18	28	32
Thickness in inches..................	0.025	0.038	0.044
Length in inches.....................	48	48	48
Breadth in inches....................	20	14	14

The thicker sheathing is used on the bows.

The sheets are put on in strakes, running fore and aft. The after end of each sheet overlaps the forward end of the next, and the lower edge of one strake overlaps the upper edge of the one below it.

Iron ships may be sheathed with copper or alloy by attaching to the iron skin a complete wooden surface to hold the sheathing-nails. This is, however, very expensive. See "Watts, Rankine, etc., Shipbuilding."

It has also been proposed to employ zinc, amalgamating its surface with mercury, so as to preserve it from the action of the sea-water; a galvanic current is thus established which prevents corrosion of the iron.

The ship of Trajan, sunk in the Lake of Nemi and recovered after many centuries had elapsed, was found by Alberti (sixteenth century) "to consist of pine and cypress in excellent preservation, which, besides a coating of black pitch, had a double covering of canvas glued on, and over it a sheathing of lead fastened with brass nails."

In 1613, a junk of 800 or 1,000 tons was seen by European navigators in Japan, entirely sheathed with iron. European vessels were first sheathed with copper in the seventeenth century.

In "Sir Richard Hawkins's Voyage to the South Sea," 1593, various kinds of sheathing to prevent the ravages of the teredo are mentioned. In Spain, very thin sheets of lead were used, but were not durable; canvas had been tried, but unsuccessfully. He recommends charring the outside of the planks and coating them with pitch or tar. In China a kind of varnish was employed. He also speaks of a compound of pitch and glass. His father had invented the best method then used in England; it consisted of two thicknesses of extra planking, between which was tar and hair in two layers. This was cheap and effective. The adhesion of barnacles and sea-weeds was a minor consideration.

Sheath'ing-met'al. The following are some of the alloys employed : —

Muntz's, copper, 60; zinc, 1.
Mushet's, copper, 100; zinc, ½.
Revere's, copper, 95; zinc, 5.
Wetherstedt's, copper, 90 to 97; antimony, 3 to 10.
Collins's (red), copper, 8; zinc, 1.
Collins's (yellow), copper, 10; zinc, 8.
Collins's (white), copper, 1; zinc, 16; tin, 16.
Pope's, lead, 1; zinc, 3; tin, 2.
Cast and roll into sheets at about 200°. See ALLOY.

Another alloy of Mushet's is composed of copper, 100 pounds; zinc, 0.5 ounce; tin, 0.5 ounce; antimony, 1 ounce; arsenic, 2. Or, the 100 pounds of copper may be alloyed with either one of the following: zinc, 2 ounces; antimony, 4 ounces; arsenic, 8 ounces; tin, 2 ounces.

Sheath'ing-nail. 1. (*Nautical.*) A cast nail of an alloy of copper and tin, used for nailing on the metallic sheathing of vessels. They are flat and polished on the head, countersunk beneath the head.

Weight of Composition Sheathing-Nails.

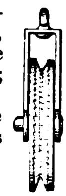
No.	L'gth.	No. in a Pound.	No.	L'gth.	No. in a Pound	No.	L'gth	No. in a Pound
	Ins.			Ins.			Ins.	
1	¾	290	6	1	190	10	1⅝	101
2	⅞	260	7	1⅛	184	11	1¾	74
3	1	212	8	1¼	168	12	2	64
4	1⅛	201	9	1½	110	13	2¼	59
5	1¼	199						

2. (*Carpentry.*) A nail, in size 6*d.* to 8*d.*, used to nail on sheathing for shingling or slating.

Sheath'ing-pa'per. A large and coarse paper made for an inner lining of the metallic sheathing of vessels.

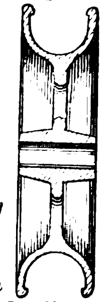
Sheave. 1. (*Hoisting.*) The grooved wheel in the *shell* of a block or pulley over which the rope runs. It is generally, in wooden blocks, of lignum-vitæ, and has a brass *bushing*, called a *coak*, which runs on the *pin*. See BLOCK; PULLEY; TACKLE, etc. A *Shiver*.

Fig. 4935.



Serrated Sheave.

Fig 4936.



Iron Sheave.

The pulley was known to the Greeks and Romans. Vitruvius describes the sheaves (*orbiculi*) in the blocks (*trochlea* or *rechamus*).

To increase the adhesion of the rope on the sheave, the latter may be serrated. This opposes the slipping of the rope. Fig. 4935.

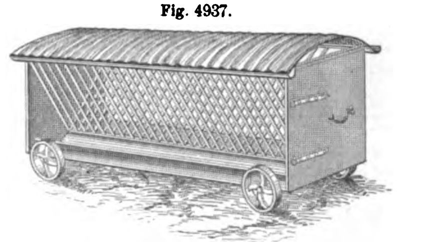
2. (*Locksmithing.*) A sliding *scutcheon* for covering a keyhole. See SCUTCHEON.

Shed. 1. (*Loom.*) The space between the upper and lower warps, forming a raceway for the shuttle.

2. (*Building.*) A lean-to frame building of one story.

Shed-roof. (*Building.*) A *lean-to*. Having but one inclined side.

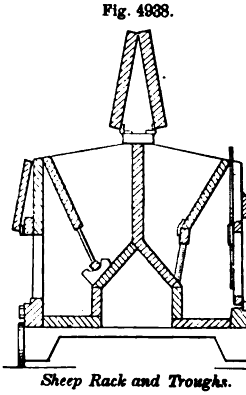
Fig. 4937.



Sheep-Rack.

Sheep-dip'ping Ap'pa-ra'tus. An English apparatus for dipping sheep, to enable their fleeces the better to protect them against the damp and changeable weather.

Fig. 4938.



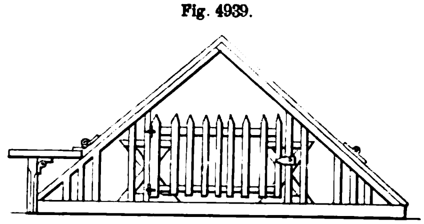
Sheep Rack and Troughs.

Sheep-hold'er. (*Husbandry.*) A cradle or table to hold a sheep while being shorn. Figs. 4942-4.

Sheep-hook. (*Husbandry.*) A shepherd's crook.

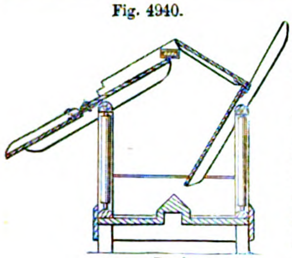
Sheep-rack. The portable wrought-iron sheep-rack (Fig. 4937) is mounted on four wheels, and has a wrought-iron hay-rack in the middle, a trough at each side, doors at the ends, and a corrugated iron roof with eave-gutters.

Fig. 4939.



Sheep Rack and Shed.

Fig. 4940.



Sheep-Rack.

Fig. 4938 is a double rack with lids, feed-troughs, and shutters.

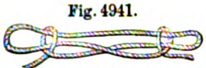
In Fig. 4939, the two feed-racks are placed in a shed whose hinged sectional roof is supported on angular end-framing and is convertible into an open shed.

In Fig. 4940, the doors are hinged and cleated to make a transferable open or covered rack for feed.

Sheep's-foot Trim'mer. A pair of shears or cutting-pinchers to trim the excessive growth of the hoof.

Sheep-shank. A peculiar mode of taking up the slack of a rope and shortening it temporarily. The rope is doubled in three parts, a hitch is taken over each bight with the standing part and jammed taut. See 42, Fig. 2777, page 1240.

Fig. 4941.

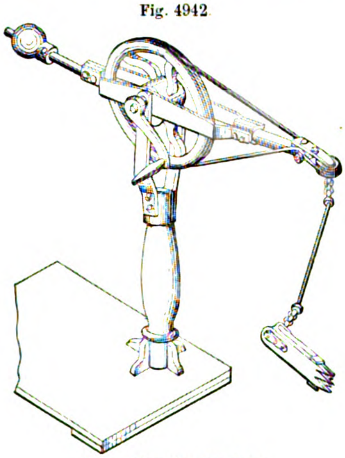


Sheep-Shank.

Sheep-shear'ing Ma-chine'. (*Husbandry.*) A machine for giving motion to the shears wherewith sheep are shorn. The shears are usually angular cutters reciprocated over guards, which act as the other halves of the shears, much as in the manner of mowing-machine cutters, but on a very small scale.

In Fig. 4942, which may stand as an example of a score of different machines of this class, the shears are at the end of a flexible shaft, which is rotated by band connection from the fly-wheel on the crank-shaft. The vibrating shears have a shield to prevent the wool being cut more than once, and are attached by a flexible connection and tumbling-rod to a counterbalance

Fig. 4942.



Sheep-Shearing Machine.

arm, which is pivoted upon a standard, in which is placed the driving-wheel which gives motion to the knife.

In another machine, a vibrating motion is communicated to the cutter while being moved in any direction or passed over the body of the sheep, so that two different persons may work with one machine at the same time and operate upon two different animals, while either cutter may be stopped independently of the other by simply releasing the lever which holds up its driving-shaft. The machine may be driven by horse, dog, steam, or water power.

See the following list of United States patents, which includes horse-clipping machines: —

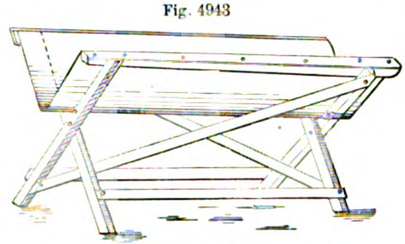
No.	Name.	Date.	No.	Name.	Date.
12,760.	Lancaster	1855	82,673.	Alwood	1868
14,354.	Fisher	1856	84,905	Reid	1868
14,840.	Wilder	1856	84,926.	Wilson *et al*	1868
15,948.	Jenkins	1856	88,317.	McCarty *et al.*	1869
16,461.	Bradley	1857	88,340.	Smith *et al.*	1869
16,720.	Chambers	1857	90,877.	Salom *et al*	1869
*18,151.	Jenkins	1857	94,803	Walker *et al*	1869
23,187.	Morgan	1859	96,742.	Tidmarsh	1869
32,184.	Cutler	1861	104,222.	Smith *et al*	1870
42,572.	Fullum	1864	107,128.	Twigg	1870
44,171.	Evans	1864	108,489.	Knight	1870
44,618.	Eccles	1864	114,477.	Richardson *et al.*	1871
*45,703.	Davis	1865	116,216.	Pratt	1871
45,821.	Emery	1865	116,885.	Tally *et al.*	1871
46,226.	Emery	1865	117,774.	Harlow	1871
*52,293	Kennedy	1866	118,417.	Wyatt	1871
53,777.	Davis	1866	119,019.	Evans	1871
*59,089.	Smith	1866	122,852.	Priest *et al.*	1872
59,103.	Washburn *et al.*	1866	123,508.	Pratt	1872
65,077.	Harlow *et al.*	1867	125,809.	Grout	1872
65,130.	Spelman	1867	125,911.	Smith *et al.*	1872
66,966.	Jenkins	1867	135,293.	Smith	1873
69,541.	Clark *et al*	1867	136,903.	Harrison	1873
70,861.	Kingsley	1867	137,220.	Lengelee	1873
*72,103.	Smith *et al*	1867	144,136.	Priest	1873
72,214.	Maynard *et al.*	1867	153,846.	Reynolds *et al.*	1874
77,093.	Renshaw	1868	154,603.	Hamilton *et al.*	1874
79,179.	Alwood	1868	156,409.	Clark	1874
*79,293.	Adie	1868	157,156.	Chaquette	1874
81,210.	Reid	1868	157,157.	Chaquette	1874
82,404.	Harsin *et al*	1868			

* Reissued.

Sheep-shear'ing Ta'ble. A holder or bench to hold a sheep while being sheared.

Fig. 4943 has a canvas bed supported on a double X-frame, and of sufficient capacity to hold the sheep.

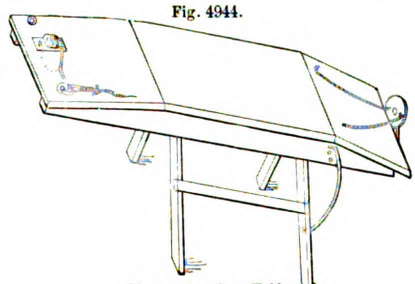
Fig. 4943



Sheep-Shearing Table.

In using Fig. 4944, the sheep being laid on the table, the cords attached to the rotating wheel fasten the hind legs. The curved spring hook holds its

Fig. 4944.



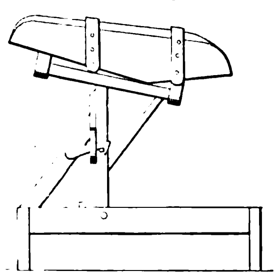
Sheep-Shearing Table.

neck, and the cord and snap secure the front legs to the eye-bolts on the table.

In Fig. 4945, the sheep is strapped in a trough, which is so pivoted as to give any presentation to the shearer, and to dump the animal when the operation is concluded.

Sheep-shears. The blades are united by a steel bow which makes them self-opening, the cutting being done by the grasp of the hand.

Fig. 4945.



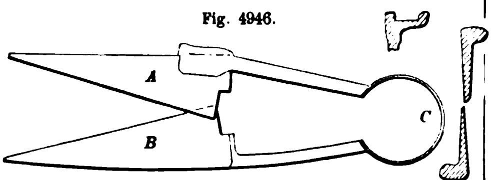
Sheep-Holder.

C, Fig. 4946, shows the bow, *A B* the blades; the example differs from the common sheep-shears in having a flanged projection at the heel of each blade, enabling the operator to take a firmer hold.

In Fig. 4947, the central blade affords cutting-edges to each of the side blades.

In Fig. 4948, the central blade is pivoted to one of the main blades, and its slotted shank is pivoted to an oscillating lever, which has its fulcrum on a

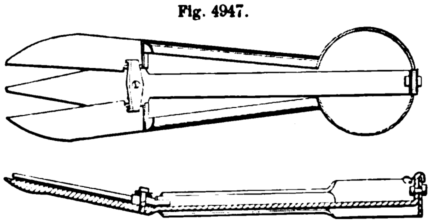
Fig. 4946.



Sheep-Shears.

stud from the side bar, and has a slotted connection to a pivot on the other main blade.

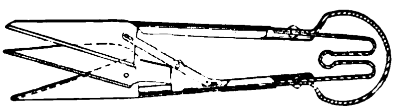
Fig. 4947.



Sheep-Shears.

In Fig. 4949, the teeth of the cutters are double-edged. The cutter-plates are connected by a screw

Fig. 4948.

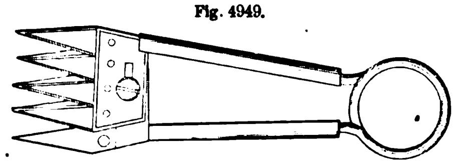


Three-Bladed Shears.

which is secured to one plate and traverses a slot in the other plate. The spring has one or more coils.

Fig. 4950 is a sheep-shears with a six-fingered comb and a revolving bladed disk. It is designed

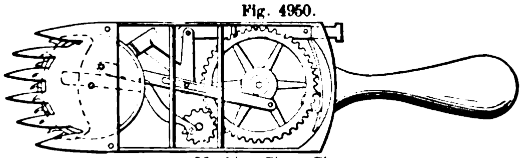
Fig. 4949.



Multiple-Bladed Shears.

to be used in a machine such as Fig. 4942. The shearing-comb is suspended from a crane by means

Fig. 4950.

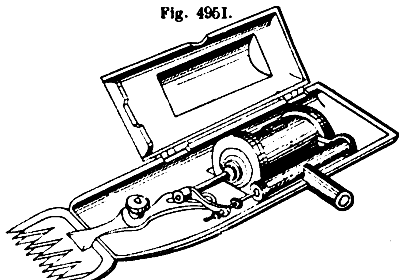


Machine Sheep-Shears.

of a flexible shaft, rotated by a hand wheel and belt, and descending in line with the axis of the main-wheel of the shearing-comb, to which it imparts motion and from which the cutters of the comb are actuated.

Fig. 4951 is a portable sheep-shearing instrument operated by air under pressure, the engine to operate the cutters being inclosed within the handle, and

Fig. 4951.



Sheep-Shearing Machine.

the compressed air being conducted thereto by a flexible pipe. The reciprocating cutter is oscillated by a lever.

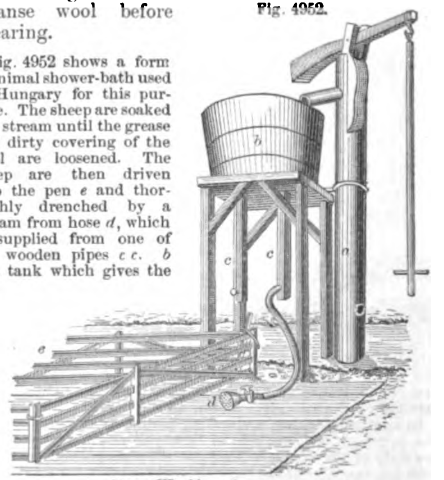
Sheep'skin. The tanned skin of a sheep, in demand for many of the commoner uses of leather, — shoe-binding, bookbinding, and wash-leather. In the latter case it is a substitute for chamois, and, indeed, is often tanned to represent goat and buck skins.

Sheep-split. The divided skin of a sheep. One half is a thin *skin* and the other a *split*.

Sheep-wash'ing Ap'pa-ra'tus. A mechanical arrangement to cleanse wool before shearing.

Fig. 4952 shows a form of animal shower-bath used in Hungary for this purpose. The sheep are soaked in a stream until the grease and dirty covering of the wool are loosened. The sheep are then driven into the pen *e* and thoroughly drenched by a stream from hose *d*, which is supplied from one of the wooden pipes *c c*. *b* is a tank which gives the necessary *head* to the flow of water. This tank is kept filled by pump *a*.

Fig. 4952.



Sheep-Washing Apparatus.

Sheer. 1. (*Shipbuilding.*) The upward curvature

of the lines of a vessel toward the bow and stern. Different views are entertained by different naval constructors as to the proper amount to be given. Sharp vessels generally have more than full-built ones; small vessels more than large ones; and merchantmen more than men-of-war.

When the deck is perfectly flush from stem to stern, a vessel is said to have a straight sheer.

2. (*Nautical.*) The position of a ship riding at single anchor with the anchor ahead. When riding at short scope of cable, when she swings at right angles to the cable, exposing a larger surface to the wind or current, and causing the anchor to drag, she is said to *break her sheer.*

The only natural boat occurring to the writer, made specifically for the purpose, is that built of eggs by the gnat. It consists of, say, from 250 to 350 eggs; is sharp, high fore and aft, convex below, concave above, and floats uniformly keel down. It has a natural sheer, and though it pitches and rolls in its mimic ocean, is trim and lively and never founders. To say that it is never wrecked would be too much.

"The best-laid schemes o' [gnats] and men
Gang aft a-gley."

Sheer-bat'ten. 1. (*Shipbuilding.*) A strip nailed to the ribs to indicate the position of the wales or bends preparatory to those planks being bolted on.

2. (*Nautical.*) A horizontal batten seized to the shrouds above the dead-eyes to keep the latter from turning.

Sheer-boom. (*Lumbering.*) A boom in a stream to catch logs and direct them toward a log-pond. One end is moored to the shore, and it has rudders set at such an angle as to catch the force of the current obliquely, and thus maintain its position at a certain angle across the direction of the stream.

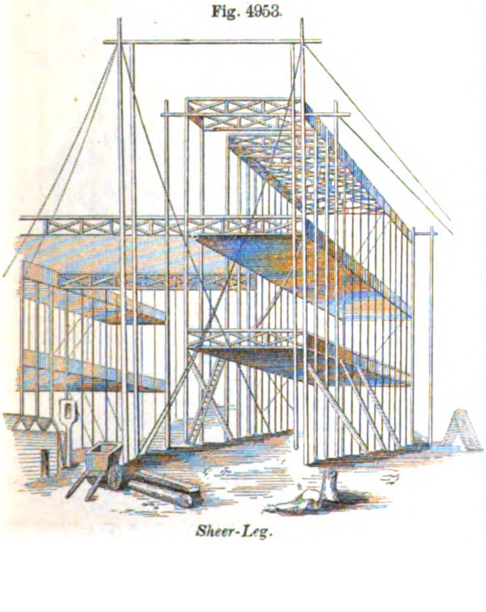
Sheer-draft. (*Shipwrighting.*) The plan of elevation of a ship whereon is described the outboard works, as the wales, shear-rails, ports, drifts, heads, quarters, post, and stem, etc., the hang of each deck inside, the water-lines, etc. (MEADE.) The *sheer-plan.*

Sheer-hulk. (*Nautical.*) An old vessel fitted with sheers for taking out and putting in masts of vessels. See SHEERS.

Sheer'ing. Deviating to either side of the line of the course.

Sheer-lash'ing. (*Nautical.*) The mode of lashing together the legs of the sheer at the cross. The middle of the rope is passed around the cross, the ends passed up and down respectively, then returned on their own parts and lashed together.

Fig. 4953.



Sheer-Leg.

Sheer-leg. (*Hoisting.*) Sheer-legs were employed in lieu of scaffolding in the erection of the Crystal Palace building at Sydenham, 1851. Two poles were placed upright and connected at top by a cross piece; the whole being steadied by guys. The columns were hoisted into a vertical position by a rope and pulley, and held until they were bolted to their bases. When two columns had been fixed in position, a connecting piece was attached to each end of the girder, which was raised by the same means and bolted on to the tops of the columns.

Sheer-line. 1. (*Shipbuilding.*) The line of the deck at the side of the ship.

2. (*Military.*) The stretched hawser of a flying bridge along which the boat passes.

Sheer-mast. (*Nautical.*) One formed of a pair of spars, between which the yard of the sail is slung.

Sheer-plan. (*Shipbuilding.*) A vertical, longitudinal, 'midship section of a vessel, on which are projected various lines which, in an architectural drawing, would be shown by an elevation, as, —

Water lines (blue).	Main-breadth line.
Level lines.	Top-breadth or top-timber line.
Diagonal lines (red).	Top-side line.
Buttock and bow lines.	Cutting-down line.

Sheer-rail; Waist-rail. (*Shipwrighting.*) A rail surrounding a ship on the outside, under the gunwale.

Sheers. 1. (*Nautical.*) Originally spelt *shears,* from the resemblance, in form, to cutting shears. Bailey, 1725; Phillips' "World of Words," 1658. Modern maritime custom has otherwise determined it.

An apparatus consisting of two masts, or *legs,* secured together at the top, and provided with ropes or chains and pulleys; used principally for masting or dismantling ships, hoisting in and taking out boilers, etc.

This kind of hoisting-machine has two legs. The *derrick* has one; the *gin,* three. The two former require guys; the latter stands independently.

The legs are separated at their feet to form an extended base, and are lashed together at their upper ends, to which the guy-ropes and tackle are attached. The sheers has one motion on its steps describing an arc, and is inclined from the perpendicular to a greater or less extent as required, by slacking or hauling on the guy-rope or fall of the sheer-tackle.

Temporary sheers are made of two spars lashed together at top and sustained by guys.

Permanent sheers are sloped together at top and crowned with an iron cap bolted thereto. It is now usually mounted on a wharf, but was formerly placed on an old hull called a *shear-hulk.*

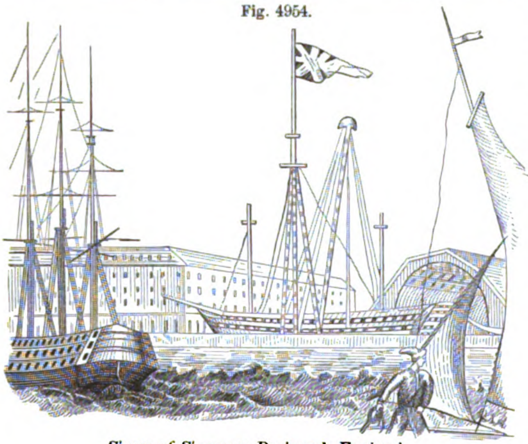
The sheers of Sheerness Dockyard, England (Fig. 4954), are 127 feet long, with an average diameter of 37 inches, and framed like a lower mast of a first-rate.

In Fig. 4955, *A* represents Wylie's sheers. *a a* shows the sheers overhanging a vessel *b b,* in position for raising or lowering an object on the wharf. *c,* the two engines. *d,* a long screw for working the sheers. *e,* hoisting-winch with wormed barrel. *f f,* purchase-blocks.

B, the sheers at Woolwich Dockyard, end and side elevation. The spars *b c* and central mast *a* are *made,* the pieces being joined by dowel-pins and iron plates. They are connected with each other by straps *d* and with the mast by braces *e,* and the spars *c* are swiveled on a collar at the foot of the central mast.

A similar contrivance is used in mining and for suspending the tackle used in mounting and dismounting guns.

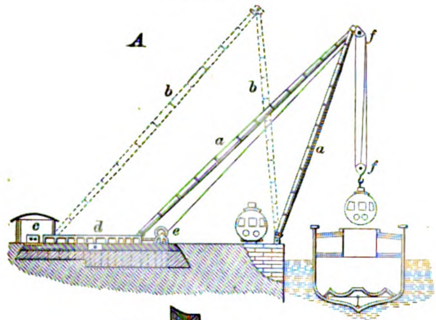
Fig. 4954.

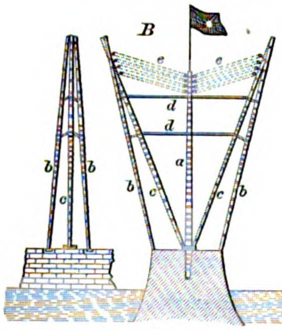


Sheers of Sheerness Dockyard, England.

Sheer-strake. (*Shipbuilding.*) The strake under the gunwale in the top side. It is generally worked thicker than the rest of the top sides, and is scarfed between the drifts.

Fig. 4955.





Sheers.

Sheet. 1. (*Nautical.*) A rope attached to the clew of a sail, in order to extend it. Lower square sails, or courses, have another rope, the *tack*, attached to each clew, serving to haul forward and secure the weather corner of the sail, while the lee corner is hauled aft by the sheet. Upper sails have sheets only.

Fig. 4956.

Sheet-Bend.

2. A thin plate of metal or glass.

3. A broad piece of paper. The same printed.

Sheet-an′chor. (*Nautical.*) The largest anchor of a ship. Others are known as *bower*, *stream*, *kedge*, etc. See ANCHOR.

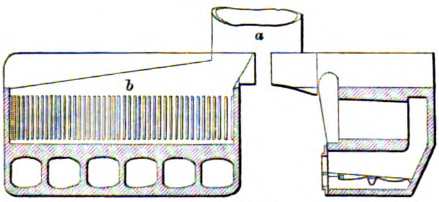
Sheet-bend. (*Nautical.*) *a.* A double hitch formed by laying the bight of one rope over that of another, passing its two parts under the two parts of the other and upward through its bight crosswise and overlaying it.

b. The strongest cable on board ship; bent to the sheet-anchor.

Sheet-flue Boil′er. A marine steam-boiler in which the flues are formed of flat sheets instead of cylindrical pipes.

Lamb and Summers, English patent. The cut illustrates the boilers of the English troop-ship "Himalaya." *a*, chimney; *b*, flues, 48 in number, 6′ 5″ long, 3′ 9″, $1\frac{5}{8}$″ wide; water-spaces, $2\frac{5}{8}$″.

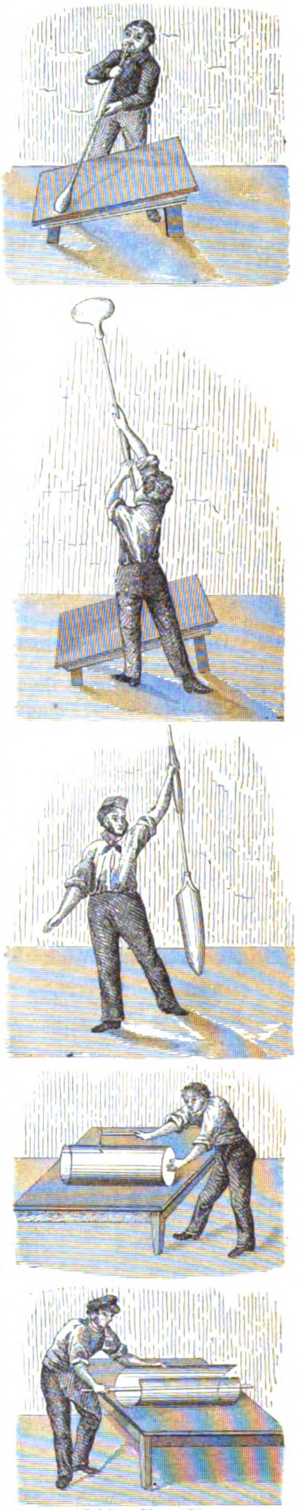
Fig. 4957.



Sheet-Flue Boiler.

Sheet-glass. In the Continental method of making sheet-glass, — introduced into England in 1850 by Chance Brothers, Birmingham, on the occasion of the construction of the World's Fair Expo-

Fig. 4958.



Making Sheet-Glass.

sition building by Sir Joseph Paxton,—the workman takes up a quantity, some 12 or 14 pounds of the semi-fluid material from the melting-pot upon the end of his tube, and elongates it by rolling upon a wooden table; he then blows it into an elongated spheroidal form, and then swings it around in a vertical circle, reheating it two or three times, until the end not attached flies open and the glass assumes the form of a hollow cylinder. The cylinders are cut longitudinally with a diamond, and placed in a furnace, where they open out into sheets under the influence of heat. Glass made in this way is also known as *cylinder*, *broad*, *spread*, *German* glass. (See CYLINDER-GLASS.) The composition is the same as *crown*-glass.

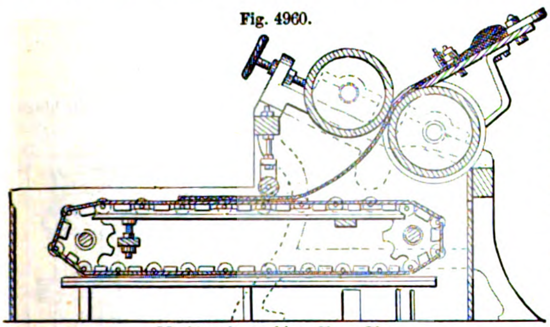
Fig. 4959.

Flattening the Sheet.

Figs. 4958, 4959, show the various operations and the conditions of the glass in the various stages.

Sheet-glass Ma-chine′. A machine for rolling hot plastic glass into a sheet. The melted glass is poured on to a table on which are side-pieces to regulate the opening through which it passes, and, consequently, the width of the layer. From the inclined table it passes between the rollers, whose distance apart regulates the thickness of the sheet. The platform is made of hinged plates with slides, and is inclosed by a casing, which has openings with slides to regulate its temperature, and also an adjustable roller to press the glass upon it and straighten any bend.

Fig. 4960.



Machine for making Sheet-Glass.

The Messrs. Chance, of Birmingham, are understood to have spent about £100,000 in attempts to manufacture heavy plate glass by similar means. See page 982. See also Bessemer's English patent, 1849.

Sheet′ing. 1. (*Fabric.*) Common muslins, bleached or unbleached. Sometimes made of double width, for sheets.

2. (*Hydraulic Engineering.*) A lining of timber or metal, for protection of a river-bank. Timber is the usual material, and consists of *sheet-piles* or of *guide-piles* and planking, fortified by anchoring to the bank in the rear.

3. (*Tobacco.*) Laying the leaves flat to be piled in *books*. See TOBACCO-SHEETING MACHINE.

4. (*Wool-manufacture.*) A form of batting. See next article.

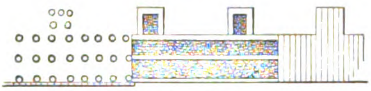
Sheet′ing-ma-chine′. 1. (*Wool-manufacture.*) A wool-combing machine for bringing the fiber into an even sheet. The surface of a drum is provided with long comb teeth, like porcupine quills, and hence called a *porcupine roller*. The *sheeter*, having gathered a bat, is denuded by stripping off the envelope of wool, which is then ready for *combing*. Ross's English patent, 1851.

2. (*Tobacco.*) A machine for smoothing tobacco-leaves. See TOBACCO-SHEETING MACHINE.

Sheet′ing-pile. (*Hydraulic Engineering.*) A plank, tongued and grooved, driven between two principal piles, to shut out the water.

The exterior piles of a coffer-dam or other structure, serving to sustain a filling in of earth, masonry, or other material.

Fig. 4961.



Sheeting-Piles.

Sheet-ir′on. In the British Exhibition of 1851, the American department exhibited some specimens of extremely thin sheet-iron. The friendly competition which resulted is worthy of notice.

Gillott, the celebrated steel-pen maker (deceased, December, 1871), rolled sheets the $\frac{1}{1800}$ part of an inch in thickness. These iron sheets were smooth and easy to write upon, though porous when held up to the light. Fine tissue-paper is about the $\frac{1}{1200}$ part of an inch in thickness; and the famous Pittsburg letter written on iron, which gave rise to the competition, was a sheet $\frac{1}{1000}$ of an inch. The dimensions were, $8 \times 5\frac{1}{2}$ inches $= 44$ square inches area, the weight 69 grains.

The Marshfield Iron-Works, of Caermarthenshire, Wales, made a sheet of the same dimensions, weighing only 46 grains.

The Hope Iron-Works, Staffordshire, England, made a sheet of 119 square inches area, weighing 89 grains, which, reduced to the former standard of 44 inches area, is equal to 33 grains.

The Marshfield tries again, and reduces it to $23\frac{1}{2}$ grains; a thickness of 2,583 sheets to the inch.

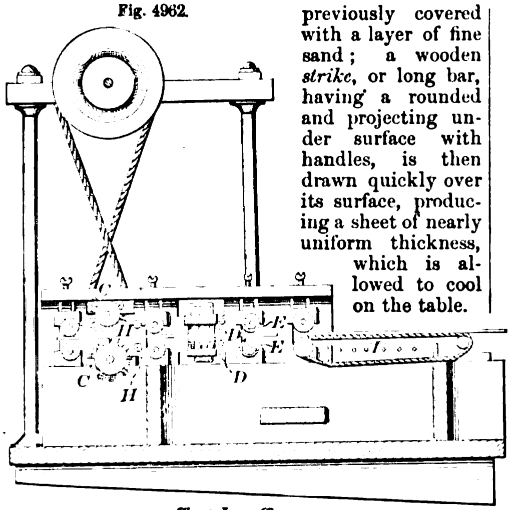
The Upper Forest Tin-Works, of Swansea, now wear the palm, having produced a sheet $10 \times 5\frac{1}{2} = 55$ inches area, weighing but 20 grains, equal to 16 grains for an area of 44 inches, and having a thickness of $\frac{1}{4800}$ of an inch. See also RUSSIA IRON.

Sheet-ir′on Gage. See SHEET-METAL GAGE.

Sheet-ir′on Clean′er. An apparatus for cleansing the surfaces of iron sheets after rolling. It consists of a series of feed-rollers, which pass the sheet between a series of revolving brushes *C C*, and another pair of flat brushes *D D*, which have a reciprocating motion across the top and bottom surfaces of the sheet, upon which, meanwhile, jets of water are forced through small tubes *H H* for that purpose. The sheet then passes between two elastic squeezing-rollers *E E*, which deprive it of a great proportion of the moisture, and is then passed over a furnace *I*, which completes the drying process and prevents oxidation.

Sheet-lead. The old process of making sheet-lead is by pouring the molten metal upon a table having raised ledges at each side, its top having been

Fig. 4962.



Sheet-Iron Cleaner.

previously covered with a layer of fine sand; a wooden *strike*, or long bar, having a rounded and projecting under surface with handles, is then drawn quickly over its surface, producing a sheet of nearly uniform thickness, which is allowed to cool on the table.

When prepared by milling or rolling, a plate of the metal some six or seven feet square and six inches thick is cast in an iron frame. This is hoisted upon the rolling milling-machine, which consists of a long frame provided with a number of wooden rollers, over which the plate is drawn, and having midway of its length two heavy metallic laminating-rollers, between which the plate is drawn a sufficient number of times to reduce it to the required thickness, the distance between the rollers being successively reduced previous to each operation.

For thin sheet-lead this may have to be repeated several hundred times. When the sheet has grown too long for the table, it is cut in two and each part milled separately.

When finished, it is cut into lengths which are formed into rolls. The thickness is indicated by the number of pounds which a square foot weighs.

By another plan, the metal is formed into thin pipes, which are opened longitudinally and flattened out. In making pipe, the lead is forced through an annular space between a core and an inclosing pipe. Hydraulic power is used.

Weight of Lead per Square Foot.

Thickness.	Weight.	Thickness.	Weight.	Thickness.	Weight.
Inches.	Lbs.	Inches.	Lbs.	Inches.	Lbs.
.10	5.899	.14	8.258	.17	10.028
.11	6.489	1/7	8.427	.18	10.618
1/9	6.554	.15	8.848	.19	11.207
.12	7.078	.16	9.438	.20	11.797
1/8	7.373	1/6	9.831	.21	12.387
.13	7.668				

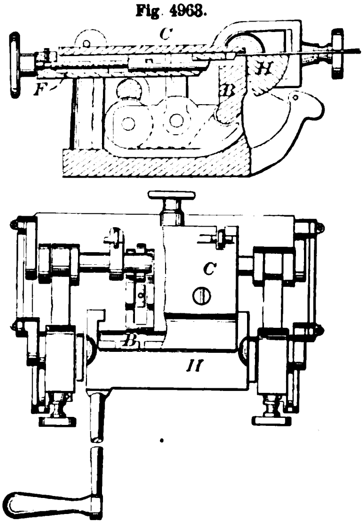
Sheet-met'al Bend'ing-ma-chine'. One for forming plates into shape between dies or rollers.

The folding-bar *H* is secured to shafts which rotate in adjustable bearings on bars attached to a cam-shaft. When the folding-bar is rotated, the cams cause the folding-knife *C* to hold the metal while being bent, and the folding-bar is prevented from being raised too high by slotted straps. A gage, adjustable by a screw *F*, is arranged beneath the folding-blade to regulate the width of the lock.

The distance between the folding-bar and the bed-piece *B* is adjustable by a screw to determine the suddenness of the bend at the angle. Fig. 4963.

In Fig. 4964, the frame *A* is adapted to receive counterpart dies *K G* of various curves, which are brought together by the movement of a lever, shaping the sheet of metal between them. The flat die *O*, also removable, is used in forming some descriptions of eaves-troughs.

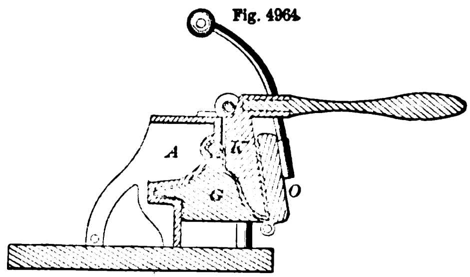
Fig. 4963.



Sheet-Metal Bending-Machine.

Fig 4965 is a machine for forming rectangular pans. The

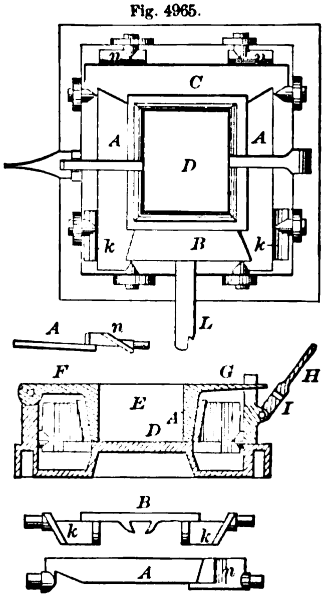
Fig. 4964.



Sheet-Metal Bending-Machine.

sheet of metal is placed on the block *D*, and held by the hinged interior forming die-clamp *F E G*, secured by throwing up the lever *H*, so that its slot *I* engages the arm *G*. The side-forming plates *A A B C* have cam-faces *k k n n* corresponding with each other in each plate, so that, on turning up the plate *B* by means of the lever *L*, they are caused to close in simultaneously upon the sides of the die-clamp *F E G*, bending the sheet-metal to the required shape.

Fig. 4965.

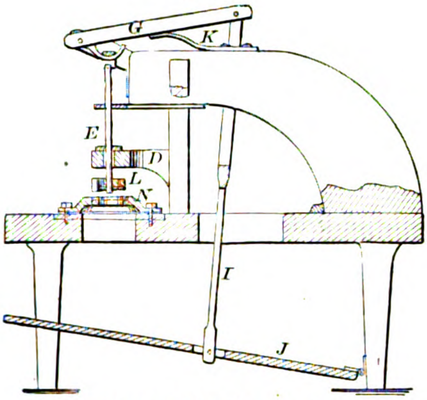


Machine for forming Bread-Pans.

Sheet-met'al Die. A former, one of a pair, between which sheet-metal is struck.

The machine (Fig. 4966) is especially designed for cutting out

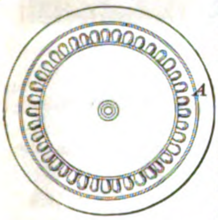
Fig. 4966.



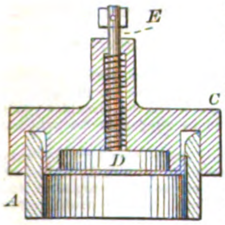
Tinner's Sheet-Metal Forming-Machine.

flaring work, such as the sides of pans, pails, and basins. The dies L N are adjustable to suit the size of the work. The knives are made in sections, so as to be readily detached for sharpening. The upper die L is fixed to the rod E, passing through the curved guide D, and brought down by the lever G, operated through the pitman I and treadle J; a spring K throws the die up again after each depression.

Fig. 4967.



In Fig. 4967, the upper inner edge of the hollow die A has flutings or serrations whereby the tin or other metal to be struck up is crimped evenly to prevent the uneven lapping and consequent breaking of the metal. A plunger D, within the upper die C, operated by a spiral spring, serves to free that die from the lower one after a stroke is made.



Die and Plunger.

Sheet-met′al Draw′-ing-press. A machine for stamping out seamless articles from sheet-metals.

It consists of an upright frame with a vertically reciprocating cross-head a carrying a blank holder b containing a reciprocating plunger. The blank holder and plunger are independently operated by cams on shafts driven by a worm and wheel. By the action of the plunger the blank is forced into the die c, which imparts the desired shape.

The blank holder is adjustable to adapt the press for drawing different thicknesses of metal.

Sheet-met′al Fold′er. See SHEET-METAL BENDER; SHEET-METAL FORMER; SEAMING-MACHINE.

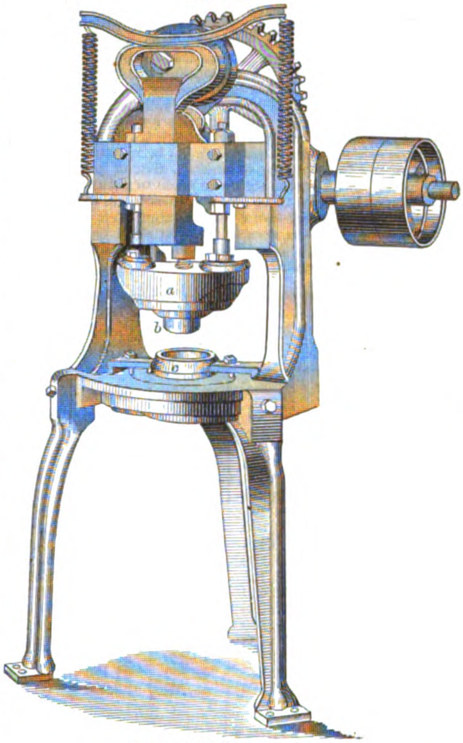
Sheet-met′al Form′ing-ma-chine′. A machine for bending sheet-metal into form.

In Fig. 4969, the upper die H is hinged to the lower die E, is lifted to place a sheet of metal in place for stamping, and then thrown over and the arm G secured by a catch. The central part F of the lower die has hinged side and end formers g, which, when the two dies are drawn downward, descend between guides C D, which throw up the formers g, and bend the metal to the required shape against the upper die H. Square pans are thus produced

Sheet-met′al Gage. A measure for thickness of sheet-metal.

The pocket-gage (A, Fig. 4970) consists of a V-shaped piece a provided with an adjusting-screw c and a gage-screw d; the latter passes through a collar b and is attached to a thimble e

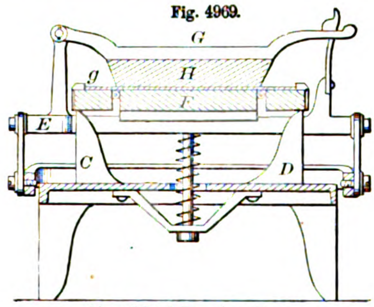
Fig 4968.



Sheet-Metal Drawing-Press.

surrounding the collar. The collar is graduated to fortieths of an inch, the distance by which the screw is moved at each turn,

Fig. 4969.

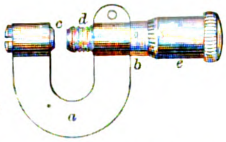


Sheet-Metal Forming-Press.

and the beveled edge of the thimble is circularly divided into twenty-five parts. The number of complete turns of the screw

Fig. 4970.

A



B

Sheet-Metal Gages.

d indicated on the collar b + the distance it has advanced in another partial revolution shown by the graduations on the thimble gives the distance between the abutting ends of the two screws c d, and consequently the thickness of a sheet of metal

or wire which can just be inserted between them, in thousandths of an inch. Thus, if the screw has made four and a fourth revolutions, four divisions on the collar *c*, each equivalent to twenty-five thousandths of an inch, will have been passed over by the thimble, and the mark five on the thimble will coincide with the longitudinal line on the collar, showing that the gage is open to one hundred and five thousandths of an inch.

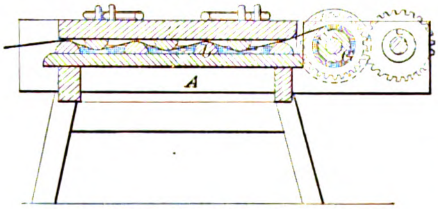
B, Fig. 4970, consists of a stand *a* with a slotted upright having an adjusting-screw *c* above, and a screw *d*, with a milled head and carrying a dial, passing through its lower part. One turn of the screw, whose threads are 1/10 inch apart, causes one rotation of the dial, the edge of which is divided in one hundred parts, enabling measurements to be made to thousandths of an inch. The sheet-metal to be gaged is inserted in the slot of the upright. The adjusting-screw is set so that when the points of the two screws meet, the zero of the dial shall be opposite an index or pointer which shows the number of divisions passed over, and is firmly secured by a set-screw.

Weight of one Square Foot of various Metals.

Thickness in Inches.	Weight in Pounds.				
	Wrought-Iron.	Cast-Iron.	Copper.	Brass.	Lead.
0.0625	2.535	2.345	2.860	2.738	3.693
0.125	5.070	4.690	5.720	5.476	7 386
0.1375	7.605	7.035	8.580	8.214	11.079
0.25	10.140	9.380	11.440	10.952	14.772
0 3125	12.675	11.725	14.300	13.690	18.465
0.375	15.216	14.670	17.160	16.428	22.158
0.4375	17.851	16.415	20.020	19.166	25.851
0.5	20.280	18.760	22.880	21.904	29.544
0.5625	22.815	21.105	25.740	24.642	33.237
0.625	25.350	23.450	28.600	27.380	36.930
0.6875	27.885	25.795	31.640	30.118	40.623
0.75	30.410	28.140	34.320	32.856	44.316
0.8125	32.945	30.485	37.180	35.594	48.009
0.875	35.480	32.880	40 040	38.332	51.702
0.9375	38.015	35.225	42 900	41.170	55.405
1.	40.550	37.570	45.760	43.908	59.098

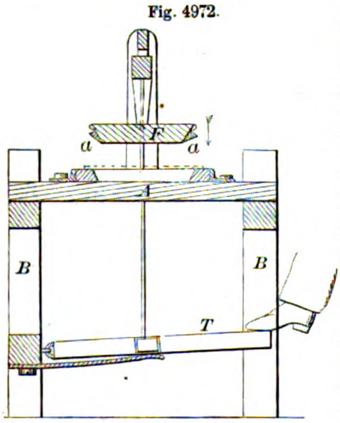
Sheet-met′al Pol′ish-er. One for clearing the surface of scale or stain before tinning, painting, etc.

Fig. 4971.



Sheet-Metal Polishing-Machine.

Fig. 4972.



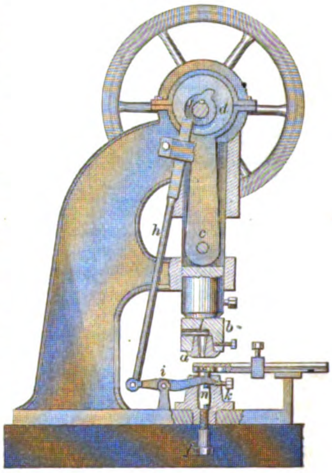
Sheet-Metal Press.

The sheets of metal are drawn through a trough *A* and presser *b* having corrugated surfaces, and are wound upon a removable spindle *G*. The sheets of metal are passed through a trough, having pressure applied to corrugated scouring surfaces, between which the metal passes to a removable sleeve on a revolving shaft.

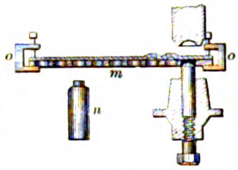
Sheet-met′al Press. A machine for forming articles of sheet-metal by pressure.

That illustrated consists of a table having two uprights *B B*, the upper ends of which are united by a bar *A*; said uprights form the guides for a beam which carries the punch *F*, and to which a rising and falling motion is imparted by a treadle *T*. The punch is secured to the beam by means of a stem, the lower end of which fits in a socket in the punch. The punch is made to correspond to the shape of the pans to be produced, and from its corners project wings *a a* which, when the punch is depressed, fit into corresponding slots in the corners of a die; this die is constructed of a series of sections which are made wedge-shaped, and is held in position by adjustable brackets.

Fig. 4973.



Sheet-met′al Punch. A machine for perforating sheet-metal.



Seifurth's Punching-Machine.

In Seifurth's punching-machine the die *a*, fixed in the block *b* by a screw, is caused to reciprocate by means of a pitman *c* and eccentric *d*. The punch *n* is stationary and adjustable in hight by a screw *f* beneath. The cam *g* and rod *h* operate the lifter *i*, which has two prongs, one on each side of the punch-holder *k*; these rise after the blow is given, and immediately fall back, allowing the workman time to adjust the sheet of metal before the die returns; the die and block have openings *l* through which the punchings escape.

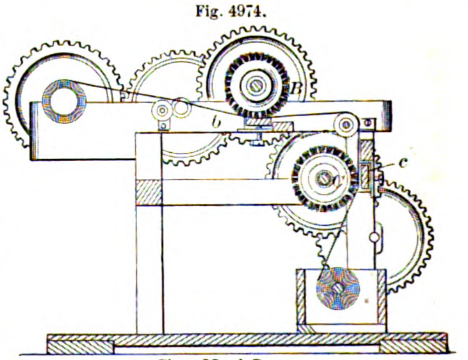
A gage *m*, secured by clamps *o* to the sheet, serves to guide the punch; the holes in these are larger than the diameter of the face of the punch *n*, which has a convex shoulder; this arrangement permits holes of various shapes to be punched without using special gages.

By employing different gages any description of holes may also be punched without the necessity of previously laying off and marking their positions. By varying the hight of the punch, impressions of any desired depth may be made in the metal. See also PUNCH.

Sheet-met′al Scour′er. A machine for cleaning sheet-brass and other metal after annealing.

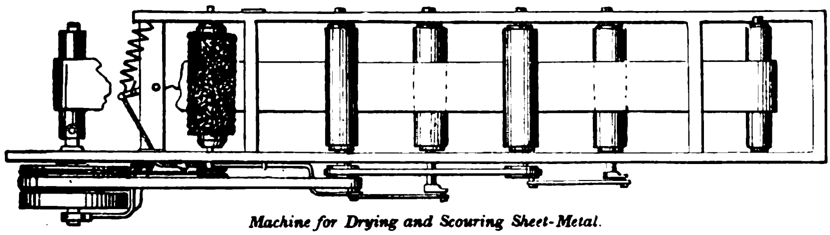
The metal being drawn through the machine is held against the wire brushes *B C* by the riders *b c*, and it is thus scoured and polished. See also Figs. 4962, 4971.

Fig. 4974.

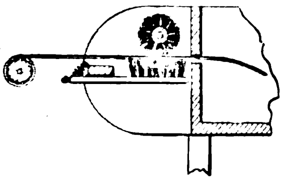


Sheet-Metal Scourer.

Fig. 4975.



Machine for Drying and Scouring Sheet-Metal.



A series of rollers covered with an elastic or fibrous material for holding sand, is so arranged as to pass the sheet-metal alternately above and below a roller. A vibrating motion is given to two of the under rollers by connecting-rods attached to crank-pins peculiarly arranged on pulleys. A pivoted brush is made to reciprocate across the under surface of the sheet-metal.

Sheet-met'al Shears. (*Tinman's Tools.*) A shears having one leg bent for insertion into a work-bench or table to which it is fixed. See SHEARS.

Sheet-met'al Straight'en-er. The sheet is subjected to gradually diminishing bends between rollers or surfaces that act crosswise of the bends or buckle of the plate.

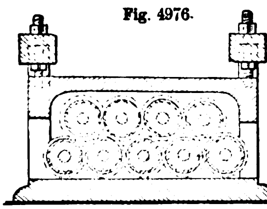
Sheet-met'al Work'er's Tools. See PLUMBER'S AND SHEET-METAL WORKER'S TOOLS.

Sheet-pile. A closing pile; one of thick plank driven between the main piles of a work to close the aperture. A *sheeting* pile.

Shelf. (*Building.*) A ledge for holding articles, secured to a wall, etc.

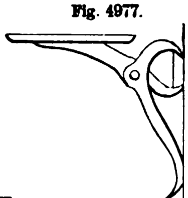
A removable shelf (Fig. 4977) has a bracket with

Fig. 4976.



Machine for straightening Sheet-Metal.

Fig. 4977.



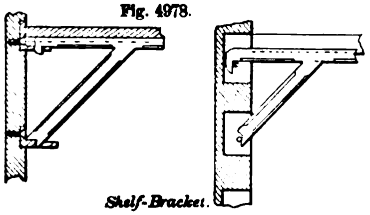
Shelf.

pivoted arms, whose jaws embrace a cleat which supports it; one of the arms resting against the wall serves as a brace. The claws of the bracket are pivoted together, the ends of the lower being turned up for the attachment of the shelf, and that of the other turned down for a brace.

2. (*Shipbuilding.*) An inner timber following the sheer of the vessel and bolted to the inner side of the ribs to strengthen the frame and sustain the deck-beams. See BEAM; SPIRKETING.

Shelf-brack'et. A device for supporting a shelf. In the example, the inner end of the horizontal bar of the bracket has a hook-catch, and the lower end of the brace has a notch, which respectively take over or bear against the bars of the vertical series which are placed in the back of the case.

Fig. 4978.



Shelf-Bracket.

Shell. 1. (*Ordnance.*) A hollow projectile containing a bursting-charge, which is exploded by a time or percussion fuse. (See CANNON; PROJECTILES; FUSE.) Invented at Venlo, 1495; used by the Turks at the siege of Rhodes, 1522.

Bomb-vessels were constructed in France, 1681.

Shells are usually made of cast-iron, and for mortars and smooth-bore cannon are spherical; but for rifled guns, they are, with the exception of Whitworth's and a few others, cylindrical and have a conoidal point. They are caused to take the grooves in a rifled gun, to receive a rotary motion, by means of a disk or ring, the *sabot*, which is expanded in act of firing, or by studs on the body of the shell. Those on the Whitworth principle are polygonal in section, corresponding to the bore of the gun, which they accurately fit.

Round shells for guns are made thicker than those for mortars, and have a reinforce at the fuse-hole; in mortar shells this is dispensed with.

The application of the rifled principle and elongated projectiles to cannon attracted little attention until the Franco-Italian war of 1859, where their efficacy was fully demonstrated.

Among the earliest American improvers in this line were James and Read, but no great practical results were achieved until after the beginning of the late civil war, when the talent of a host of inventors was concentrated upon it, resulting in bringing both projectiles and cannon into a very efficient state within a year or so after the beginning of the contest.

Ordnance shells have been constructed in great variety, some depending upon the force of the charge to burst the shell into fragments of indefinite size; others having lines of easy fracture indented in them; others built up of pieces, which become separated when the charge explodes, as the Armstrong; others full of bullets, as the shrapnell.

Among the more prominent American inventions are, —

Sawyer's, 1855 (*a*). This has a layer of soft metal with flanges outside the inner iron shell, which is forced forward by the shock of firing so as to fill the bore, while the flanges take the grooves.

Read, 1856 (*b*). Has a wrought-iron cup imbedded in a groove at the base of the shell.

Major Laidley, 1857 (*c*). A metallic jacket surrounds the cylindrical part of the shell, and is attached by being imbedded in a groove or by dowels. Sufficient space is left between the two for the entrance of gas.

Hubbell, 1860 (*d*). A circumferential recess in the shell receives a leaden band, which includes a wire coil, and has circumferential grooves to prevent stripping. The whole is covered with canvas.

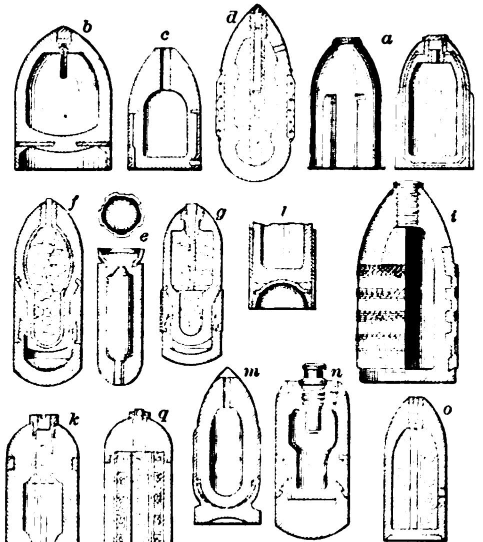
Parrott, 1861 (*e*). A cup of brass or iron is let into the base of the shell, and swaged so as to nearly correspond to the grooves and *lands* of the gun, leaving a very small windage, which is entirely overcome by the expansion of the cup on firing.

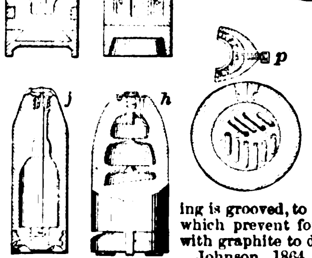
Hotchkiss, 1862 (*f*). The shell is made in two parts, the front one being thinned at the rear and surrounded by a soft metal ring, which is expanded at the moment of firing by an annular wedge at front of the rear part. When filled with leaden balls, it is termed a bullet-shell. A later form (*g*) contains a charge of powder, separated from the balls by a plate, and ignited by the fuse, so as to give them an additional impulse at the moment of bursting.

Another improvement consists in making longitudinal grooves in the shell, to insure the passage of flame to the fuse at the moment of firing. A disk of soft metal may also be interposed between the base and front sections to moderate the shock when the two are impacted, and lessen the danger of fracture.

h. At a later period, the powder-chamber was divided into several communicating compartments, to avoid the danger of the bursting-charge becoming ignited by friction against the sides and exploding within the gun,—an event which sometimes happens. Varnishing the interior also lessens danger from this source.

Fig. 4979.





Shells.

Broadwell, 1866 (*i*). The soft metal packing is grooved, to receive bands of cord, which prevent fouling, and are coated with graphite to diminish friction.

Johnson, 1864 (*j*). The shell has a charging-hole closed by a screw-plug at its base. A rod armed with a percussion-cap extends longitudinally through the powder-chamber, and the cap is exploded by an anvil, which is detached from the breech-plug and thrown forward when the shell strikes.

Absterdam, 1864 (*k*), employs one or more bands of an alloy composed of copper and zinc, suddenly cooled after heating, and a cup-shaped sabot cast into a semi-dovetail groove at the base; this is sawed through in several places to permit its more ready expansion; the bands diminish windage and keep the projectile axially in the bore.

Boekel, 1864 (*l*). A flexible metallic casing fits tightly over the rear part of the shell, extending beyond its base; a cup of less diameter rests against the base, and is imbedded in a soft metal packing.

Dahlgren, 1861 (*m*). The cylindrical part of the shell has longitudinal projections fitting the grooves of the gun; and is shouldered to form an abutment for the soft metal sabot, which has an annular groove and is attached to the spheroidal base of the shell.

Hotchkiss, 1865 (*n*). A disk of soft material is interposed between the base-piece and the body of the projectile, to gradually check the forward motion of the base and prevent danger of fracture.

Birney, 1862 (*o*). A tube containing the bursting-charge passes longitudinally through the shell, resting on its base, and is surrounded by an incendiary composition.

Shaffner, 1866 (*p*). The shells contain a bursting-charge of nitro-glycerine in vials packed with gun-cotton and a honeycombed lining of india-rubber, to deaden the concussion and prevent explosion in the act of firing.

Long, 1866 (*q*). The bursting-charge is surrounded by a series of barrels containing several charges of powder and ball, and fired by fuses at the moment when the shell explodes.

2. (*Pyrotechny.*) Shells of paper or wood filled with stars, serpents, or gold-rain frequently form a part of pyrotechnic displays. The first are made by pasting strips of paper in successive layers over a spherical wooden former, each layer being allowed to dry before another is applied; the shell is removed from the mold by cutting it into two parts, which are afterward joined by pasting strips over their edges. Wooden shells are turned in two hemispheres out of poplar or other light wood of sufficient size; these are then united in a similar way. Both kinds are provided with a time-fuse, and fired from a mortar with a small charge of powder.

3. (*Nautical.*) *a*. The wooden outer portion or casing of a block, which is mortised for the *sheave*, and bored at right angles to the mortise for the *pin*, which is the axis of the sheave or sheaves.

Fig. 4980.

Shells.

Fig. 4981.

Shell.

b. A kind of thimble dead-eye block employed in joining the ends of two ropes. In Fig. 4980, *a a'* are sections, and *b b'* plans of shells. In Fig. 4981, 1 represents a joint by a spherical shell, each loop, *a* and *b*, being made by ties and splices, and surrounding the shell *c*. 2 represents a round turn; the cord *a* is passed through the bight of the cord *b* over the button *c*, where it is secured by an ordinary knot.

4. (*Weaving.*) The *upper* and *under shells* are the bars of the *lay*, which are grooved to receive the reed.

5. An engraved copper roller used in calico-printing.

6. (*Optics.*) A concave-faced tool of cast-iron, in which convex lenses are ground. The glasses are attached to the face of a *runner*, which is worked around with a circular swinging stroke, so as not to wear either the glasses or the shell into ridges. See RUNNER.

7. (*Steam.*) The exterior plates of a boiler form the shell.

Resistance of Wrought-Iron collapsing Pressure, and of the Shells of Boilers to an internal or bursting Pressure. (HASWELL.)

Tensile Strength = 55,000 Pounds to the Square Inch.

Diameter.	Thickness.	Bursting Pressure per Square Inch.		Diameter.	Thickness.	Bursting Pressure per Square Inch.	
		Single Riveted.	Double Riveted.			Single Riveted.	Double Riveted.
Feet.	Ins.	Lbs	Lbs.	Feet.	Ins.	Lbs.	Lbs.
2	1/4	573	745	7.6	5/16	191	248
2.6	1/4	458	596		3/8	229	298
3	1/4	382	496	8	5/16	179	238
3.4	1/4	318	414		3/8	215	279
	5/16	398	518	8.6	5/16	168	219
3.6	1/4	327	426		3/8	202	263
	5/16	409	532	9	5/16	159	207
4	1/4	286	372		3/8	191	248
	5/16	358	465	9.6	5/16	150	196
4.6	1/4	254	331		3/8	181	235
	5/16	318	413	10	5/16	143	186
5	1/4	229	298		3/8	172	224
	5/16	286	372		1/2	229	298
5.6	1/4	208	270	10.6	5/16	136	177
	5/16	260	338		3/8	163	212
	3/8	312	406		1/2	218	284
6	1/4	191	248	11	3/8	156	203
	5/16	239	311		1/2	208	271
	3/8	286	372	11.6	3/8	149	194
6.6	5/16	220	287		1/2	199	259
	3/8	264	344	12	3/8	143	166
7	5/16	204	266		1/2	191	248
	3/8	245	319				

8. The hard covering of many species of mollusks; employed for various purposes in the arts. Lime is

frequently produced by burning oyster-shells. Another variety yields mother of pearl.

The manufacture of rings for the arms and ankles, from conch-shells imported from the Malayan Archipelago, is still almost confined to Dacca; the shells are sawn across for this purpose by semicircular saws, the hands and toes being both actively employed in the operation. The introduction of circular saws has been attempted by some Europeans, but steadily resisted by the natives, despite their obvious advantages.

9. A coarse kind of coffin; or a thin interior coffin inclosed by the more substantial one.

Shell-au'ger. A wood-boring tool having a large hollow receptacle for the chips. It is used in boring timbers for pump-stocks and wooden pipes. See BIT.

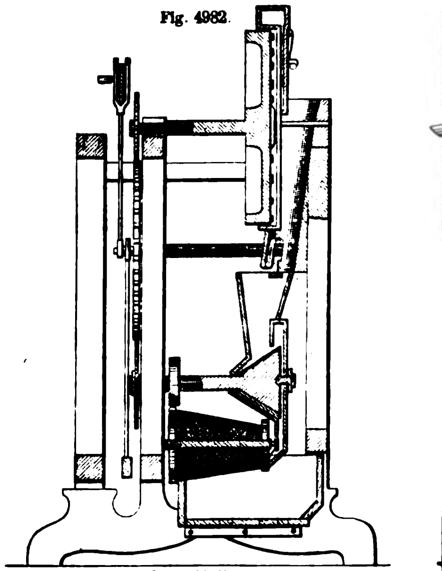
Shell-bit. A wood-boring tool used in a brace. It has a semi-cylindrical form, terminates in a sharp edge, and has a hollow shank. See BIT.

Shell-boat. A boat with a light frame and thin covering; one kind of racing-boat.

Shell-but'ton. A hollow button made of two pieces, front and back, joined by a turn-over seam at the edge, and usually covered with silk or cloth.

Shell'er. (*Husbandry.*) A machine for rasping or rubbing the grain from the cob. In Fig. 4982, the corn is shelled by the revolution of the toothed

Fig. 4982.

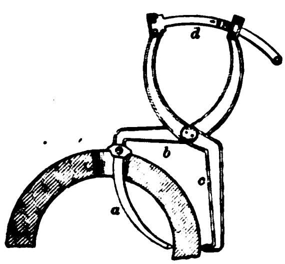


Corn-Sheller.

disk. The grain is conveyed to the grinding hopper, and the cobs are thrown out by a spring worked automatically. See also CORN-SHELLER, page 628.

Shell-fou-gasse'. (*Fortification.*) A mine charged chiefly with shells and covered with earth.

Fig. 4983.



Shell-Gage.

Shell-gage. (*Ordnance.*) An instrument for verifying the thickness of hollow projectiles. It is provided with a set of removable curved arms *a*, each corresponding to a particular kind of shell, which screw into a socket on the leg *b* of the calipers, and are inserted within the fuse-hole of the shell. The thickness of the wall is measured between the points of the arm *a* and leg *c*. The arc *d* is graduated so as to show the proper thickness for each caliber, any deviation from which beyond certain limits causes the rejection of the shell.

Shell-gold. Chips or thin lamina of gold prepared by beating; applied to surfaces for decorative purposes.

Shell-gun. (*Ordnance.*) One for throwing shells or bombs.

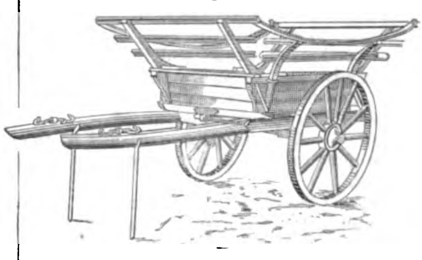
Shell-hook. (*Ordnance.*) A pair of tongs with hooks which are inserted into the ears of a shell and by which it is carried to the mortar.

Fig. 4984.

Shell-Pump.

Shell-pump. (*Well-boring.*) A tube with a clack-valve at its foot, used for removing the detritus from a bored shaft. A hollow cylinder having an inwardly opening valve at bottom, attached to the lower end of the boring-rod for the purpose of bringing up comminuted material. See SAND-PUMP.

Fig. 4985.



Shelving.

Shelv'ing. 1. (*Husbandry.*) Additional top rails to a cart or wagon for enabling it to hold a larger load of bulky material, such as straw, sheaves, or hay.

2. Arrangement of shelves in a store or wareroom, to hold goods or stock.

Sheth. That portion of a plow — sometimes called the post or standard — which is attached at its upper end to the beam and at points below affords places of attachment for the share, mold-board, and landside in ordinary plows. In shovel-plows it fills a similar function as the part to which the share or shovel is secured.

Shield. 1. (*Weapon.*) A portable defensive armor carried in front of the person.

The ancient Greek shield, as described by Homer, was long enough to cover the man from the face to the knee. This was exceeded by the *pavise* of the Middle Ages, which was as tall as a man, and was carried by a *pavisor*, who therewith shielded an archer. It was also carried in assaults on fortifications.

The Roman troops were drilled in modes of combining their shields so as to make a carapace, each soldier holding his shield aloft, the shields overlapping in such a manner as to glance off arrows and other missiles. It was called a *testudo*, from its resemblance to the back of a tortoise.

The shield of the Roman legionary was of wood covered with leather, and studded with metal; it was 4 feet by 2½.

The shield of the ancient Briton was round and of basket-work.

The Norman shield was kite or pear shaped.

In the time of Edward IV. it had become triangular.

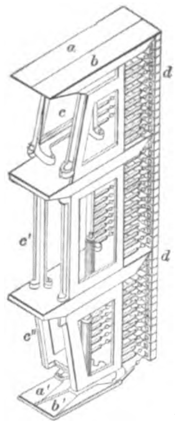
In South Africa it is made of rhinoceros hide.

The shield fell out of use when the broadsword was exchanged for the small sword and rapier. The introduction of fire-arms has farther changed the tactics, and the shield is a thing of the past with civilized nations.

It would be a grateful accessory to the sharpshooter under some circumstances.

2. (*Hydraulic Engineering.*) The shield used by

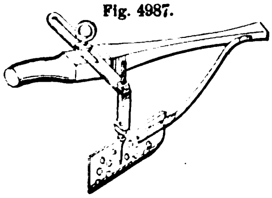
Fig. 4986.



Brunel's Shield (Thames Tunnel).

Brunel during the excavation of the Thames tunnel consisted of a strong iron framing, divided into compartments *c c' c''*, within which the men worked. The top and bottom were formed of independent sections *a a' b b'*, which were advanced alternately by means of jack-screws, and the front was protected by ranges of boards *d d*, which were separately removed to enable the men to excavate the mass of earth in front by small portions at a time, and then replaced as the sections advanced to secure the soft ground from pressing into the shield. The arch of brick was built in behind as the shield advanced.

Fig. 4987.



Shield for Corn in Plowing.

3. (*Husbandry.*) A fender-plate attached to the share of a corn-plow to keep clods from rolling on to the young plant.

Shield-ship. (*Nautical.*) One carrying movable shields to protect the heavy guns except at the moment of firing. This was superseded by the Timby turret, or revolving tower.

Shift. 1. (*Break-joint.*) A mode of arranging the tiers of plates, bricks, timbers, planking, etc., so that the joints of adjacent rows shall not coincide.

In wooden ships, the *shift* is so arranged that in any given cross-section there are at least four *strakes* of plank to one *butt*.

In brickwork the joint is alternate. See Bond.

2. (*Mining-engineering.*) A *fault* or dislocation of a lead, seam, or stratum, accompanied by depression of one portion, destroying the continuity. A *slip*.

3. A turn of men; as a *day-shift* and a *night-shift*. A *double shift* or *single shift* indicates two sets or one set of men to a work. A *three-turn shift* consists of three relays, working eight hours each.

Shift'er. (*Knitting-machine.*) One of the beardless needles (or awns, as they have no eyes) which, by suitable mechanism under the control of their attendant, operate to disengage the outer loops of the course and put them on the next inner or the next outer needles for narrowing or widening.

Shift'er-bar. (*Knitting-machine.*) A bar having stops or projections, whose office it is to stop one needle-carrier bolt while they lift the other needle-carrier bolt.

Shift'ing. (*Nautical.*) The parting of tackle-blocks which have been pulled together. *Fleeting.*

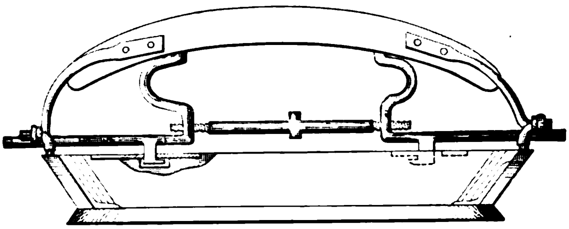
Shift'ing-bar. (*Printing.*) A cross-bar removably dovetailed into a *chase*.

Shift'ing-gage. An adjustable gage.

Shift'ing-plank. (*Ordnance.*) An oaken plank 6 feet in length by 1 foot wide and 2¼ inches thick, and beveled at each end; used, in conjunction with the rollers, blocks, and other implements for mechanical maneuvers, for shifting cannon from one level to another.

Shift'ing-rail. (*Vehicle.*) An upper rail or lazy-

Fig. 4988.



Shifting-Rails for Carriage-Tops.

back to a buggy or carriage, removable at pleasure. In the example, the upper rail is detached from the seat by the disengagement of its feet from the slots in the upper edge of the seat, back, and sides.

Shim. 1. (*Machinery.*) A thin piece of metal placed between two parts to make a fit. It is sometimes used in adjusting the parts of a journal-box to the crank pin or wrist either in the original fitting or in taking up lost motion.

2. (*Stone-working.*) One of the plates in a jumper-hole to fill out a portion of the thickness not occupied by the *wedges* or *feathers*.

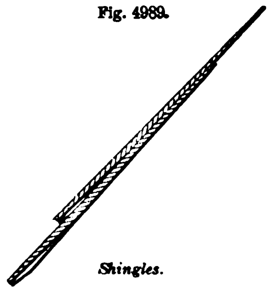
3. (*Agricultural.*) A shallow plow for breaking the surface of land and killing weeds.

Shin. (*Railway-engineering.*) A fish-plate.

Shin-boot. (*Menage.*) A horse boot having a long leather shield to protect the shin of a horse from being injured by the opposite foot; used on trotting horses.

Shin'gle. (*Building.*) A thin piece of wood, having parallel sides and thicker at one end than the other; commonly used as a roof-covering, instead of slates, tiles, or metal.

Fig. 4989.



Shingles.

Shingles are made either by riving and shaving, or sawing; or they are sawed and planed; or they are cut from the steamed block by powerful knives.

Shingles are laid with one third of their lengths to the weather. They are usually 18 inches long, and so have 6 inches of *margin*; this is the *gage* of the shingle; the other two thirds is *cover*. The excess over twice the *gage* is the *lap* or *bond*.

The width of a shingle is about 6 inches in the mode of counting, so that a shingle of 12 inches running width counts as two. Boxes of a given size are made to pile them in, which saves trouble in counting; the clamp or yoke is then put around them, and the bunch removed. See patent 72,581 of 1867.

Pliny says that the best shingles are made of oak, but they are more easily cut from pine. He cites Cornelius Nepos to the effect that down to the time of the war with Pyrrhus, Rome was roofed solely with shingles, a period of 470 years. It is to be presumed that they gave way to tiles, which maintained their supremacy in Europe till the introduction of slate.

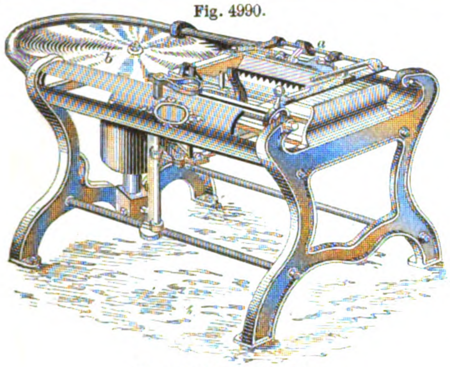
Machines are made for *riving*, *sawing*, *cutting* shingles; also for *planing* and *jointing* the rough shingle.

Shin'gle-joint'ing Ma-chine'. A machine for truing the edge of a rough shingle. It is of the nature of a saw or a circular planer, and acts upon the edge of the shingle, which is pushed along the bench.

Shin'gle-ma-chine'.

In the example (Fig. 4990). the shingle-block is held by jaws in a carriage *a* which reciprocates to and fro over the horizontal

Fig. 4990.

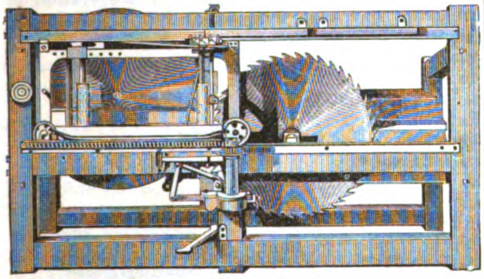


Evarts' Shingle-Machine.

saw *b*. As it makes the feed-stroke, the saw cuts a shingle from the block, and as the carriage *a* returns, the table tilts, a jaw opens and drops the block; the jaw being closed, the carriage is again pushed forward to have a shingle sawed from the lower edge of the block; on its return the table is tilted in the other direction, so as to cut shingles, *butts* and *points*, from the block. To alter the thickness of the shingle, turn the set-screws in the tilting-table up or down, as the case may be. To alter the taper, turn the set-screws in the tilt-handle.

Fig. 4991 is a machine in which the circular saw and jointer are on the same frame. The block is held by spiked rolls in a carriage which presents the bolt, butts and points alternately.

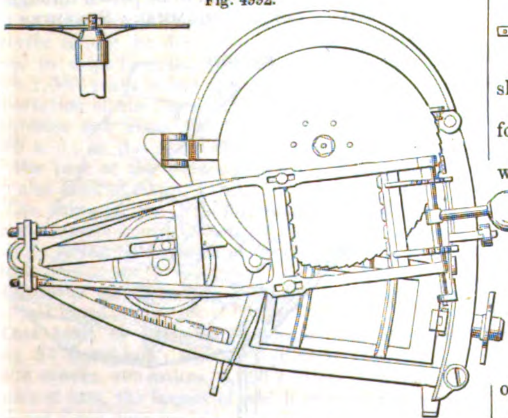
Fig. 4991.



Parker's Shingle-Machine.

The saw used has a diameter twice the length of the shingle to be sawed, and the block is presented sideways to the saw, so that the cuts of the teeth are nearly parallel with the fibers of

Fig. 4992.



Shingle-Machine.

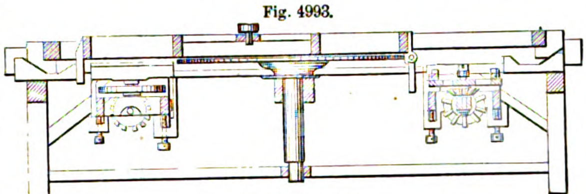
the wood. The result is a smoother surface, approximating that of a shaved shingle.

In Fig. 4992, the machine has an automatic clamp and a tilting frame; the bolt is fed automatically to the circular saw at a comparatively slow speed, and returned at a faster rate. The saw is formed of circular segments around the blades, which form a chute to carry off the sawdust. At the end of its back stroke the counterbalance rises, unclamps the block, which drops, and is reclamped when the effective stroke commences. The belt-frame is oscillated by a crank which is operated by a worm-wheel and belt from the saw-shaft.

Fig. 4993 is a longitudinal section of a machine with two bolt-clamps, running together, one block yielding a shingle as the carriage passes in one direction, and the other, on the return, being presented to the saw on the opposite side. The reciprocating block-carriage is supported on a tilting track alternately inclined to the plane of the saw in opposite directions. The blocks are tilted by a rotary table, so that the butts are cut from alternate ends of the blocks.

Fig. 4994 is a top view of a machine of this description. The bolt-carriage is reciprocated by means of a cross-head with a straight slot in which works the wrist-pin of a crank which gives to the carriage an unequal progressive reciprocation; the diamond-shaped slot in connection with the wrist-pin of the crank working therein gives uniform feed to the bolt-carriage. The dogging devices act automatically and operate by weight

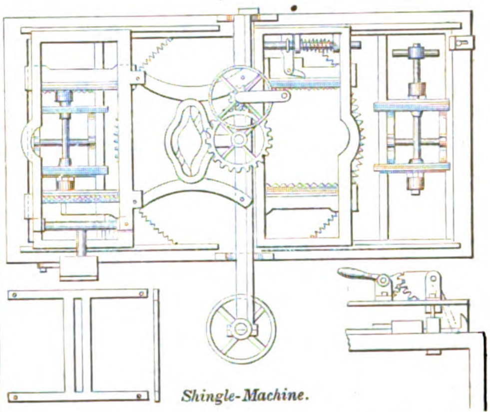
Fig. 4993.



Shingle-Machine.

and spring respectively. The two double taper-cams on one shaft alternately tilt the block to give taper to the shingles.

Fig. 4994.



Shingle-Machine.

Shin'gle-mill. A saw-mill for cutting logs into shingles.

Shin'gle-nail. A cut nail (6*d.*) of proper size for fastening shingles on a roof.

Shin'gle-plan'ing Ma-chine'. A machine in which roughly rived or sawn shingles are faced by planing in the direction of the grain of the wood.

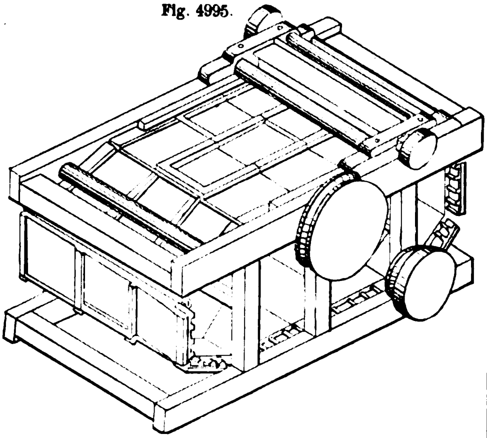
In Fig. 4995, the shingle blank is placed in one of the wedge-shaped pockets on the outer surface of the endless carrier, and passes beneath the rotary cutter, which removes the portion above the carrier.

There are other forms of planing-machines specially adapted for surfacing shingles.

Shin'gler. An eccentric wheel or roller revolving within a concave and pressing the dross out of the *loop* or *ball* from the puddling-furnace.

In the figure, the *loop a* is pressed between the three cam-rolls *b c d*, the first of which has a collar *b'*

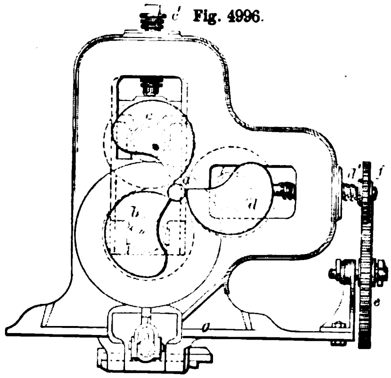
Fig. 4995.



Shingle-Planing Machine.

at each end, between which the other two work; *c* is adjustable by a screw *c′*, and *d* is backed by a screw *d′*, which yields when the thickness of the bar is excessive, and is brought back to place by a weighted lever on the axis of the wheel *e*, which engages with the pinion *f* that turns the screw.

Fig. 4996.



Brown's Shingler.

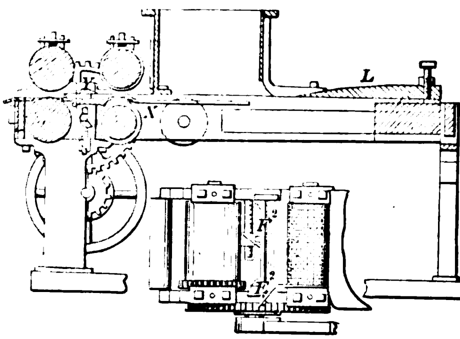
The squeezed bar drops on to the bed-plate *g* of the machine, and is then pressed longitudinally by a bell-crank lever device. See SQUEEZER; TRIP-HAMMER; STEAM-HAMMER.

In Siemens' process for shingling and compressing puddled balls, the ball is placed on a turn-table and subjected to the pressure of three or more hydraulic rams advanced simultaneously toward it horizontally in radial directions. The pressure being relieved and the rams withdrawn by counterweights and springs, the turn-table is partly turned so as to present fresh portions of the ball to the rams, which are again advanced. When the ball has thus been squeezed all round, a ram or screw head is brought to bear on it vertically, and the rams are advanced with a higher degree of pressure, after which the consolidated metallic mass is withdrawn to be rolled, hammered, or converted into steel. To economize power, two sources of hydraulic pressure are employed, the one giving a low pressure for the first part of the operation, and the other a much higher pressure for completing it. Instead of using a number of separate hydraulic cylinders, the several pressure-heads may be worked from one hydraulic cylinder, or by steam or other power.

Shin′gle-riv′ing Ma-chine′. One in which a block is fed to the knife, or the knife to a block, from which a shingle is split with the grain. See also SHINGLE-MACHINE.

In the example (Fig. 4997), the block lies in the hopper, and a portion projecting below is split therefrom between the stationary and reciprocating knives

Fig. 4997.



Shingle Riving and Planing Machine.

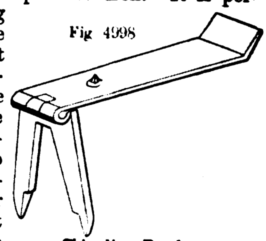
X L, which are in the same plane. The blank is then forced to the feed-rollers, which carry it between the upper and lower shaving-knives and the edging-knives E^2 F^2; the upper knife *Y* is gradually depressed to give the taper to the shingle passing endwise beneath it. The shingle is split, shaved, tapered, and jointed at one continuous operation.

Shin′gle-saw. See SHINGLE-MACHINE.

Shin′gle-trap. (*Hydraulic Engineering.*) A structure of posts or piles and boards fastened thereto, raised some distance above the surface of a beach, and operating to catch shingle, sand, and silt, so as to prevent the denudation of the shore and the encroachment of the sea upon the land. See GROIN.

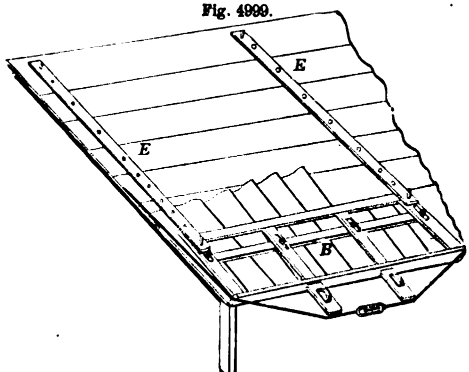
Shin′gling. (*Iron-working.*) The operation of removing slag, etc., from puddled iron. It is performed in a strong *squeezer*, or under the trip-hammer. Its object is to press out as perfectly as practicable the liquid cinder which the ball still contains; it also forms the ball into shape for the puddle-rolls. A heavy hammer effects this object most thoroughly, but not so cheaply as the squeezer. The ball receives from 15 to 20 blows of a hammer, being turned from time to time as required; it is now termed a *bloom*, and is ready to be rolled or hammered; or the ball is passed once through the *squeezer*, and is still hot enough to be passed through the puddle-rolls. See TRIP-HAMMER; SQUEEZER; STEAM-HAMMER.

Fig. 4998.



Shingling-Bracket.

Fig. 4999.



Shingling-Gage.

Shin'gling-brack'et. A device to enable a carpenter to stand on a roof while nailing on shingles.

Shin'gling-gage. A device for adjusting shingles in the proper position for nailing. In the example, the butts of the shingles are placed against the bar *B*, which is adjusted by the gaging-straps *E E* after each course of shingles is nailed.

Shin'gling-ham'mer. (*Metal-working.*) The tilt or other power hammer which acts upon the ball from the puddling-furnace and forces some of the remaining impurities therefrom. The iron is converted into a *bloom*, which may be rolled at the same heat and be thereby converted into bar-iron. The bars may be cut and made into *fagots* or *piles* for reheating and rerolling. For some purposes, or with some qualities, the bars, after the single rolling, are in a merchantable condition.

Blooming is used as synonymous with *shingling*, and is sometimes called *tilting*, as it was always performed with a tilt-hammer until the steam and other power hammer and squeezers were introduced.

Shin'gling-hatch'et. A tool with a poll, used in nailing on shingles, a bit for occasionally trimming them to fit, and a claw for drawing the nails.

Shin'gling-mill. (*Metal-working.*) A rolling-mill or forge, where puddled iron is hammered to remove the dross, compact the grain, and turn out malleable iron.

Shin'gling-tongs. Heavy tongs, usually slung from a crane and used in moving the ball of red-hot iron to and beneath the trip or steam hammer.

Ship. (*Nautical.*) A three-masted vessel, with square sails on each mast.

Noah's ark being 300 cubits long, 50 broad, and 30 high, and the cubit being that estimated by Mr. Greaves, would make the ark 547 feet long, 91 feet 2 inches wide, and 54 feet 8 inches high. 25,820 tons capacity.

The proportions are relatively much like those of the "Great Eastern," which was about 18,000 tons.

Ships with masts, yards, and square sails are shown in the ancient paintings of Eléythya, Egypt.

The Bible and other historical authorities agree in giving precedence to the Phœnicians in the matter of maritime navigation. Jacob (1689 B. C.), in assigning prophetically the dwelling of Zebulon, placed him "at the haven of the sea, and he shall be for a haven of ships, and his border unto Zidon." Zebulon failed, it may be mentioned, to possess the land assigned to the full extent. The same may be said of Dan, Simeon, and other tribes for a period of nearly five hundred years after Joshua led them across Jordan.

The prophecy of Balaam, about 1452 B. C., that Assyria should be destroyed by people who should come in ships from the coast of Chittim, was more than 1,000 years before the accomplishment. The deportation of the Jews to Egypt in ships under the Ptolemies and Titus was foretold by Moses, about 1450 B. C., as the result that follows unfaithfulness on the part of the people whom he led and served. See also Ezekiel, chap. xxvii.

The ships on the Nile for navigating during the inundation are from 10,000 to 24,000 bushels burden.

Some of the Nile vessels in former times were very large.

Diodorus mentions one built by Sesostris, about 478 feet long.

One built by Ptolemy Philopater was 420 feet long, 57 feet beam; was 83 feet high, and carried 4,000 rowers, 400 sailors, 3,000 soldiers. It had 40 banks of oars, the largest of which were 57 feet long and weighted with lead in the handles.

The royal barge on the Nile was nearly as large.

The galley built under the superintendence of Archimedes for Hiero, of Syracuse, was constructed by Archias of Corinth. It had 20 tiers of oars and 3 decks, the middle deck having on each side 15 dining-apartments, besides other chambers, sumptuously furnished, and the floors paved with mosaics from the story of the Iliad. On the upper deck were gardens with arbors of ivy and vines, and a temple of Venus paved with agates and roofed with cypress wood. It was adorned with pictures and statues, and furnished with couches and drinking-vessels. It had a library, baths, cabins for the soldiers, and stabling for 20 horses. In the forecastle were 2 immense cisterns, one of fresh water for consumption, and the other of salt water for a fish-pond. From the sides of the vessel projected ovens, kitchens, mills, and other offices built upon beams, and each supported by a caryatid 9 feet high.

Around the deck were 8 wooden towers for defense, the garrison of each being 4 soldiers and 2 archers. On this upper deck was the catapult for hurling stones of 300 pounds weight, and the ballista for throwing darts 18 feet long a distance of 300 yards.

The ship had 4 anchors of wood and 8 of iron, and the pump for removing bilge-water was the Archimedean screw. The crew for evolutions was 600 men, and the commissaries' stores included 60,000 bushels of corn, 10,000 barrels of salt fish, and 20,000 barrels of salt meat. She was at first called the "Syracuse," and afterward the "Alexandria." The mainmast came from England.

Hiero became tired of his great toy, and put the vessel to carrying corn. Finding the draft of water too great to enter any of the surrounding harbors, which detracted from its usefulness, he had to get rid of it like a king; so he loaded it with corn and sent it to Alexandria (coals to Newcastle), as a present to Ptolemy, king of Egypt, who admired. examined, emptied it, and hauled it on shore, and then forgot it. So does history, for that is the last we hear of it.

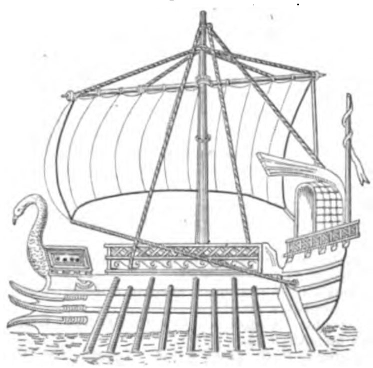
The penteconter is mentioned by Herodotus (I. 152). It had 50 rowers, who sat 25 on a side, on thwarts of the same level. The navy of Polycrates consisted of penteconters.

Biremes, where the rowers sat in 2 ranks, on different levels, were probably invented by the Phœnicians, and were known to the Assyrians in the time of Sennacherib. One is represented in the palace of that monarch at Kouyunjik.

Triremes were invented by the Corinthians about 750 B. C.

Fig. 5000 is a view of a Roman *biremis*, or two-banked galley. The Romans, by the account of Livy, first became aware of the importance of a fleet during the second Samnite war, B. C. 311.

Fig. 5000.



Roman Biremis.

As their colonies spread, especially when the Pontian Islands were embraced in their bounds, the necessity grew. In the time of the first Punic war the Romans became a maritime power, clearly foreseeing that in default of a navy Carthage could not be subdued. See also Smith's "Dictionary of Greek and Roman Antiquities," p. 783 *et seq.*

A. D. 1500. The "Great Harry," constructed by Henry VII., was the first ship of the English royal navy. Previous to this the navy consisted of vessels furnished by certain maritime towns.

1515. The "Henry Grace de Dieu," of 1,000 tons and 122 guns, mostly of small caliber, was built under the orders of Henry VIII. It was a sea-going failure

The "Caraçon," built by Francis I., ditto.

1603. The English navy consisted of 42 ships.

1610. The "Prince," 1,400 tons, built by James I.

The "Carrack" was a large ship. The "Santa Anna" was the property of the Knights of St. John, of about 1,700 tons, sheathed with lead, and built at Nice, 1530. It was a floating fortress, and aided Charles V. in taking Tunis in 1535. It had a crew of 300 men, and 50 pieces of artillery.

Of celebrated voyages may be mentioned that of the Phœnicians in the time of Pharaoh Necho (B. C. 610) in circumnavigating Africa.

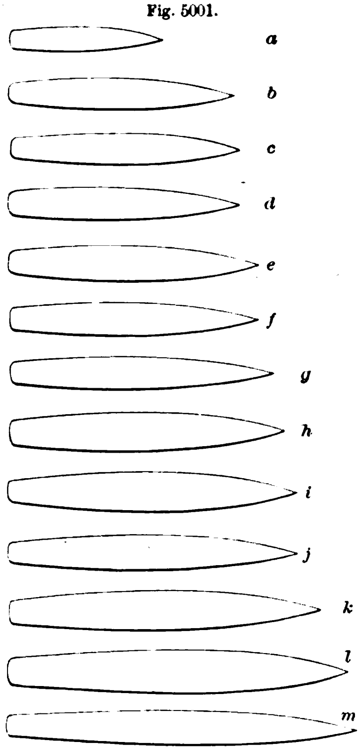
Christopher Colon in crossing the Atlantic, 1492.

Vasco de Gama in doubling the Cape of Good Hope, November 20, 1497.

Ferdinand Magellan in discovering the Pacific Ocean, into which he sailed from the Straits of Magellan, November 28, 1520, and which he named the Pacific Ocean. He sailed across the Pacific, reached the Ladrones, was killed by mutineers; the vessel anchored at Tidore, November 8, 1521, having been at sea 27 months.

Sebastian de Elcano, Magellan's lieutenant, doubled the Cape of Good Hope, and on September 7, 1522, the "San Vittoria" anchored at St. Lucar, near Seville, Spain; the first circumnavigation of the earth.

Fig. 5001.



Proportions of Ocean Steamers.

a, "Baltimore," N. G. Lloyd's line. Length, 185 feet; beam, 29 feet; length to breadth, 6·38.

b, "Peruvian," Allan line. Length, 270 feet; beam, 38 feet; length to breadth, 7·11.

c, "Moravian," Allan line. Length, 290 feet; beam, 39 feet; length to breadth, 7·44.

d, "Leipzig," N. G. Lloyd's line. Length, 290 feet; beam, 39 feet; length to breadth, 7·44.

e, "Minnesota," Williams & Guion line. Length, 332 feet; beam, 42 feet; length to breadth, 7·90.

f, "Rhein," N. G. Lloyd's line. Length, 332 feet; beam, 40 feet; length to breadth, 8·30.

g, "Westphalia," Hamburgh line. Length, 340 feet; beam, 40 feet; length to breadth, 8·50.

h, "Pennsylvania," American S. S. Co. Length, 343 feet; beam, 43 feet; length to breadth, 7·91.

i, "Russia," Cunard line. Length, 358 feet; beam, 43 feet; length to breadth, 8·33.

j, "Queen," National line. Length, 358 feet; beam, 41 feet; length to breadth, 8·73.

k, "Ville du Havre," French line. Length, 423 feet; beam, 49 feet; length to breadth, 8·63.

l, "City of Montreal," Inman line. Length, 433 feet; beam, 44 feet; length to breadth, 9·84.

m, "Atlantic," White Star line. Length, 435 feet; beam, 41 feet; length to breadth, 10·61.

The following works on seamanship may be consulted: —

Falconer's "Dictionary." "The Ship, its Origin and Progress." Steinitz. London, 1849. "Sheet Anchor." Lever. London (Am. ed.), 1854. "Kedge Anchor." New York, 1852. Luce's "Seamanship." Newport, R. I., 1863. Young's "Nautical Dictionary." London, 1863. Totten's "Naval Text-Book." New York, 1862. "Sailor's Word Book." Adm. Smyth. London, 1867. "Shipbuilding," by Rankine, Watts, Barnes, and Napier. Wiley & Sons. New York.

In Plate LIX., the upper figure is a longitudinal midship section of a steam sloop-of-war, carrying 22 guns. Vessels of this class are of 1,100 to 1,200 tons measurement, and have engines of 200 to 300 horse-power.

The next view shows the gun or spar-deck plan of the same.

The lower or berth deck is not shown by plan view. It contains the cabins, state-rooms, and accommodations for officers and crew in vessels of this class.

The sectional plan of the upper hold shows the arrangements of the lower deck, the bins for stores, stowage of the hatch, chain-cable lockers, arrangement of boilers, and general distribution of fuel; also magazine and shell-room.

The plan of lower hold shows the arrangement of keelsons, engine-bearers, and boiler-bearers, stowage of tanks and provisions in fore-hold, and details of magazine and light-room.

Ship'build-ing. See under the following heads:

After-timbers.
Air-port.
Anchor-stock planking.
Angle-iron.
Apostles.
Appendages.
Apron.
Arch-board.
Armor-plating.
Auxiliary screw.
Backing.
Balance-frame.
Balance-section.
Balcony.
Bay.
Beak.
Beak-head beam.
Beam.
Beam-line.
Bearding.
Bearding-line.
Bearings.
Bend.
Bending-strakes.
Berth and space.
Bevel.
Beveling.
Beveling-board.
Beveling-edge.
Bilge.
Bilge-board.
Bilge-keel.
Bilge-piece.
Bilge-plank.
Bilge-pump.
Bilge-ways.
Bill-boards.
Bills.
Bindings.
Binding-strakes.
Bitt-heads.
Bitts.
Black-strake.
Body-plan.
Body-post.
Bollard-timber.
Bolster.
Bolt-auger.
Bolt-strake.
Booby-hatch.
Boundary line.
Bow-lines.
Bracket.
Breadth-line.
Break.
Breast-beam.
Breast-hook.
Breast-rail.
Breastwork.
Breech.
Bridge.
Bridle-port.
Broadside.
Building-block.
Building-slip.
Bulge-ways.
Bulkhead.
Butt.
Buttock.
Buttock-line.
Cable-tier.
Caboose.
Calking.
Camber.
Cant-timber.
Cap-scuttle.
Carline.
Carvel-build.
Cat-beam.
Cat-hole.
Ceiling.
Center-line.
Chain-bolt.
Chain-locker pipe.
Chain-plate.
Chain wale.
Channel.
Chase.
Chock.
Clamp.
Clinch-built.
Clincher-built.
Clinker-built.
Coal-bunker.
Coamings.
Cock-pit.
Companion.
Companion-ladder.
Compass-timber.
Conversion.
Copper-bottomed.
Copper-fastened.
Counter.
Counter-rail.
Counter-timber.
Cove.
Cowner.
Cradle.
Cross-beam.
Cross-chock.
Cross-pawl.
Cross-piece.
Cross-spall.
Cross-timber.
Crutch.
Cutting-down line.
Cutting-down staff.
Cutwater.
Dagger-piece.
Dagger-plank.
Dead-door.
Dead-flat.
Dead-light.
Dead-rising.
Dead-wood.
Dead-works.
Deck.
Deck and side lights.
Deck-hook.
Deck-plate.
Development.
Diagonal-built.

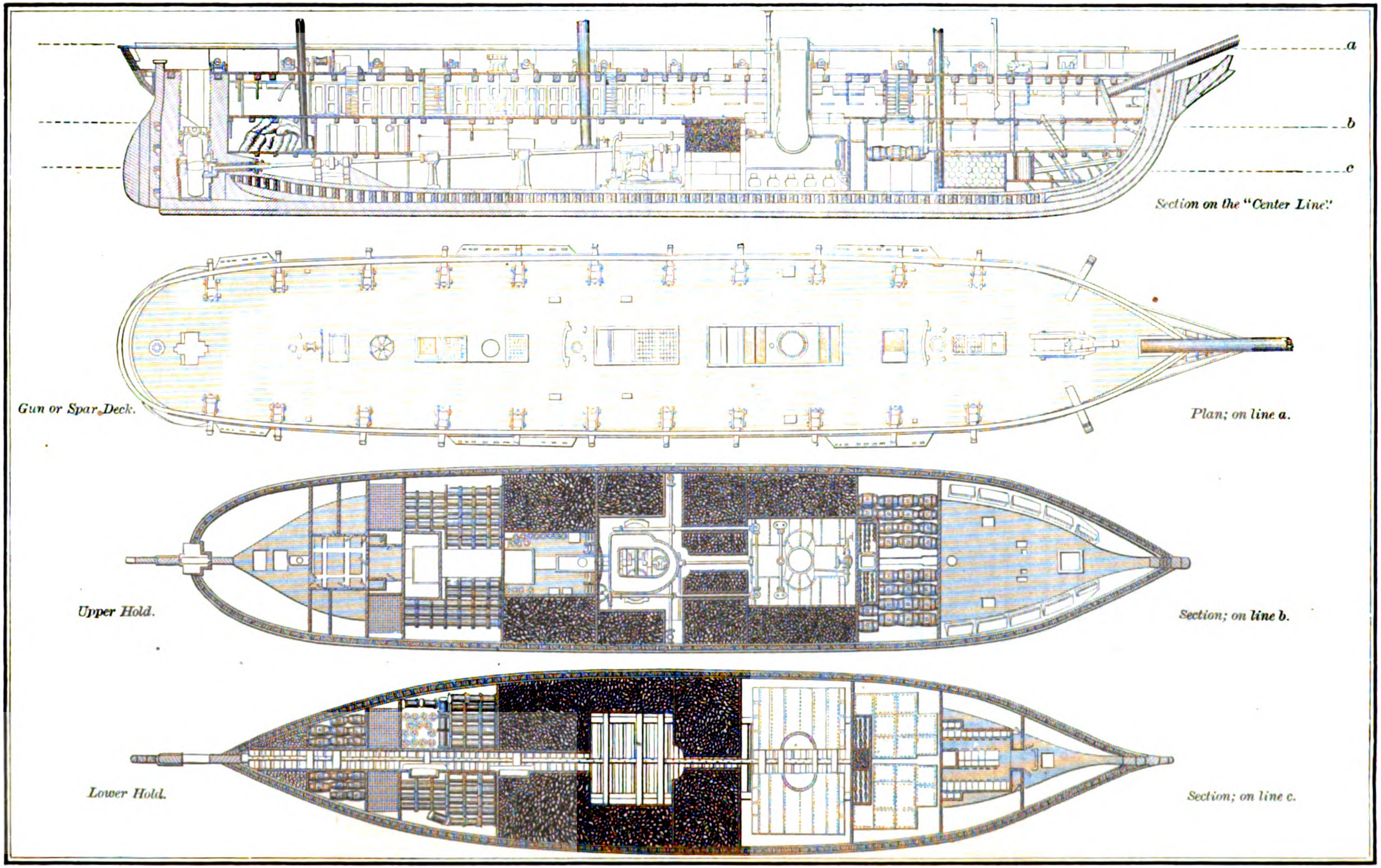


PLATE LIX.

STEAM CORVETTE OF 22 GUNS.

1200 *tons burden*, 300 *horse-power*.

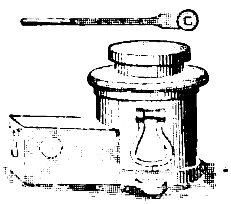
See page 2154.

Diagonal lines.
Diagonals.
Diminishing-stuff.
Dog-shore.
Double futtocks.
Dowsing-cheeks.
Drift-piece.
Dump-bolt.
Entering-port.
Expansion.
Face-piece.
False keel,
Fashion-piece.
Fay.
Faying-surface.
Fender-bolt.
Fife-rail.
Figure-head
Filling.
Filling-timber.
Fit-rod.
Flat.
Floor.
Floor-head.
Floor-plan.
Floor-timber.
Flush-deck.
Foot-waling.
Forecastle.
Fore-foot.
Fore-hook.
Fore-rake.
Fork-beam.
Forming.
Frame.
Free board.
Furring.
Futtock.
Futtock-plank.
Futtock-plates.
Futtock-shrouds.
Gallery.
Galley.
Gangway.
Garboard-strake.
Gore.
Gripe.
Ground-timbers.
Ground-way.
Guard.
Gun-deck.
Gun-room.
Gunwale.
Half-breadth plan.
Half-breadth staff.
Half-floor.
Half-port.
Half-timbers.
Hammock-nettings.
Hang.
Hanging-knee.
Harpings.
Hatch.
Hatchway.
Hawse-hole.
Hawse-piece.
Head
Head-knee.
Head-ledge.
Heel.
Heel-post.
Hight-staff.
Hog-chain.
Hog-frame.
Hold.
Hold-beam.
Hood.
Hooding-end.
Hook.
Horse-iron.
Horseshoe-clamp.
Horsing-up.
Hull.
Hurricane-deck.
Hydraulic block.
Ice-breaker.
Independent piece.
Inner post.
Keel.
Keelson.
Key-model.
Knee.
Knight-heads.
Knuckle-timber
Lace-piece.
Land.
Landing-strake.
Lapstreak.
Launch.
Ledges.
Lee-board.
Leefange.
Lengthening-pieces.
Level lines.
Light
Light-port.
Light-room.
Limber.
Limber-holes.
Limber-strake.
Line.
Lodging-knees.
Long timber.
Loof.
Main-breadth line
Main piece.
Making-iron
Manger
Mast.
Mast-carling.
Midship-bend.
Mold
Molding.
Molding-edge.
Moot.
Munnions.
Navel-hood.
Newell.
Nog.
Orlop.
Pad.
Paddle-box.
Paddle-wheel.
Pale.
Pallet.
Partners.
Paying.
Pillow.
Pin.
Plan.
Planking.
Planking-clamp.
Plank-shear.
Ploe.
Poop.
Poop-deck.
Poppet.
Port.
Port-flange.
Porthole-closer.
Port-lid.
Port-sash.
Propeller.
Pump-dale.
Pump-well.
Quarter.
Quarter-deck.
Quarter-gallery.
Quick work.
Rabatment
Rabbet
Race-knife
Raft-port.
Rail.
Rake.
Ram.
Reaming-iron.
Relieving-gear.
Rib.
Ribband
Ribband-line.
Rider.
Riding-bitt.
Rising.
Rising-floor.
Rising-line
Rising-square.
Rising-wood.
Risings.
Room and space staff.
Rough-tree rail.
Round-house.
Round-up.
Rove.
Rudder.
Rudder-band.
Rudder-case.
Rudder-chains.
Rudder-coat.
Rudder-post.
Rule-staff.
Run.
Rung.
Rung-head.
Saddle.
Samson-post.
Scantling
Screen-bulkhead.
Screw.
Screw-alley.
Screw-post.
Screw-well.
Scupper.
Scuttle.
Seam.
Set-bolt.
Sett.
Shaft-alley.
Shaft-pipe.
Shaping.
Sheathing
Sheer.
Sheer-line.
Sheer-plan.
Sheer-strake.
Shelf.
Shift.
Shole.
Shore.
Siding.
Sister keelson.
Skeg.
Skin.
Slee.
Sleeper.
Slice.
Sliding-keel
Sliding-way.
Slip.
Slip-way.
Snaped timber.
Sny.
Snying.
Sole.
Spales.
Span-shackle.
Spar-deck.
Spiling.
Spirketing.
Sponson.
Sponson-rim.
Spring-beam
Spurs.
Square frame.
Square stem
Square timber.
Square tucks
Staff.
Stanchion
Standard
Staple-knee.
Station
Stealer
Steerage.
Steering-wheel.
Steeving.
Stem.
Stem-knee.
Stem-piece.
Stem post.
Stemson.
Step.
Stepping-line.
Stern.
Stern-frame.
Stern-post.
Sternson.
Stirrup.
Stocks.
Stomach-piece.
Stool.
Stopper-bolt.
Stopping-up pieces.
Straight of breadth.
Strake.
String.
Stringer.
Surmark.
Sweetening-cock.
Syphering.
Tabernacle
Tabling.
Taffrail.
Tank.
Templet.
Term.
Term-piece.
Texas.
Thick-stuff.
Throat.
Timber and room.
Timber-hatch.
Timber-head.
Top and butt.
Top side.
Top timber.
Top-timber line.
Touch.
Towing-post.
Trail-board.
Transom.
Tread.
Tree.
Treenail.
Trigger.
Trimming.
Tuck.
Tumbling-home.
Twin-screws.
Waist.
Wale
Washboard
Water-lines.
Water-way.
Way.
Wing
Wing-passage.
Wing-transom.
Wood-lock
Wrain-bolt.

Ship'build-ing-dock. A chamber with a floor and walls of stone masonry, having an opening toward the adjoining harbor, which can be closed when required by a pair of folding gates or by a floating caisson gate. The size is according to the length and beam of the vessel designed to be built in it. The sides slope off in a series of steps at about an angle of 45°, so as to form abutments for shores and scaffolding. The width at top is equal to the width at bottom plus twice the depth. See also DRY-DOCK; GRAVING-DOCK.

Ship-jack. A compact and portable form of hydraulic jack, adapted for lifting ships and other heavy objects; the number required being proportionate to the weight. The launch of the "Great Eastern" was ultimately effected by the employment of these jacks.

Fig 5002.



Ship-Jack.

Ship-pen'du-lum. A pendulum with a graduated arc, used in the

navy to ascertain the *heel* of a vessel, so that allowance may be made in laying a gun for the inclination of the deck.

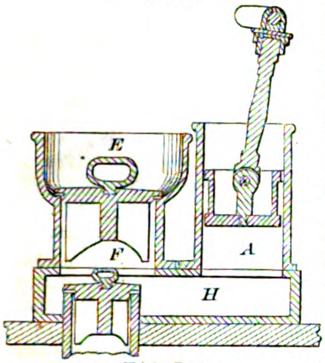
Ship's Ar′mor. See ARMOR-PLATING.

Ship's Berth. (*Nautical.*) *a.* The position occupied by a ship in an anchorage or dock or beside a wharf.

b. A standing bed-place on shipboard.

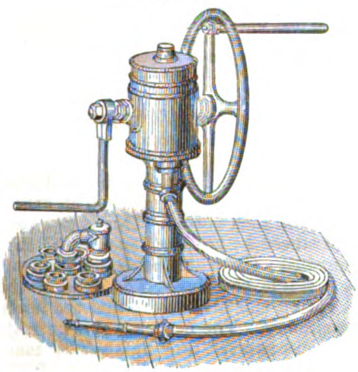
Ship's Pump. A suction-pump for freeing a ship's hold from water. That illustrated is provided with a chamber *H* above the deck, with which the head of the pump-barrel and foot of the suction-tube *A* communicate. The cover *E* and valve *F* are removable, so that ready access may be had to the interior of the pump. Downton's pump is used in the British navy as a bilge, deck-washing, and fire-engine pump. It has three buckets, one above another, in the barrel, and an air-chamber in the head, so as to discharge a continuous stream of water. When fitted with deck or suction plates, it is capable of drawing water from three to six different parts of a vessel.

Fig. 5003.



Ship's Pump.

Fig. 5004.



Ship's Pump with Hose.

Ship-thim′ble. (*Nautical.*) An eyelet or metallic grommet, forming an eye in a sail or to a rope.

Ship′wright's Tools. See WOOD-WORKING TOOLS AND MACHINES.

Shirr. (*Fabric.*) An elastic cord inserted in cloth or between two pieces. See RUBBER THREAD.

Shirred Goods. (*Fabric.*) Goods with elastic cords (*shirrs*) interwoven in suspenders, garters, etc.

Shirt′ing. (*Fabric.*) Bleached or unbleached cotton cloth, of quality and texture suited for undergarments.

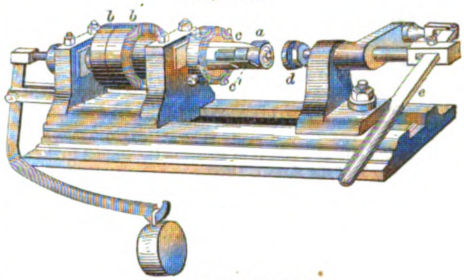
Shive. 1. A bung.

2. The scale or bark removed from the fibrous portion (*hare*) of hemp and flax in *braking*.

3. A SHEAVE (which see).

Shive-cut′ting Ma-chine′. (*Wood-working.*) A machine for cutting shives or bungs. It has heads *a* and *d*, between which the board, out of which the bungs are to be cut, is placed. The cutters *c c′* are on a hollow spindle, which is rotated by a band on the pulley *b*. *b′* is a loose pulley. The board to be cut being in position, the lever *e* is moved, driving forward the head *d* and forcing the board against

Fig. 5005.



Shive-Cutting Machine.

the head *a*, which retreats, allowing the cutters *c c′* to make an annular groove, which goes through the board and produces a bung. The lever is then backed; the head *a* is advanced by means of the weight, which acts upon the rear of the spindle, and the bung is forced from between the cutters and drops to the floor.

Shiv′er. 1. A small *sheave.*

2. A small wedge or key.

Shoad; Shode. (*Mining.*) Surface ore in pieces mixed with other matters, and indicating the *outcrop* of a lode or vein in the vicinity.

The method of finding the vein by tracing the *shoadstones* to their source at the *strike* is called *shoading.* Holes dug to prospect or intercept the vein are called *shoad-pits.*

Shoal-a-larm′. An audible alarm consisting of a bell, whistle, or trumpet, rung or blown by power derived from the rocking of the vessel, which is moored at the shoal, or by machinery moved by the current, tide, or wind. See FOG-ALARM.

Shoal-in′di-ca′tor. (*Nautical.*) A buoy or beacon placed upon a shoal to indicate its position to mariners.

Shock. 1. (*Husbandry.*) *a.* A collection of *sheaves* standing together in the field, for the grain to ripen. Called in England a *shook* or a *stook.* It has usually twelve sheaves, but customs differ.

b. A collection of cut stalks of corn standing in the field around a central core of four stalks, whose tops are diagonally woven together and bound at the intersection. This central support holds the stalks while they are being set up, and is called a *gallows.* The shock should be bound when about one third of the stalks are in place, and bound again when all are gathered. It should be of a conical form when completed.

2. See SHOOK.

Shod′dy. (*Fabric.*) A cloth made from worn woolen rags. These are torn to pieces by a machine having spiked rollers (termed a devil), cleansed, and the fiber spun with a certain proportion of new wool, the yarn being afterward woven into the full-bodied but flimsy fabric, termed shoddy.

Mungo is made from tailors' clippings similarly treated.

Sho′der. (*Gold-beating.*) The package of gold-beater's skin employed in the second stage of gold-leaf making. The first package is the *kutch.* The last is the *mold.*

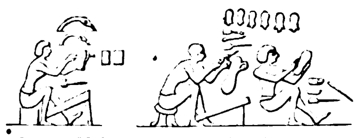
Shoe. 1. (*Apparel.*) *a.* A covering for the foot, made of leather in Europe, America, and some other parts; of paper and various fabrics in China and Japan; of wood in Holland and France (sabots); of dressed skins among the North American Indians (moccasins).

A shoe has a thinner and more elastic leather for the upper, and one or two thicknesses of thicker leather for the sole. The parts are united by stitches, pegs, nails, screws, cement. See BOOT; MOCCASIN; SABOT.

Among the interesting series of trades practiced by the Egyptians in the times of Joseph and of Moses, and illustrated in the tombs of Thebes and elsewhere, are shown the shoemaker at his bench engaged in boring a leather sole with an awl. The latter is also represented, as also two pieces of leather not yet cut to shape, and two thongs ready twisted, which are to be attached to the sole as a means of securing the sandal to the foot. The painting is of the time of Thothmes III., the contemporary of Moses, 1490 B. C.

Another shoemaker's shop is represented in a Theban painting, where a larger stock and selection of tools are shown. Two men are employed; one is piercing the side piece by which the thongs are attached to the soles, and the other tightening the thread in the time-honored way, gripping it by the teeth. The tools are a mallet, bent and straight awls, a scraper, and a tool like a comb, which probably had a row of points for marking the places for piercing with the awl.

Fig. 5006.



Sandal-Makers and Shoemakers in Thebes.

In Dr. Abbott's collection of Egyptian antiquities, now in the possession of the Historical Society of New York, are a number of shoes which have survived the lapse of centuries. While many of them are shriveled, dried, and dilapidated, sufficient remains to identify their form and mode of construction. The most interesting one is yet occupied by the foot of a mummy. The bones and dried integuments reveal a form of extreme elegance, with a highly arched instep and feminine grace and proportions. The material of the shoe has become brittle by the desiccation of perhaps 25 centuries, and is falling to pieces. It appears to have been of kid, but is securely locked in a case, and does not admit of very close inspection.

The shoes of the ancient Egyptians were made of papyrus, leather, or textile fabrics. The *upper* was sewed to the *sole*, but an examination of a number of shoes of that ancient people has failed to reveal a *heel*.

The Chinese and the inhabitants of India have had shoes from time immemorial. Skins, silk, rushes, linen, wool, wood, bark, and metal have been used by these Orientals.

The Homeric heroes are represented without shoes. Moses wore sandals or shoes in the wilderness of Sinai. The early Greeks and Romans used them but little; succeeding ages introduced foot coverings of various kinds: the sandal with latchet; the same with a toe-piece or cap; a leather moccasin, or soleless shoe; a shoe in which the toes are exposed (Fig. 4557, *e*); a shoe, as we understand it; slippers; boots; buskins, etc., etc.

The material was of *tanned* or *tawed* skins.

Homer, Ovid, and Pliny agree in celebrating the skill of Tychius, the Bœotian, in the art of shoemaking. The latter credits him with the invention of leathern shoes. It may be supposed that the sandal and moccasin had been in use from time immemorial, and that Tychius united an upper to a sole and formed a shoe.

If so, he had been anticipated in this by the Egyptians.

Artaphernes, speaking to Histiæus, said, "Aristagoras drew the sandal on, but it was of your stitching." See SANDAL.

"Extravagance has descended to our clothes and shoes." — ATHENÆUS.

The Roman senators wore leathern (or skin) boots reaching to the midleg: these were usually black, but Roman magistrates wore red shoes on occasions of ceremony.

The Roman foot-gears were the *calceus*, or shoe, and the *solea*, or sandal. The former had an upper and sole, and was tied upon the instep with a latchet or lacing. See SANDAL.

The *solea* was a cork or wooden sole, covered above and below with leather, and stitched on the edge. It left the upper part of the foot bare, and was secured by straps, which were crossed over the instep and wound about the ankle. No buckle.

The *caliga* was the coarse shoe of the Roman soldier and company officers. The regimental officers, so to speak, wore the *calceus*. The sole of the *caliga* was thickly studded with hob-nails.

Other protections for the foot were the *cothurnus* and the *socca*. See Smith's "Dictionary of Greek and Roman Antiquities."

The shoes of the Emperor Marcus Aurelius had separate compartments for the toes, as we see by a statue of that monarch.

The small shoes and cramped feet of the Chinese ladies cannot be traced farther back than the tenth century A. D.

From the twelfth to the fifteenth centuries shoes were made for the fashionables with long toes, stuffed with *tow*. In the reign of Richard II., the toes of the boots were chained to the knees. In 1493, Parliament limited the length of the *pike*, or useless projection, to two inches.

In the seventeenth century very high heels were in vogue among the English ladies.

See "The Boot and Shoe Makers' Assistant," London, 1853, for an excellent display of early foot-coverings.

The Syrian shoes are made to be easily shifted on and off, as they are left at the entrance to a mosque or room. They are made of various materials for indoor or outdoor wear; leather for the latter. They have boots also, but the representations of their "foot-gear" with which we are favored by travelers make very poor affairs of either shoes or boots, they appearing to have no broad sole, but to resemble heavy moccasins.

Fig. 5007.

Syrian Shoes.

Isambard M. Brunel invented, in 1810, a machine for making seamless shoes. Sir Richard Phillips states as follows, in his "Morning Walk from London to Kew": —

"I was shown his manufactory of shoes, which is full of ingenuity, and, in regard to subdivision of labor, is on a level with the admired manufactory of pins. Every step is effected by the most elegant and precise machinery; while, as each operation is performed by one hand, so each shoe passes through 25 hands, who complete from the hide, as supplied by the currier, 100 pairs of strong and well-finished shoes per day. All the details are performed by the ingenious application of the mechanic powers; and all parts are characterized by precision, uniformity, and accuracy. As each man performs but one step in the process, which implies no knowledge of what goes before or comes after him, so the persons employed are not shoemakers, but invalided soldiers, who are able to learn their respective duties in a few hours. The contract at which these shoes are delivered is 6*s.* 6*d.* per pair ($1.56), being at least 2*s.* (44 cents) less than what was before paid for an inferior article."

Brunel's nailed shoes did not answer the expectations formed of them; the nails were found to penetrate the leather of the soles and hurt the soldiers' feet in marching, so that the scheme was finally abandoned.

Shoes are now largely made by machinery. Several different methods and a great variety of machines are employed. In one process, a thread is cut upon a brass wire, and the screw thus made is forced through the sole and upper placed on an arm beneath and riveted and then cut off. This is repeated as the shoe is advanced by the workman, until the operation is finished; the whole being effected automatically by a single machine. The ends of the wires are then cut off and filed down, and the heels nailed on by machinery. The heels are also burnished and the soles sand-papered and finished by machinery. See NAILING, PEGGING-MACHINE; pages 2161, 2162; also the pages here following.

India-rubber shoes and boots are made by the following process: —

The gum is ground and cleaned.

Is triturated with say 3 per cent of sulphur.

Dissolved in benzine or other solvent.

The *cement* thus obtained is spread upon fabric by rollers; the lower roller carrying the cloth moves slower than the heated upper roller, and thus generates a friction which *grinds* the gum into the cloth.

The cloth is cut by pattern into the required shapes and sizes.

These are united by rubber cement over a last.

They are treated with linseed-oil varnish laid on with a brush.

Put in a heater, 280° Fah., for 7 hours.

b. A *snow-shoe*; a *racket*.

2. (*Farriery.*) A metallic plate nailed to the hoof of a horse, mule, or ox, to preserve the hoof from wear and prevent it from becoming sore. See HORSE-SHOE.

3. (*Machinery.*) *a.* A bottom piece on which a body is supported, as the *ink*, *step*, or support for the lower end of a vertical shaft.

b. A piece on which an object is placed while moving, to prevent its being worn.

4. (*Building.*) *a.* A block or base piece for the reception of a pillar, or on the top of a column for the reception of a truss, girder, or other portion of the flooring or roof-frame.

b. An iron plate having an inclined seat adapted to receive the foot of a rafter.

5. (*Shipwrighting.*) The step of a mast; it rests on the keelson.

6. (*Nautical.*) *a.* The *bill-block.* A wooden piece secured to an anchor during the operation of *fishing*; it holds the point as the anchor rises, and keeps it from tearing the ship's side.

b. A board lashed to the fluke to extend its area and consequent bearing surface when in the ground.

c. A foot-board on which a spar is erected, to act as a jib in hoisting.

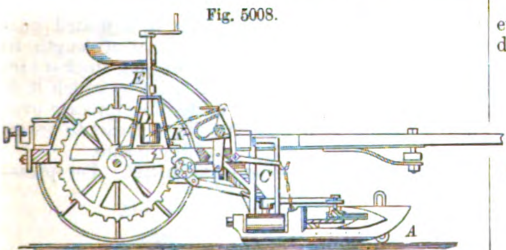
7. (*Wheelwrighting.*) *a.* A strip of wood or steel fastened beneath the runner of a sled or sleigh, to take the wear. Cast-iron soles of a peculiarly hard quality are used to advantage, and are bolted to the runners. Otherwise called a *sole.* See SLED.

b. A drag to receive the wheel of a vehicle to retard the course of the latter in going down hill. But little used in this country, where we have convenient wagon and carriage locks. See WAGON-DRAG.

8. (*Agriculture.*) *a.* The metallic block on the inner end of a finger-bar; it runs on the ground next to the standing grain. To it the finger-bar is hinged in harvesters of the usual construction.

Fig. 5008, *A*, shoe; *C*, bell-crank lever, having attached a chain *K*, which is wound upon the drum

Fig. 5008.



Mowing-Machine.

D on the crank-shaft *E*, to raise the finger-bar from the ground.

b. The shaking portion of a winnowing-machine or grain-separator, in which the grain is separated from the chaff and offal. The shoe is pivoted at one end and oscillated by power applied to the other. It is furnished with riddles and sieves, and the grain, etc., under treatment is subjected to a blast of air from a rotary fan.

9. (*Milling.*) The spout beneath the feeding-hopper which conveys the grain from the latter to the eye of the runner. The shoe is shaken by a *damsel* on the spindle.

10. (*Mining.*) *a.* An inclined trough used in an ore-crushing mill.

b. A removable piece of iron at the bottom of a stamp or muller in a stamp-battery, ore-grinder, or amalgamator.

11. (*Railway-engineering.*) That part of a car-brake which is brought in contact with the wheel in the act of stopping a train.

That shown in Fig. 5010 has a metallic sole *C*,

Fig. 5009.

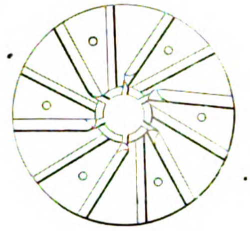
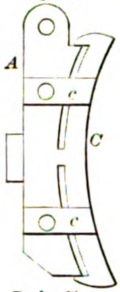

Shoe.

Fig. 5010.



Brake-Shoe.

with arms *c c* embracing the wooden shoe *A*, and having holes to receive pins or blocks which pass through the shoe.

12. The iron point of a pile.

13. The short horizontal section at the foot of a rain-water pipe, to give direction to the issuing water. The top end is the *head.*

Shoe-block. (*Nautical.*) One having two sheaves which revolve in planes at right angles to

Fig. 5011.


Shoe-Block.

Fig. 5012.

Shoe-Stretcher.

each other. They are generally used as *buntline-blocks* to courses, the *buntline* reeving in the upper sheave, and the *whip* in the lower one.

Shoe-brush. Shoe-brushes formerly were always employed in pairs, — a hard brush for removing the dirt and polishing, and a softer one for spreading the

Fig. 5013.


Shoe-Edge Trimmer (Shoe-Machine Manufacturing Co.).

blacking. It is now usual to unite the two, a small circular soft brush being attached to the back of the hard brush, which is frequently provided with a handle. The soft brush is sometimes cylindrical and turns on pivots.

Shoe-butts. (*Leather.*) Stout leather for soles.

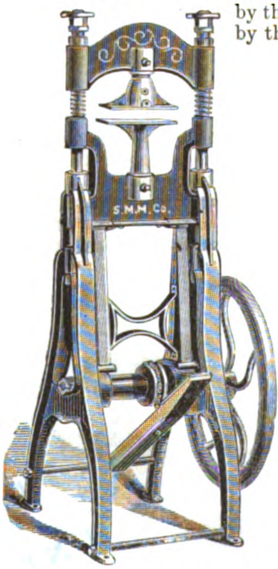
Shoe-clasp. A buckle for closing some kinds of shoes.

Shoe-dis-tend′er. An implement for expanding a somewhat tight shoe. An expanding-last. In the example (Fig. 5012), the cap *D* and heel-plug *C* are driven apart by the action of the screw, and thereby stretch the shoe.

Shoe-edge Trim′mer. (*Shoemaking.*) The shoe is mounted upon a jack, the carriage of which has communicated to it a movement of translation and rotation, so that while the side of the sole is being trimmed, the shoe is fed longitudinally against the knife, but at the toe and heel is rotated beneath it. The knife is universally jointed, to permit the hand of the operator to determine the different bevels cut.

Shoe-em-boss′ing Ma-chine′. (*Shoemaking.*) For embossing boot and shoe fronts with any required ornamental design before they are worked up. It can be made to emboss the fronts of finished shoes by a simple attachment. The upper platen is moved by the treadle and returned by the springs.

Fig. 5014.



Shoe-Embossing Machine.

Fig. 5015.

Shoe-Eyeleting Machine.

Shoe-eye′let-ing Ma-chine′. Eyelets are fed one by one from the reservoir at the top, down the inclined ways, and are seized at the foot between the plunger and anvil, and riveted in their proper places in the shoe or strip of leather, which is held and fed by the operator.

Shoe-fast′en-er. A device for closing a shoe. A button-hook.

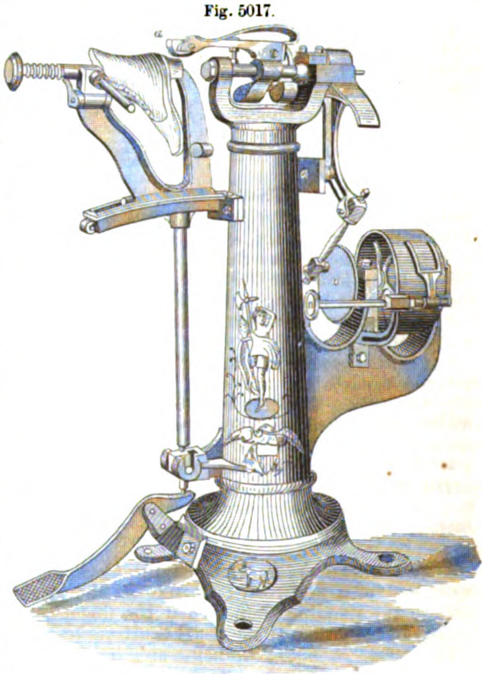
Fig 5016.

Shoe-Hammer.

Shoe-ham′mer. A hammer with a slightly convex, broad face, and a wide, thin, rounding peen, whose length is transverse to the handle. Used in pounding leather upon the lapstone, to condense its pores. Also in driving pegs. The peen is used in pressing out the creases incident to the crimping of the leather.

Shoe-heel Bur′nish-ing-ma-chine′. A machine in which a shoe or boot is chucked and revolved against a burnishing-tool. The one shown

Fig. 5017.

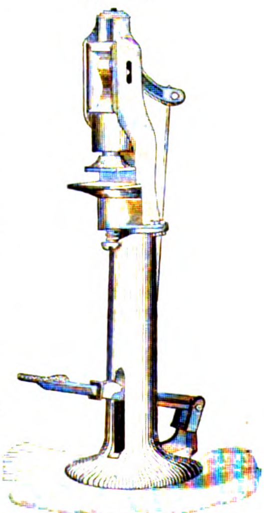


Shoe-Heel Burnishing-Machine.

in Fig. 5017 uses a *hot-kit*, that is, a heated burnisher. A flexible gas-pipe of sufficient length to follow the oscillations of the burnishing-stock *a* carries to the interior of the tool a jet by which it is kept heated. The tool is made to reciprocate over the surface of the heel, passing from breast to breast at each oscillation with an elastic pressure.

Shoe-heel Press′ing-ma-chine′. For pressing together the *lifts* which compose a boot or shoe heel, and dispensing with the shop work of hammer and lapstone. The bed is adjusted vertically by a screw to any thickness to which the blank heel may be built, and the plunger brought down by the depression of the treadle with such force as to compact the lifts together.

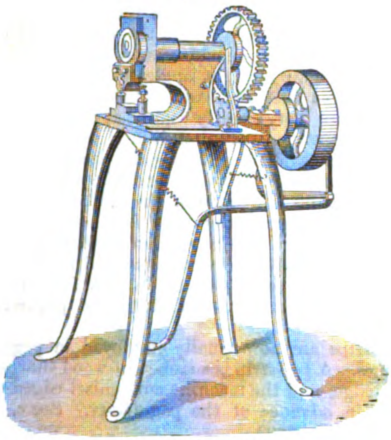
Fig. 5018.



Heel-Pressing Machine.

Shoe-heel Prick′ing-ma-chine′. The operation of this machine succeeds that of the heel-pressing machine. The compressed lifts, secured together in heel form by tacking, are placed upon the platen and pierced with all the

Fig. 5019.

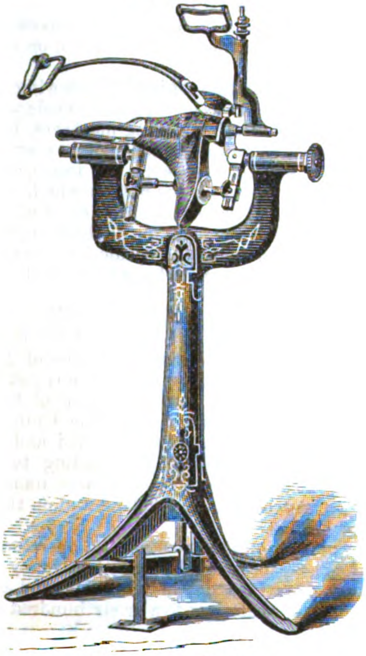


Heel Pricking-Machine.

nail-holes simultaneously, by the descent of the plunger carrying the gang of awls. The heel is then ready to receive the nails for attachment to the shoe.

Shoe-heel Trim′mer. The Coté heel-trimmer was patented in the United States in 1873, but first introduced into use in the Dominion of Canada. The shoe is held stationary by the treadle-clamp, and the knife-stock, which is centrally pivoted to the outer plate or jaw bearing upon the tread-lift, is then

Fig. 5020.



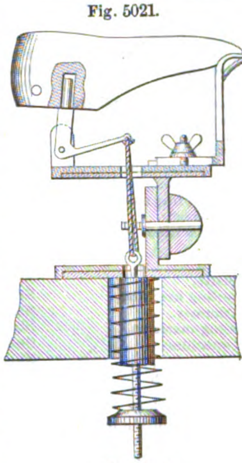
Coté Shoe-Heel Trimmer.

grasped in the hands of the operator, and moved to give a sweeping cut to trim the heel.

Shoe′ing-ham′mer. (*Farriery.*) A light hand-hammer used for shoeing horses.

Shoe′ing-horn. A device to assist in putting on a shoe. It is inserted between the heel of the person and the rear part of the counter of the shoe. Frequently made of polished horn, but also of sheet-metal.

Fig. 5021.



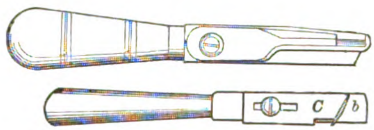
Shoe-Jack.

Shoe-jack. A holder for a last while a shoe is in process of manufacture. See Figs. 5017, 5020; PEGGING-MACHINE, Figs. 3603 and 3606. In the example, by horizontal and vertical adjustments, which incline it as required, the last is presented in a convenient position for stitching or pegging the work.

Shoe-key. (*Shoemaking.*) A hook by which a last is withdrawn from a boot or shoe.

Shoe-knife. A thin blade of steel affixed by a tang in a wooden handle, and used by shoemakers for cutting and paring leather. One shown in Fig.

Fig. 5022.



Guarded Shoe-Knife.

5022 is provided with a gage or guard *C* having a turned-up lip *b*, and adjustable by means of a slot and thumbscrew to determine the depth of cut.

Shoe′mak-er's Pinch′ers. The jaw-tool with which a shoemaker strains the leather over the last. See *L S*, Fig. 3726, page 1706.

Shoe′mak-ing-ma-chine′. Mark Isambard Brunel obtained an English patent, August 2, 1810, No. 3369, for a machine making boots and shoes. It was intended for fastening the soles to the upper by metallic pins or nails. It shows a press with clamping plates the shape of the sole, between which the leather is pressed, their margins forming the guide for a knife which cuts them to form. The sole is then clamped on a last, and a plunger with an awl and punch at the end is brought down by a lever. The pegs of "metal, leather, bone, whalebone, catgut, or any other animal or vegetable substance fit for it," are placed by hand in the holes made by the awl. As each one is driven the awl on the plunger makes a hole for the next peg. The peg-holes are spaced by notches on the guide-plate, which is clamped on the shoe-sole, and exposes a half-inch margin of sole all round. Metallic pins are clinched; others are beaten and seared.

The modern practice is to divide the various operations among a number of machines, which are separately considered on the adjacent pages.

Shoe′mak-ing Ma-chin′er-y and Ap-pli′-an-ces.

Beating-out machine.
Binding-roller.
Block-plane.
Boot-channeling machine.
Boot-crimper.
Boot-edge trimmer.
Boot-grooving machine.
Boot-heel cutter.

Boot-holder.
Boot-seam rubber.
Boot-shank machine.
Boot-stretcher.
Boot-tree.
Boot-tree and seam-rubber.
Boot-turner.
Bottom-lining machine.
Button-hole cutter.
Channeling-machine.
Counter-chopping machine.
Counter-dividing machine.
Counter-skiver.
Creasing-machine.
Crimper.
Die.
Edge-plane.
Edge-setting machine.
Edge-trimmer.
Embossing-machine.
Eyelet-machine.
Float.
Folding-machine.
Hand-pegger.
Head block and jack.
Heel-breasting machine.
Heel-burnishing machine.
Heel-cutting machine.
Heel-face dresser.
Heel-grinding or bottom-finishing machine.
Heel-machine.
Heel-polisher.
Heel-pressing machine.
Heel-pricking machine.
Heel-seat cutter.
Heel-share.
Heel-trimmer.
Instep-stretcher.
Jack.
Lap-shaver.
Lap-skiving machine.
Last and standard.
Last-holder.
Lasting-awl.
Lasting-jack.
Lasting-machine.
Lasting-pinchers.
Lasting-tool.
Leveling-machine.
Lining-marker.
Machine-awl.
Machine-knife.
Machine-needle.
Mallet.
Marking-stamp.
Marking-wheel.
Nail-driver.
Nailing-machine.
Pasting-machine.
Peg-cutter.
Peg-float.
Pegging-awl.
Pegging-jack.
Pegging-machine.
Pinchers.
Punch.
Punching-machine.
Rand-forming machine.
Randing-machine.
Rolling-machine.
Sand-papering machine.
Screw-press.
Seam-roller.
Seam-set.
Shank-cutter.
Shank-cutting machine.
Shank-last and standard.
Shank-laster.
Shoe-embossing machine.
Shoe-eyeleting machine.
Shoe-heel burnisher.
Shoe-heel presser.
Shoe-heel pricker.
Shoe-heel trimmer.
Shoe-jack.
Shoe-shave.
Shoe-stretcher.
Shoe-tree.
Side-welt machine.
Skiver.
Slicker.
Sole-cutting machine.
Sole-finishing machine.
Sole-leather cutter.
Sole-leather molding-machine.
Sole-leather rolling-machine.
Sole-leather splitting-machine.
Sole-leather stripping-machine.
Sole-leveler.
Sole-molding machine.
Sole-rounding machine.
Sole-shaper.
Splitter.
Splitting-machine.
Stamping-machine.
Standard.
Strip-cutting machine.
Stripping-machine.
Tip-punching machine.
Vise.
Waxer.
Wax-thread sewing-machine.
Welt-awl.
Welt-cutter.
Welt-guide.
Welt-knife.
Welt-machine.
Welt-trimmer.
Wrinkling-machine.

Shoe-nail'ing Ma-chine'. See NAILING-MACHINE, Figs. 3283, 3284, 3285, pages 1507, 1508.

Shoe-pack. A moccasin of tanned or tawed leather. See PAC.

Shoe-peg. (*Shoemaking.*) A small slip of wood used to fasten the upper to the sole, and the soles to each other. See Fig. 3568, page 1648.

Shoe-pegs are said to have been invented by Joseph Walker, of Massachusetts, about 1818.

They are made by machinery. The bark is peeled off the log, which is then sawed into slices across the grain, a little thicker than the length of a peg. The face of each block which is intended for the heads of the pegs is planed smooth.

The block is grooved by a machine in which a V-shaped cutting-tool reciprocates rapidly across the face of the block, which is advanced the thickness of a peg between each stroke of the cutter, by feed-rollers. After the block has been grooved one way, it is again grooved at right angles to the first grooves, the surfaces of the block on one side now presenting a regular succession of quadrangular pyramids, which are the points of the yet embryo pegs.

The splitting is done on machines by a vertically reciprocating knife, which drives into each groove in turn, as the block is fed beneath it, the object being not to split the pegs entirely apart, but to have them hang together at the heads. The blocks are fed to the splitting-knives by fluted rollers, the flutes of which fit the grooves in the blocks made by the grooving-machine. When the block has passed through the splitting-machine once, it is turned and fed through again at right angles to the direction in which it was first fed, and after this operation the pegs are very nearly split apart, but they still hang together somewhat like a bunch of split lucifer matches. After the second feeding, knotty and faulty parts are removed, and the block is forcibly thrown off the table of the splitting-machine on to the floor, and the pegs fall asunder. The pegs are then dried in a tumbler heated by steam-pipes, bleached with sulphur fumes till they assume a uniform white color, run through a fanning-mill to free them from dust, and finally packed for market.

Peg-strips are now usually employed in pegging-machines. A *peg*-strip is a ribbon of wood sharpened on one edge, and the machine cuts chisel-edged pegs from it in advance of the peg-driver. See *c*, Fig. 3598, and Fig. 3603.

The largest factory of shoe-pegs in this country is at Burlington, Vt., where one factory transforms every day four cords of wood into four hundred bushels of shoe-pegs.

There are now many substitutes for wooden pegs; the cable screw-wire, pegs of pressed leather, rivets of various kinds. See Fig. 3598.

Shoe-peg machinery includes the *slabber* or *siding-machine*, for fitting the bearing surface of logs preparatory to sawing; sawing or *heading* machine; *boring*-machine for cutting out knots; *pointer*; *splitter*; *bleaching*-apparatus; *fan-blower*; *steam-dryer*; *polisher*; *separator*; *winnower*, or *duster*.

Shoe-pock'et. (*Ménage.*) A small leather pocket attached to a saddle for the purpose of carrying one or more extra horseshoes when on a journey on horseback.

Shoe-sew'ing Ma-chine'. The sewing-machine for boots and shoes was for some time made somewhat as the ordinary leather sewing-machines, but these did not reach the inside of the shoe in a satisfactory manner to sew the upper to the insole, although stitches could be put on the outside which sewed the soles together. The sewing-machine in which a device at the end of the jack, inside the shoe, was made to act in concert with the needle, piercing the sole from the outside, seems to have fulfilled the requirements of the case.

The machine of the McKay Sewing-Machine Association, shown in Plate LX., is the result of more than three years' effort and an expense of $130,000 before a practical working machine was put in operation (in 1861). The number of pairs of boots and shoes sewed on the machine in the United States up to the present time is two hundred and twenty-five millions (225,000,000), according to reports made by the manufacturers. A large number have also been sewed on it in England and on the Continent of Europe.

One or two of the most skillful operators on the machine have occasionally sewed as many as nine hundred pairs in a day of ten hours, and any good operator can easily sew five or six hundred pairs in a day.

In preparing a shoe for this machine, an inner sole is placed on a last; the upper is then lasted and secured to the inner sole, and the outer sole is then tacked on. This outer sole is channeled for the reception of the enchained part of the stitch. A large spool attached to the rotating horn is provided with thread coated with shoemaker's wax, and the thread, which passes from such spool about guides in the horn, to a whirl at the tip of the horn, is heated to warm the wax by a lamp carried on the horn. The whirl is a small ring placed at the end of the horn, and through which there is an opening for the pas-

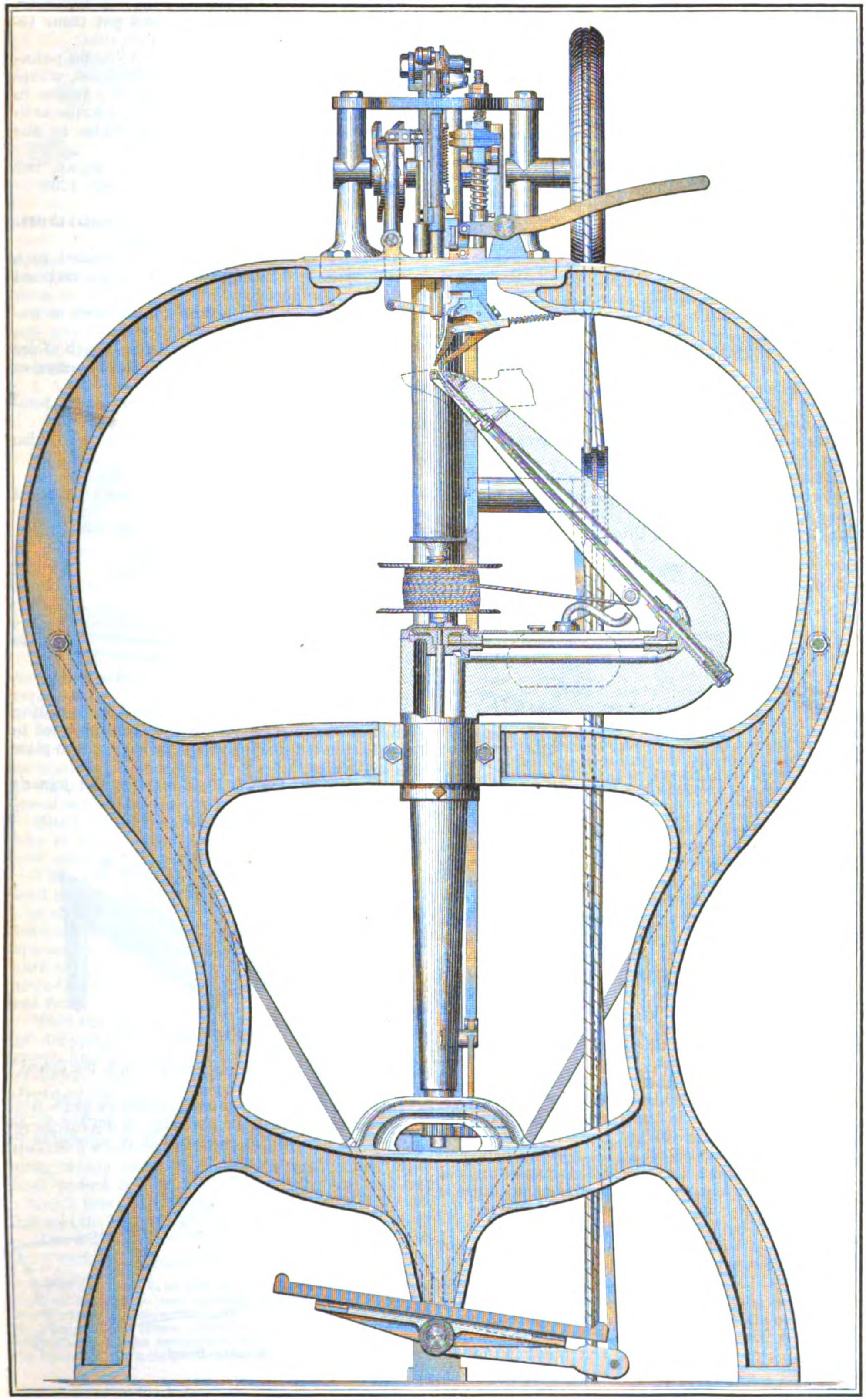


Plate LX. McKAY SHOE-SEWING MACHINE. See page 2162.

sage of the needle. A shoe is placed on the horn, as shown in dotted lines, and the stitching is commenced preferably at or near the shank, and as the stitching proceeds, the horn is rotated and the shoe moved thereon so as to bring it properly under the action of the needle. The hooked needle, after penetrating the sole resting on the horn, has the waxed thread laid in its hook by means of the whirl, and in ascending it draws a loop of thread through the sole and upper. A cast-off closes the hook and prevents the escape of the loop, while the shoe is moved for a new stitch, and when the needle next descends it passes through the loop on its shank and draws a new loop up through it, in this way enchaining one loop with another. Just enough thread is drawn from the spool to form a stitch, and this action is automatic, according to the thickness of the material being sewn.

Shoe-shave. (*Shoemaking.*) An implement on the principle of the spoke-shave, for trimming the soles of boots and shoes.

Fig. 5023.

Shoe-Shave.

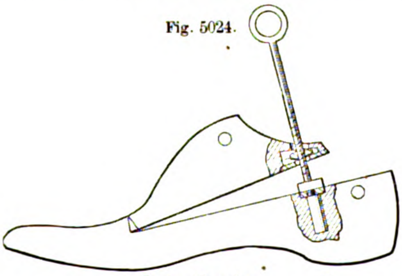
Shoe-sole. See Sole.

Shoe-stir′rup. (*Saddlery.*) A stirrup having a foot-rest shaped like a shoe.

Shoe-stone. A whetstone for a shoe-knife.

Shoe-stretch′er. An expansible last for distending shoes. The example shows one for stretching the instep. The nut, through which the operating screw passes, plays freely in the recess of the last block. The block may be elevated by a short screw taking into a nut in the last, or by a long screw resting upon a bearing screwed into said nut.

Fig. 5024.



Instep-Stretcher.

Shoe-valve. (*Hydraulics.*) A valve at the foot of a pump-stock, or at the bottom of a reservoir. In the figure it is shown as attached to a reservoir; the lever is moved by a rod which passes upward through a tube reaching to the water level. The screw-socket of the tube is shown on the right.

Fig. 5025.

Shoe-Valve.

Sho′la. (*Fabric.*) A substance resembling Chinese rice-paper, manufactured in India from the cellular pith-like stems of the *Hedysarum lagenarium*, and used for making life-buoys, boxes, bottle-cases, hats, and numerous other articles. Its cellular structure and lightness particularly adapt it for the manufacture of hats, and the ivory-like surface which may be imparted to it, for ornamental objects.

Shole. (*Shipbuilding.*) A piece of plank put under a shore where there is no ground-way.

Shook. 1. (*Coopering.*) A package containing the staves and heading of a cask ready for setting up. The materials for a cask are thus placed, ready prepared, in a compact form for transportation. Whalers carry out the staves and headings for oil-casks ready prepared in *shooks*, and put them together on board as the catch of fish requires.

Casks are also shipped in *shooks* to Africa for palm-oil and to other parts for other commodities, where the inhabitants lack the ability or the means to make their own packages. They form a staple article of exportation from the United States to the West Indies.

2. Furniture made in parts and not set up, but shipped in packs. See Knock-down, page 1239.

3. A set of boards for a box.

Shoot. 1. (*Architecture.*) The horizontal thrust of an arch or vault upon the abutments.

2. (*Hydraulics.*) *a.* A channel in a river forming a cut-off or an inclined plane for logs.

b. A branch from a main trunk or water-pipe.

3. (*Mining.*) A vein or branch of ore running in the same general direction as the *lode*.

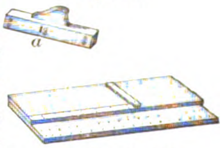
4. A trough or inclined plane to carry coal, lumber, or what not. A *chute.*

5. (*Weaving.*) The *weft* thread of a *web.* Also called the *woof, filling,* or *tram.*

Shoot-board. See Shooting-board.

Shoot′ing-board. 1. (*Stereotyping.*) A board or planed metallic slab with a plane-race on which an object is held while its edge is squared or reduced by a side-plane. It is used by carpenters and joiners, but the form shown in Fig. 5026 is especially adapted to the uses of the stereotyper in trimming the edges of stereotype-plates. The plate is held by the left hand upon the upper bench, resting against the bar. The side-plane *a* is reciprocated in the race, the bit shaving away the edge of the plate presented to it.

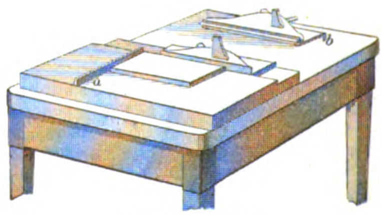
Fig. 5026.



Shooting-Board.

2. (*Joinery.*) Fig. 5027 illustrates the joiner's shooting-board mounted on a table. *a* is the board; *b*, the side-plane.

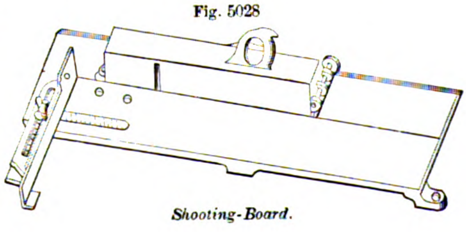
Fig. 5027.



Shooting-Board.

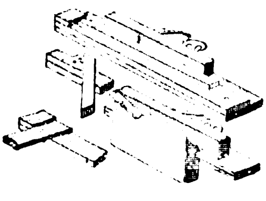
In Fig. 5028, the plane reciprocates on ways, and is adjustable to or from the edge or surface to be acted upon; a stop or holder that is adjustable to

Fig. 5028



Shooting-Board.

Fig. 5029



Shooting-Plane.

or from the plane, as well as at any angle, is also attached to the table.

Shoot'ing-plane. A side-plane used, in connection with the shooting-board, for squaring or beveling the edges of stuff.

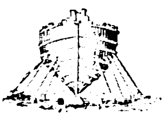
Shoot'ing-stick. (*Printing.*) A piece of wood or metal, usually about 1 foot long, 1½ inches wide, and ½ inch thick, by which the *quoins* are driven in *locking up* the *form* in the *chase.*

The *form* lies on the *imposing-stone*, the *foot* and *side sticks* are against the pages, and the *quoins* are driven between the *sticks* and the frame of the *chase.*

Shore. A prop or supporter.

1. (*Shipwrighting.*) *a.* One of the wooden props by which the ribs or frame of a vessel is externally supported while building; or by which the vessel is laterally supported on the *stocks.*

Fig. 5030.



Shore.

b. A timber temporarily placed beneath a beam to afford additional support to the deck, when taking in the lower masts.

c. A strut used to support a mast in heaving down.

d. The cap-shore is a beam placed forward of a cap to support it.

A vessel is supported in a dock by *breast-shores.*

2. (*Building.*) A *dead-shore* is a temporary post beneath a wall to carry the superstructure during repairs.

Short-pile. (*Hydraulic Engineering.*) A stick of round timber from 6 to 9 inches in diameter, and from 6 to 12 feet long. Such are driven as closely as possible without causing the driving of one pile to raise the adjacent ones. They are used to compress and consolidate ground for foundations.

Shot. 1. (*Fire-arms.*) *a.* Small spherical pellets of lead or *shot metal*, used for shooting birds and other small game.

They were originally made by rolling an ingot of lead into a sheet of a thickness corresponding to the size of the shot to be made, then cutting the lead into cubes and placing the latter in a "tumbler"; the action of the leaden cubes when rubbed against each other in the operation of the apparatus gradually rounding them until brought to a more or less spherical form.

This was superseded by the method now employed of dropping the molten metal, in a finely divided state, from a hight into water, invented by Watts, of Bristol, England, about 1782. It is said that he dreamed one night that he was out in a shower of rain, every drop of which was a round pellet of lead. Musing on the matter, he became interested in the question whether such would be the result of dropping melted lead. He accordingly melted some lead, and poured it from the top of St. Mary Redcliffe Church into water below. His plan succeeded, and he sold the invention for a handsome sum of money.

The following direction for making shot is found in a work published in the seventeenth century: —

"Melt lead down in an iron kettle, skim it, and when it is so hot that it begins to turn greenish, strew as much fine powdered auripigmentum (arsenic) upon it as will lie upon a shilling to every twelve or fifteen pounds of lead, which then must be stirred well, and the auripigmentum will flame. A little may be taken out in a ladle for an essay, and which, when reduced to a proper heat, may be dropped into a glass of water. If the drops prove round and without tails, there is auripigmentum enough therein, and the temper of the heat is as it should be; but, if otherwise, more auripigmentum must be added, and the heat augmented till it be found right."

Small shot is mentioned as hail-shot in many English statutes of the Tudors and Stuarts.

A shot-tower is usually about 180 feet high, and 30 in diameter at bottom, 15 at the upper story, where the melting is conducted in brick furnaces built against the wall around the central opening down which the melted lead is rained into a water-tank at the base of the tower. Platforms with furnaces are also built at lower elevations for making smaller sizes of shot. The method of reducing the lead to a shower of drops is either by pouring it into a sieve or by pouring it out of a wide ladle which has a serrated lip. The lead flows out in a number of streams, which break into separate drops, the resistance of the air and their cohesive tendency causing them to become spherical in falling.

Many of the drops, however, assume an elongated form, and sometimes two or more drops coalesce; these form imperfect shot, which are afterward separated.

The colanders or sieves are hollow hemispheres of sheet-iron about 10 inches in diameter, and the size of the holes is as follows for the respective sizes of shot: —

No. 0, the holes are 1/50 inch in diameter;
1, the holes are 1/55 inch in diameter;
2, the holes are 1/63 inch in diameter;
3, the holes are 1/72 inch in diameter;
4, the holes are 1/80 inch in diameter;
and by regular gradation to
No. 9, the holes are 1/380 inch in diameter.

The colander is faulty in respect of its delivering the stream at greater rapidity when full or nearly so, than when nearly empty, owing to the variation in pressure of the metal as it decreases in depth. It is now generally superseded by the ladle, which has a serrated side to divide the lead into streams equal in number to the serrations. Different ladles are used for varying sizes of shot, the serrations being more numerous for small shot and proportionately fewer for shot of larger size.

Fig. 5031.

Lead-Pouring Ladle.

The pourer takes a ladleful, perhaps 20 pounds of melted alloy, — for a little arsenic is added to the lead, — and resting it on a bar over the shaft, brings the lead into a quiescent state, scrapes away the oxide from the pouring side, and then carefully tips the ladle, so that the depth of the stream is even throughout the length of the comb, in order that the metal may be delivered in streams of equal sizes at the several notches. The drops having become partially cooled and consolidated during their fall, are received at the bottom of the tower in a *well* or reservoir filled with water, from whence they are taken and transferred to the drying-machine, where they are lightly rolled between flannel rollers, and when thoroughly dry the elongated and imperfect shot are separated by rolling the whole down a series of inclined planes, each slightly lower than the preceding and separated from it by a slight opening; the perfect ones, having a greater momentum leap the opening, while the defective ones fall through, and are remelted.

The different sizes are then separated by an apparatus resembling a chest of drawers, provided with sieves of different degrees of fineness, to which a shaking motion is imparted.

The shot are finally polished by placing them in revolving cylinders with graphite, by which, and the attrition, a black and shining surface is produced.

In 1849, a process of making shot by dropping the metal through a tube up which a strong current of cold air was driven was patented by Smith. This obviates the use of a high tower.

In 1868, Glasgow and Wood, of St. Louis, patented the making of shot by dropping the molten lead through a column of glycerine or oil, instead of air.

The sizes of drop shot vary with different manufacturers. The following gives the sizes and number of shot to an ounce, of a Baltimore and a New York house: —

Baltimore.				New York.			
Size.	No. of Pellets to oz.	Size.	No. of Pellets to oz.	Size.	No. of Pellets to oz.	Size.	No. of Pellets to oz.
TTTT	22	4	115	FF	24	4	132
TTT	26	5	140	F	27	5	168
TT	30	6	180	TT	31	6	218
T	34	7	25	T	36	7	291
BBB	39	8	365	BBB	42	8	399
BB	45	9	610	BB	50	9	568
B	52	10	1,130	B	59	10	848
1	60	11	2,200	1	71	11	1,346
2	77	12	3,200	2	86	12	2,326
3	94			3	106		

Buckshot and bullets are made by casting or by compression in dies.

Number of Pellets in an Ounce of Lead Shot of the different Sizes. (HASWELL.)

AA	40	No. 1	82	No. 5	218	No. 9	984
A	50	2	112	6	280	10	1,726
BB	58	3	135	7	341	12	2,140
B	75	4	177	8	600	14	3,150

b. Projectiles for cannon are also generically termed shot. See CANNON-BALL; CASE-SHOT; GRAPE-SHOT, etc. See list under PROJECTILES.

Ordnance projectiles are, before being issued for service, subjected to a series of tests in order to ascertain if they are sound and of proper dimensions. The instruments required are one large and one small ring-gage, and one cylinder-gage for each caliber, a hammer, and steel punches. The shot or shell is first examined, to see that it has no flaws or other visible imperfections, and is then tried by passing it through the large ring-gage. It must pass through this in all directions, but must not pass at all through the small one. It is then tried by rolling it through the *cylinder-gage*, which is set up endwise at a moderate inclination. If it sticks, it is rejected.

In the case of a hollow projectile farther examination is required. It must be struck with a hammer, to judge by the sound if it be free from flaws or cracks.

The diameter of the interior cavity is then verified at various points by means of proper gages, as is also the diameter of the fuse-hole.

The shell is next placed in a tub of water, the fuse-hole being stopped with a wooden plug having an aperture for the insertion of a pair of bellows. The shell being nearly covered with water, air is forced into its interior by means of the bellows, and if there be any holes in it the air will rise in bubbles through the water. This test also gives another indication of the soundness of the metal, as the parts containing cavities will dry more slowly than the rest.

2. (*Mining.*) A charge of powder in a blast-hole, usually fired by a *smift* or slow-match.

3. (*Weaving.*) A pattern produced by weaving warp and weft threads of different colors.

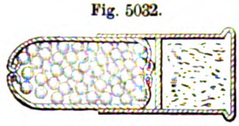
4. (*Nautical.*) Said of cables when two are spliced end on.

Shot-belt. A long leathern tube for shot, worn as a baldric, and having a charger at the lower end.

Shot-box. (*Nautical.*) A box in which grape or canister shot are placed convenient to the guns.

Shot-car′tridge. A round of ammunition for a shot-gun. The shot are frequently inclosed in a wire-gauze case to prevent their scattering too much. In the example, a fibrous, elastic tube is tied at one end, and prepared with stearine or similar substance, applied hot in a former; the small shot being inserted, the other end is tied. For breech-loaders, the cartridge is inserted into a copper capsule charged with powder and fulminate, in any usual manner.

Fig. 5032.



Shot-Cartridge.

Shot-gage. A metallic ring with a handle, used for testing cannon projectiles. Two sizes are employed for each caliber.

The *large* gage is slightly larger, and the *small* gage a little smaller, than the *true* diameter of the shot or shell, which must pass through the former but not through the latter. It is afterward rolled through a cylindrical gage, any jamming or sticking in which causes the rejection of the projectile.

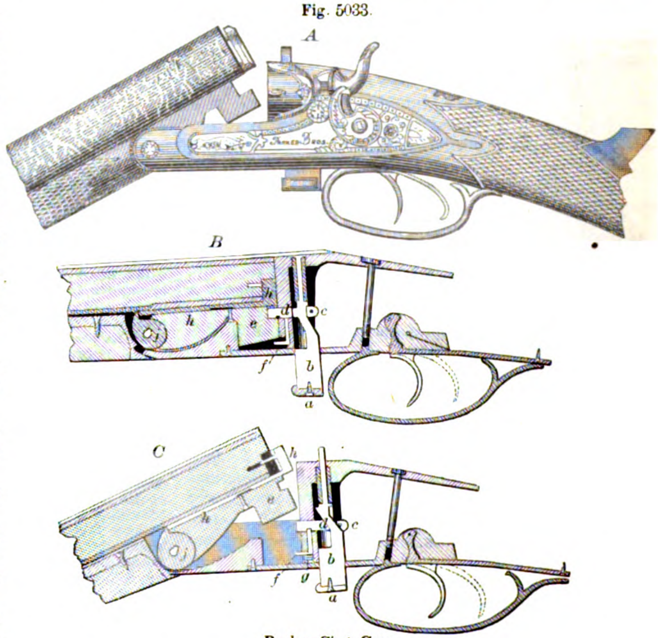
In the United States ordnance service the first are called *ring-gages*; the latter, *cylinder-gages*.

Shot-gar′land. (*Nautical.*) A wooden frame to contain cannon-balls, secured to the coamings and ledges around the hatchway of a vessel. See also SHOT-RACK.

Shot-gun. A smooth-bore fire-arm for shooting small game. Shot-guns are frequently made double-barreled, and of late years the breech-loading principle of Lefaucheux and others has been extensively introduced. Some breech-loaders, as Maynard's, are provided with interchangeable rifle and shot barrels.

Fig. 5033 is the Parker double-barrel, breech-loading gun, made by Messrs. Parker Brothers, West Meriden, Conn. *A C* show the barrels and mechanism in loading, and *B* in firing, position. For loading, the breech of the piece is placed under the right arm; by pressing on the finger-piece *a*, the lifter *b* is raised, and its beveled side, coming in contact with the screw *c*, draws the bolt *d* from a mortise in the lug *e*, releasing the barrels, which, turning on the joint *j*, are ready for the insertion of the cartridges. In this position, a small hole in the under side of the bolt comes directly over the trip *f*, which is thrown upward by the spiral spring *g*, and holds it against the lifter, whose top now projects above the frame directly in the line of sight of the gun. After inserting the cartridges, the barrels are brought down by a quick motion with sufficient force to bring the top of the barrel in line with the top of the breech-pin; the bottom of the lug *e* strikes the trip *f*, withdrawing it from the bolt *d*, which then enters the mortise in the lug; the cartridges, coming in contact with the face of the frame, are forced into the chambers, and the gun is ready for firing. As the action of the lifter not only withdraws the bolt from, but forces it into, the mortise of the lug, the fact of the top of the lifter being in place, so that the sportsman can sight along the barrel, affords an assurance that the gun is securely locked.

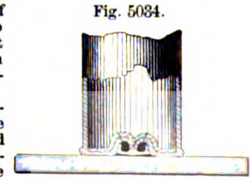
Fig. 5033.



Parker Shot-Gun.

An automatic extractor *h* inserted in a hole drilled in the lug and extending around and into the chambers of the barrels, serves to withdraw the cartridge-shells. Its front end rests against a snail on the joint *j*, on which the barrels turn; so that in assuming the position *A C*, it is forced backward, pushing out the shells sufficiently far to be readily withdrawn by the fingers.

Fig. 5034.



Cartridge.

The lock is of the rebounding class; the hammer being automatically thrown back to half-cock after firing by an arrangement which effectually prevents accidental discharge. See REBOUNDER.

Fig. 5035.

Capper.

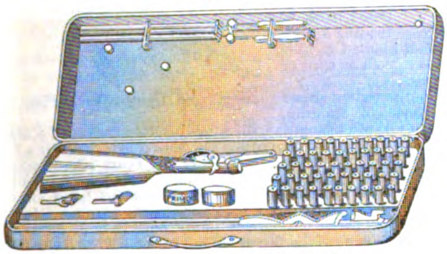
Fig. 5034 is the metallic shell used; it is made from one piece of metal, and reinforced by a *strengthener* soldered to its bottom; the Berdan primer is used in connection therewith, and is pressed home upon the nipple, so as not to project beyond the bottom of the shell, by the device (Fig. 5035).

A reversible loading plug is employed, either for charging the shells or withdrawing the caps.

Fig. 5036 shows the case containing the gun and its appurtenances complete.

Shot-lock′er. (*Nautical.*) Slats or planks pierced with holes to receive shot, and placed along the sides and round the hatchways.

Fig. 5036.



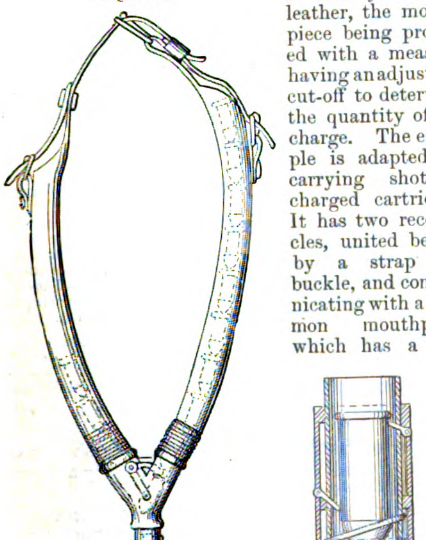
Parker Gun and Appliances in Case.

Shot-met′al. An alloy of lead, 56 parts; arsenic, 1. Used for making bird-shot.

Shot-plug. (*Nautical.*) A tapered cone of wood driven into a shot-hole in a vessel's side, to prevent leakage.

Shot-pouch. A receptacle for bird-shot, carried on the person. It is usually made of leather, the mouth-piece being provided with a measure, having an adjustable cut-off to determine the quantity of the charge. The example is adapted for carrying shot or charged cartridges. It has two receptacles, united behind by a strap and buckle, and communicating with a common mouthpiece, which has a gate permitting the escape of one cartridge at a time.

Fig. 5037.



Shot-Pouch.

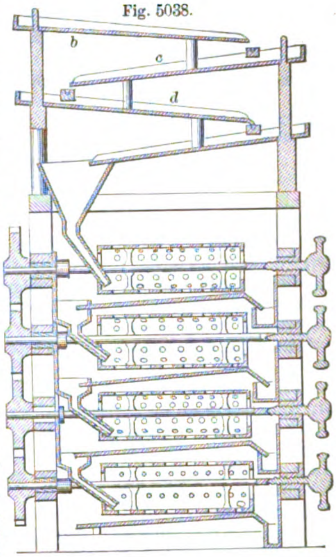
Shot-prop. (*Nautical.*) A wooden plug covered with tarred hemp, to stop a shot-hole in a ship's side.

Shot-rack. (*Nautical.*) A wooden frame, around a hatch or near a gun, in which a certain number of round shot are kept for service.

Shot-silk. (*Fabric.*) A silk stuff whose warp and weft threads are of two colors, so as to exhibit changeable tints under varying circumstances of light. *Changeable silk.*

Shot-sort′er. A frame with a series of sieves of different grades of fineness, to sort shot into various grades of size. The imperfect shot are separated by a series of inclines *b c d* with foot-troughs, over which the perfect shot are projected by their velocity, to be afterward assorted in a series of rotary screens of gradually increasing coarseness.

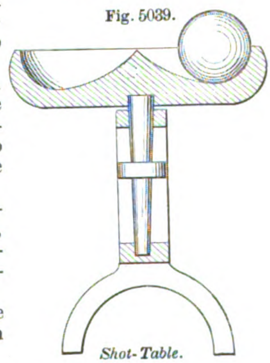
Fig. 5038.



Shot-Sorter.

Shot-ta′ble. A device for insuring the equal shrinkage of shot in all directions while cooling. It has an annularly grooved surface with a conoidal central projection, and turns on an upright spindle. The hollow spherical mold is placed thereon after the cast is made, and rotated until the casting is cool enough to be removed.

Fig. 5039.



Shot-Table.

Shot-tow′er. A tall building from the summit of which melted lead is dropped into a cistern of water. See Shot.

Shoul′der. A projection on an object, to oppose or limit motion or form an abutment, as

1. (*Vehicle.*) The butting-ring on an axle.

2. (*Carpentry.*) The square end of an object at the point where the tenon commences; as of a spoke, the stile of a door, etc. See Tenon.

3. (*Printing.*) The projection at the top of the shank of a type beyond the face of the letter.

4. (*Fortification.*) The obtuse angle formed by the junction of the *face* and the *flank* of a bastion.

5. The contraction in a lamp-chimney just above the level of the wick in an *argand* or *flat-wick* lamp. It answers the purpose of the diaphragm ring of coal-oil lamps.

Fig. 5040.

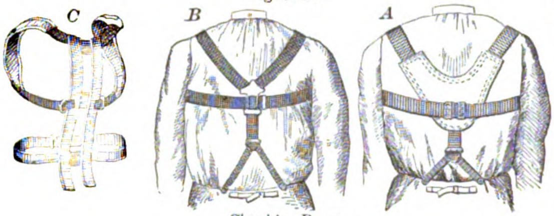
Shoulder-Block.

Shoul′der-block. (*Nautical.*) A single block having a projection at the bottom of the *shell* to prevent the rope that is rove through it from becoming jammed between the block and the yard. These blocks are

mostly used for *bumkin* or lift blocks on the lower yards.

Shoul'der-brace. (*Surgical.*) An appliance for treating round shoulders or unconfirmed curvatures of the spine. *A B* (Fig. 5041) illustrate two

Fig. 5041.



Shoulder-Brace.

forms, adapted to serve as suspenders or skirt-supporters, and used for preventing this deformity or in the treatment of its earlier stages. *C* is a brace with waist-belt and two steel back-pieces, employed in more advanced cases.

Shoul'der-ing-file. A flat safe-edged file whose narrower sides are parallel and inclined.

When made of large size and right and left, they are sometimes called parallel V-files.

Shoul'der-of-mut'ton Sail. (*Nautical.*) A triangular fore-and-aft sail, employed on boats, etc. The apex is at the head of the mast and the foot is extended by a boom.

Shoul'der-wash'er. (*Vehicle.*) The washer between a wheel and the shoulder of an axle-tree. The exterior washer is the *linch*-washer.

Shove. The central, woody portion of the stem of flax. The *boon.*

Shov'el. An implement having a hollowed blade and provided with a handle; used for raising earth or other material.

The mechanical character of a shovel consists in its adaptation for lifting and throwing loose matter. This is bringing it within closer bounds than is common in some parts of the United States, but the practice is a little loose. The term *shovel-plow* will remain in despite of anything that may be said as to the appropriateness of the name. The shape of the share was originally so nearly like that of a common pointed shovel that it has given a name to the tool. An excellent tool it is, either with one or two shovels, especially the latter. *Shares* they should be called, as their office is like that of plowshares.

The long-handled shovel with a curved, pointed blade, and a bent handle, is a Flemish tool, and a very good one.

The Flemish is heart-shaped, and has no *tread.*

The handle of the foundry-shovel is short. The blade should be of the best quality, and but slightly curved, to facilitate scattering the sand when mixing, or *turning it over* after casting.

Mining-shovels are shown at Fig. 3178, page 1451.

Bezaleel of Judah was a master mechanic, and made the shovels for the Tabernacle, 1491 B. C.; and Hiram, the widow's son of Naphtali, whose father was a man of Tyre, made the shovels for Solomon's temple, 1005 B. C. They were of brass, or rather bronze, as the copper was alloyed with tin, not zinc.

From their connection in the text with pots and tongs, they were no doubt fire-shovels. The tongs were of gold.

The wooden shovel (*palas ligneas*) was much used in Roman agriculture. Used in throwing up grain; as a winnowing-shovel it was termed *ventilabrum.*

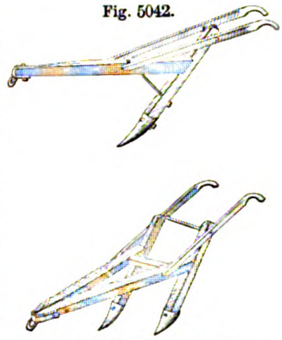
Hawkins's feeding-shovel, English patent, 1816, was for supplying coal to the bottom of a fire. It had a close cover, so as to form a box, and the handle was a sliding rod connected with a piston, by pressing which the coals were thrust into the fire.

Shov'el-plow. One having a simple triangular share, and employed for cultivating ground between growing crops.

The *shovel* is a *share*, but while objecting to the name there is no objection to the tool. They are made either single or double; so called, not that the *double-shovel* plow has, in any sense, a double shovel, but it has two sheths, and a share on each.

The *single*-shovel plow has been in use for many years; the double-shovel is a later invention. It resembles some of the plows used for a thousand years and more in Asia and Southern Europe (see *a b*, Fig. 3822, page 1743); but it is a better implement, and the double-shovel is nearly perfect in its way and for its purpose: that is, tending a crop which is planted in hills or rows, such as corn or potatoes.

Fig. 5042.

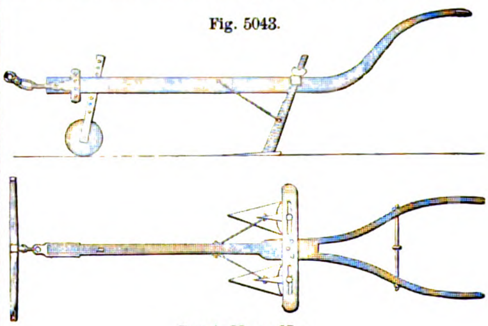


Single and Double Shovel-Plow.

The illustration shows the mode of framing. The shovels are triangular, the wings bending backward a little, and the point curved forward. The shovel is secured by a bolt to the sheth. A clevis on the nose of the beam affords means for attaching the single-tree of the horse. One plow is a foot in advance of the other; and it is a *right* or a *left* hand shovel-plow, according to the shovel which is in the advance. In the West farmers prefer left-handed plows, both in large plows and in shovel, throwing the furrow or soil to the left. In the Eastern States and in Europe the right-hand is said to be yet the favorite. Several reasons combine to make the left-hand the more convenient. Some refuse to try it. *Verbum sap.*

The nearest approach to our shovel-plow in Britain is the Scotch horse-hoe, which, when used without the middle shovel, has two shovels at the side, but parallel. This is inferior to the

Fig. 5043.



Scotch Horse-Hoe.

American oblique arrangement. The proper way to work all such tools is to go down one side of a row of plants and up the other side, using the forward shovel to work to the row, the other shovel merely cultivating the ground in the balk.

Show'er. (*Pyrotechny.*) A term applied to gold-rain, small stars of slowly burning composition, etc., constituting the decoration of a rocket or shell, and which produce the effect of a shower of fire in falling.

Show'er-bath. A bath in which a shower of water is dropped upon the person, usually a stream distributed by a strainer.

Shrap'nel. (*Ordnance.*) A hollow projectile for cannon, invented by General Shrapnel of the English artillery.

As originally constructed, the projectile consisted of an iron shell filled with balls, sufficient powder being mingled with the balls to burst the shell when the fuse ignited the charge.

It is also called *spherical case-shot*, and was designed to attain a longer range than common *case-shot* or *grape.*

The bursting charge is designed to be of just sufficient strength to open the shell without scattering the balls, which should continue their flight.

The *improved shrapnel* has its bursting charge in a cylinder in the middle of the shell.

The *diaphragm shrapnel* has its powder-chamber separated from the balls; the interstices between the latter being filled up with coal-dust.

Shrapnel are commonly filled with leaden musket-balls, melted sulphur or bituminous matter is poured in to fill up the interstices, and a chamber sufficiently large to contain the bursting charge is bored out beneath the fuse-hole.

Shrink'age. The contraction of a material in cooling after being heated; or in consequence of desiccation, as in the case of wood and clay. It is an important element to be taken into consideration in many mechanical processes.

1. (*Wood.*) The contraction of the fibers of wood is across the direction of their length.

In order to insure tight and true joints in wooden constructions, the wood should be perfectly seasoned before using. This, when effected in the natural way, which is best, requires from 1 or 2 to 10 years, according to the size and character of the piece.

2. (*Civil Engineering.*)

The volume of earth and sand in the natural bank exceeds that in embankment in the following proportions: sand, 1/7; clay, 1/9; gravel, 1/11; and the volume of rock in embankment quarried in large fragments exceeds that in bank fully one half.

The following diminutions in bulk occur when the loose material finally becomes compacted: light sandy earth, 1/8: yellow clayey earth, 1/10; gravelly earth, 1/12. — ELWOOD MORRIS.

Sand, 8 per cent; loam, 12 per cent; clay, 10 per cent; surface soil, 15 per cent; clay puddled, 25 per cent. — *New York Public Works.*

The following permanently occupy more space: hard sandstone, large fragments, 5/12; blue slate rock, small fragments, 6/10. — E. MORRIS.

Rock, one third to one half. — *New York Public Works.*

3. (*Metal-working.*) Molten metals, with the exception of some alloys, contract in cooling.

Patterns are always made larger in all their dimensions than the finished castings are required to be. For cast-iron about 1/96 is allowed, or 1/8 inch in every foot. Brass contracts rather more, 3/16 inch shrinkage to the foot being allowed. See CONTRACTION RULE.

The following table shows the actual shrinkage of various materials: —

Iron, small cylinders	= 1/16 inch per foot.
Iron pipes	= 1/8 inch per foot.
Iron girders, beams, etc.	= 1/8 in 15 inches.
Iron, large cylinders, the contraction of diameter at top	= 1/16 per foot.
Iron, ditto at bottom	= 1/12 per foot.
Iron, ditto in length	= 1/8 in 16 inches.
Brass, thin	= 1/8 in 9 inches.
Brass, thick	= 1/8 in 10 inches.
Zinc	= 5/16 in a foot.
Lead	= 5/16 in a foot.
Copper	= 3/16 in a foot.
Bismuth	= 5/32 in a foot.

This property is taken advantage of in the process of *shrinking on*, as it is termed, that is, surrounding a metallic cylinder with a ring, into which it will not enter while the ring is cold, but which slips on readily when it is heated to or below a red heat, and binds the cylinder firmly when cool: this is adopted for reinforces of some cannon, the couplings of propeller-shafts, the tires of car and carriage wheels, etc.

Shrink'ing-head. (*Founding.*) A body of molten metal in the gate of a mold, to supply metal to the casting during shrinking. A *riser.* A *sinking-head.*

Shroud. Plural, *shrouds.* 1. (*Nautical.*) *a.* Large ropes extending from the lower-mast heads to the sides of the ship, where they are fastened to the dead-eyes, which are secured to the channels. They serve to steady the mast athwartship, assist the stays and backstays in supporting it in a fore-and-aft direction, and afford means of ascending it.

The shrouds of topmasts are similarly secured to dead-eyes on the edges of the tops. Those of topgallant-masts pass over the ends of the cross-trees on the topmast-heads.

In each case the mast is supported laterally by the shrouds. The back stays are also auxiliary in this lateral support.

The *bowsprit-shrouds* extend from the head of the bowsprit to the sides of the vessel. The *futtock-shrouds* connect the topmast-shrouds around the edge of the top with the lower rigging at the cat-harpings.

Bentick-shrouds are ropes of the size of the topmast rigging, seized on to the *futtock-staves* and leading to the opposite channels, where they are set up to support the masts in heavy rolling.

Bumkin shrouds or braces; strong ropes fixed to the bumkin ends to support them in opposition to the purchase which acts on them in a contrary direction, to prevent them from rising and being sprung.

Shrouds are named from their position, or from the spar to which they are attached, as *fore, main, mizzen, topmast, topgallant,* etc.

b. The chains by which the smoke-stack is braced, in steamers.

2. (*Machinery.*) One of the two annular plates at the periphery of a water-wheel, which form the ends of the buckets.

Shroud-bri'dle. (*Nautical.*) A kind of crowfoot fastened to the shrouds, to hold sheets, braces, etc.

Shroud'ed Gear. (*Machinery.*) Cog-gear in which the cogs are protected by a flange coming out even with the face of the wheel, so that the interdental spaces are in effect mortises in the face of the wheel.

Shroud'ing. (*Hydraulic Engineering.*) The annular peripheral plates of a water-wheel, forming the ends of the buckets; usually termed the *sides* of the buckets, as occupying positions at the sides of the wheel.

Shroud-laid Rope. (*Rope-making.*) A rope made of four strands twisted around a core. A *hawser-laid* rope is of three strands twisted together without a core. See ROPE.

Shroud-plate. 1. (*Nautical.*) *a.* An iron plate fixed to a ship's side for the attachment of the shrouds.

b. A ring surrounding a mast and to which the futtock-shrouds are secured.

2. (*Hydraulics.*) One of the annular plates of a water-wheel which form the ends of the buckets.

Shroud-truck. (*Nautical.*) A wooden thimble secured to the shrouds and acting as a fair-leader for the running-rigging.

Shrunk-on. (*Metal-working.*) A term applied to iron bands, tires, or reinforces, which are placed on an object while hot, so as to shrink tightly around the object in cooling.

Shuf'fle-scale. (*Tailoring.*) A measure used by tailors. It is graduated at both ends, each end being independently adjustable.

Shuf'fling-plates. (*Locksmithing.*) A series of isolated slabs or boards, made to advance in a given plane, then to drop down, return on a lower level beneath another set of advancing plates, and then rise to repeat the movement.

Shunt. 1. (*Railroading.*) An English term signifying to switch off a car or train from the main to a side track.

2. (*Ordnance.*) The transferrence of the studs on a projectile from the deeper to the shallower sides of the grooves of a gun in passing along the bore, so that it may leave the bore axially, as is effected in Armstrong's and some other systems of rifling.

3. (*Telegraphy.*) A wire connected across the terminals of a coil, so as to divert a portion of the current.

Shunt-gun. (*Ordnance.*) A rifled gun, having two sets of grooves, — one down which the studs on the ball are passed in loading; and another, not so deep, along which the studs pass in discharging, — the ball being shunted from one set to the other at the bottom of the bore.

Shut. (*Metal-working.*) The line of junction of two pieces of metal united by welding.

Shute. A CHUTE or SHOOT (which see).

Shut'ter. 1. (*Joinery.*) A framing hung upon hinges to the sash-frame of a window, and serving

to close out the light or spectators. There are *inside* and *outside* shutters. The former are usually in several pieces, called *flaps*, which are hinged together and fold into a casing called a *boxing*.

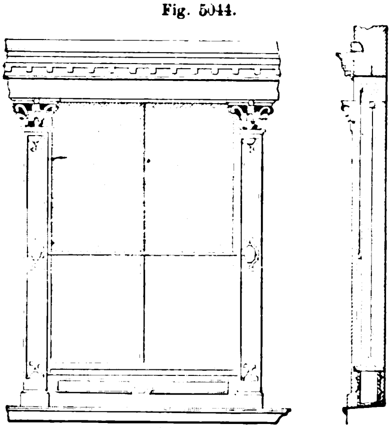
The principal piece is a *front shutter*, and the auxiliary leaf is a *back flap*.

A *flag-shutter* has but one leaf.

Some shutters are arranged to be opened and closed by a sliding movement, either horizontally or vertically; and others, particularly those for stores or shops, are made in sections so as to be entirely removed from the window.

Howards' wire shutter consists of a strong wire grating attached at each side to a band of spring-steel or brass kept in

Fig. 5044.



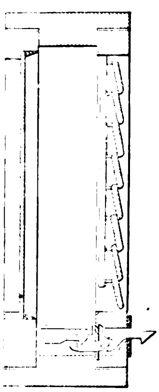
Wire Shutter.

place by a groove in the sash. The lower end is secured to a horizontal bar, and the upper to a roller, by which the shutter is raised or lowered, winding or unwinding.

2. (*Founding.*) A gate for cutting off the supply of metal to a mold. See SHUTTLE.

Shut'ter-fast'en-ing. A hook or catch for fastening a shutter; open or shut. The example has a catch for each position.

Fig. 5045.



Shutter-Fastening.

Shut'ter-hook. 1. A hook on a shutter, to fasten over a catch on the wall or window-sill.

2. A catch on the wall, to hold the shutter, which is opened against it.

Shut'ter-lift. A catch on a store-shutter, by which to lift it (*a b*, Fig. 5046).

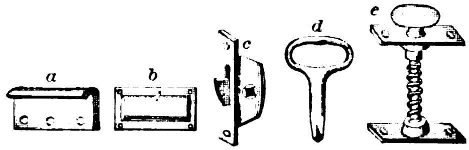
Shut'ter-lock. (*Carpentry.*) A mortise-lock in the edge of a shutter or door. *c*, shutter-lock; *d*, key.

Shut'ter-screw. (*Carpentry.*) A screw which passes through a shutter, from the inside of the store front or door, into a nut mortised into the shutter, and not exposed to the outside (*e*, Fig. 5046).

Shut'ting-post. The post or joint against which a gate or door is closed.

Shut'tle. 1. (*Weaving.*) A boat-shaped piece of wood which carries a *bobbin* or *cop*, containing the yarn of the *weft* or *woof*. The shuttle sometimes has wheels to facilitate its motion. It is

Fig. 5046.



a b, Shutter-Lifts; c d, Shutter-Locks; e, Shutter-Screw.

thrown by hand or by the fly. In the latter case, the ends of the shuttle-race form boxes into which the shuttle is received, and out of which it is driven by a *picker*.

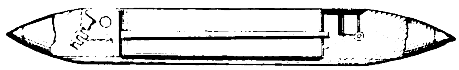
John Kay, of Bury, England, was the inventor of the fly-shuttle, 1735. This reduced the labor of weaving by one half, and raised it from the position it had occupied since the time the pyramids of Egypt were built. He, like many of his class, was driven from town to town, persecuted by the weavers who used his shuttle, died in poverty in Paris, and was buried in obscurity.

"My days are like a weaver's shuttle." — JOB.

The following show a few of the numerous varieties of loom-shuttles: —

Fig. 5047 has a spindle on a hinge. The bearing of the serpentine spring is so placed on the spindle-head as to hold the spindle up, when completely raised for the substitution of the

Fig. 5047.

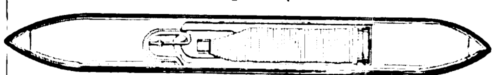


Loom-Shuttle.

bobbins; but when the spindle is slightly depressed the spring acts to return it to working position, and with accumulative force.

In Fig. 5048, the upright guide-wire placed within the cavity at the delivery end of the shuttle is so shaped as to assist the

Fig. 5048.

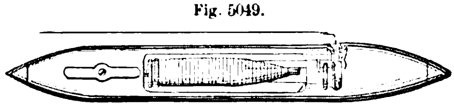


Weaver's Shuttle.

operator in guiding the thread to a narrow slit in the side of the shuttle, and thence to the eye.

In Fig. 5049, the devices are to regulate the tension of the filling as it runs from the spool to the eye of the shuttle. A spring-

Fig. 5049.

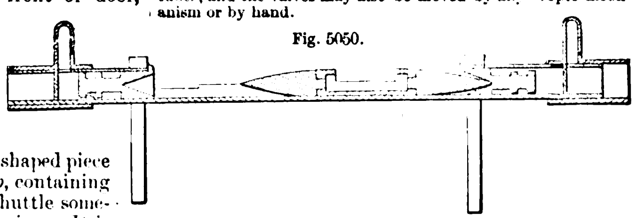


Tension Device for Shuttles

loop is placed on the inside, near the eye, in connection with a stationary wire by which the strain is equalized and the kinks straightened out. In threading, a curved wire hook is introduced through a guide-way cut in the shell of the shuttle, to catch the filling and draw it through the eye.

In Fig. 5050, the shuttle is thrown by pistons operated by condensed air. The race terminates at each end in a cylinder in which the piston plays. The air is introduced through flexible tubes, and the valves may also be moved by any proper mechanism or by hand.

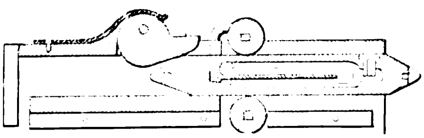
Fig. 5050.



Shuttle operated by Condensed Air.

In Fig. 5051, pickers are dispensed with, and the shuttle is driven by rapidly revolving frictional rollers, which intermittingly are brought into contact with its sides.

Fig 5051

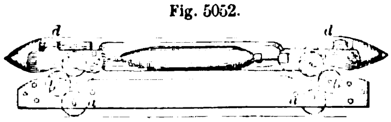


Roller-driven Shuttle.

An eccentric *swell* gradually checks the shuttle upon its being received by the shuttle-box, and instantly releases the same upon its expulsion.

In Lyall's loom the shuttle is carried through the shed on a carriage which moves on an iron raceway, and is carried back and forth by a band which receives an alternating longitudinal motion from a wheel. Upon this carriage is laid the shuttle which rests on the rollers *b b*. These rollers revolve because they are in contact with the rollers *a a*, which are in turn caused to rotate by the movement of the carriage on the raceway, and impart a precisely equal motion to the rollers *c c* of the shuttle. Hence, in passing over the lower threads of the shed, the shuttle produces no friction. The shuttle is held down by a projection above, against which the rollers *d d* play. The upper threads of the shed pass between this projection and the rollers *d d*. See POSITIVE-MOTION LOOM, Fig. 3903, page 1772.

Fig. 5052.



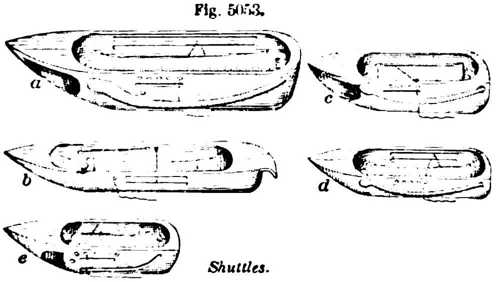
Positive-Motion Shuttle.

The *shuttle* for haircloth weaving has no *pirn*, but a spring-catch to hold the ends of the hair forming the *weft*, and carry them through the *shed* when the shuttle is thrown.

2. (*Sewing-machine.*) The sliding thread-holder which carries the lower thread between the needle and the upper thread, to make a lock-stitch. See SEWING-MACHINE.

Fig. 5053 illustrates different forms and relative sizes of shuttle employed in several lock-stitch sewing-machines.

Fig. 5053.

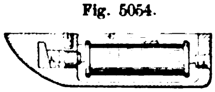


Shuttles.

a, Singer, for manufacturing purposes.
b, Howe, "C."
c, Singer, No. 5.
d, Singer family-machine.
e, another form of "Singer."

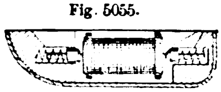
In Fig. 5054, a lever *c* is so bent and placed within the shuttle that one end bears upon the bobbin-thread, while its other end bears against a spiral spring, which presses a sliding bearing against the axis of the bobbin. The diminution of the thread relieves the pressure of the lever upon the spring.

Fig. 5054.



Shuttle.

Fig. 5055.

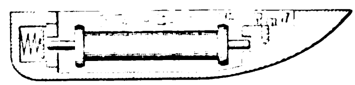


Shuttle.

Fig. 5055 has spring bearings for both journals of the bobbin.

In Fig. 5056, the thread tension is regulated by means of the free end of the spring *c* being locked in a notch of the adjustable cam *d*.

Fig. 5056.



Shuttle.

3. (*Hydraulic Engineering.*) The gate which opens to allow the water to flow on to a wheel. That side of a wheel which receives the water is known as the *shuttle* side.

4. (*Founding.*) When a casting is poured direct from the furnace, a kind of sluice, consisting of a sheet-iron blade covered with dried loam and provided with a long handle, is placed where the *sow* terminates and the ingate begins. By means of this, the molder only starts pouring when the sow is sufficiently full and the iron of the right temperature, and he controls the flow during the whole time.

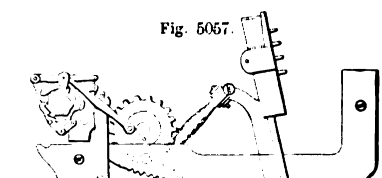
Shut'tle-bind'er. (*Weaving.*) A contrivance in a shuttle-box to catch the shuttle and prevent its bouncing out.

Shut'tle-box. A tray or case at the end of a shuttle-race, to receive the shuttle at the end of its fly.

Specifically, one of a set of compartments containing shuttles with differently colored threads, and brought into relation with the picker according to the pattern. The shuttle-boxes are adjusted vertically to bring the shuttles in the required succession to the pickers; a pattern-chain governs the movements of the rods to which the shuttle-boxes are secured.

In the example, a lever is connected by a link to a standard, upon which latter the shuttle-boxes are mounted, and is operated by two cams in such a manner as to raise or lower the standard upon which the series of shuttle-boxes is placed, so that any one of the boxes may be brought to the race from any position at every pick. The cams are actuated by a pawl and ratchet connected by rods with levers placed in contact with a revolving pattern-chain.

Fig. 5057.



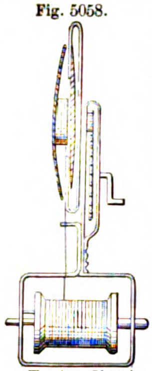
Shuttle-Box for Figure-Weaving Loom.

Shut'tle-check. (*Weaving.*) A device to prevent a shuttle from bouncing out of the box by recoil. It may be a simple binder, which grips the shuttle with sufficient force, or it may be a positive bar to the motion of the shuttle, operated by the stop motion.

Shut'tle-race. (*Weaving.*) The track on the lay on which the shuttle runs as it passes through the shed.

Shut'tle-wind'er. A device for winding a shuttle, such as the round shuttle of the Wheeler and

Fig. 5058.



Tatting Shuttle-Winder.

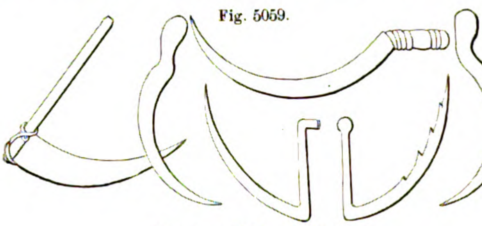
Wilson sewing-machine, or a tatting-shuttle, as in the example. The shuttle is attached to a clasp and rotated above the spool; the spring which serves to carry and revolve the shuttle also forces its jaws open to receive the thread. See also BOBBIN-WINDER, Figs. 755, 756, pages 317, 318.

Shwan-pan. The Chinese abacus. See ABACUS; SCHWAN-PAN.

Sick'le. (*Husbandry.*) A hooked blade, flattened in the plane of its curve and sharpened on its inner edge. One side of the blade is notched, so as always to sharpen with a serrated edge.

Fig. 5059 shows some patterns of sickles as used by the Egyptians, it may be said, from time immemorial; for the tombs of Beni-Hassan and Thebes show that it was used in the times of

Fig. 5059.



Egyptian Sickles (1500 B. C.).

Jacob and of Moses, an interval in which 70 persons and their servants became 3,000,000. The sickles are drawn from colored views in the tombs. In some, the blade is colored blue, to represent iron or steel; in others, it is colored to represent bronze, which was no doubt the metal more commonly used for this purpose; in fact, bronze was used even for surgical instruments down to A. D. 79, as is proved by the discovery of a complete set at Pompeii.

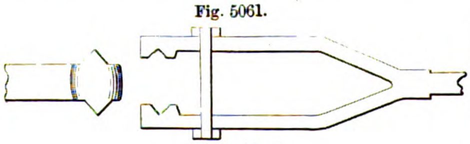
Fig. 5060.

Ancient Egyptian Reaping-Hook.

Fig. 5060 is copied from a painting in the Ancient Elethia, and indicates the shape and mode of using the sickle in Egypt. The handle was stocked at right angles to the sweep of the blade. This is not so convenient as our mode of handling, as it requires so firm a grasp to prevent rotation in the hand.

Sick'le-head. (*Husbandry.*) The pitman-head in a reaping-machine, which grasps the end of the cutter-bar. In the example, the sickle-bar head has

Fig. 5061.



Sickle-Head

conical points, which enter corresponding sockets in the forked arms of the pitman.

Side. 1. (*Machinery.*) The lateral portion of an object.

2. The surface on the *right* or *dressed* side of cloth.

3. (*Nautical.*) The part of a vessel from *stem* to *stern* and from the *gunwale* to the *main*-wale. Below the latter is the *bottom*.

Side-axe. An axe with a handle bent somewhat askew, to prevent striking the hand in hewing. A *broad-axe*.

Side-bars. 1. (*Saddlery.*) Two plates which unite the *pommel* and *cantle* of a saddle. In the Murdock saddle they are of steel, and give elasticity to the seat, which is suspended from the *pommel* and *cantle*.

2. (*Carriage.*) The longitudinal side-pieces of a traveling-forge or battery-wagon.

Side-beam Steam-en'gine. A form of *marine engine* invented by Napier of Glasgow. The original *beam-engine* was the *atmospheric engine* of Newcomen. The working-beam was elevated on a wall or pillar, the pump and piston-rods being attached to the respective ends. The extreme elevation of the beam and the want of compactness of the structure rendered desirable the change which Napier accomplished.

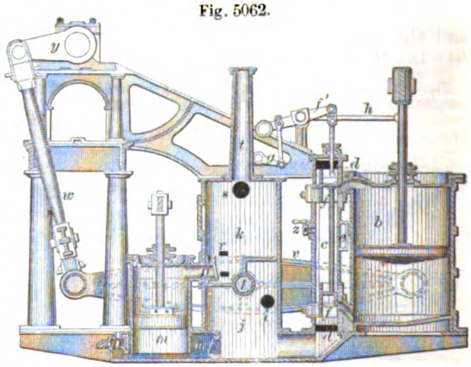
The lowering of the center of gravity increases the stability of the vessel, and, in some cases, the machinery is brought below the water-line, — an especial advantage in war-vessels.

The length of the stroke in marine engines is shorter in proportion to the diameter of the cylinder than is usual in land engines, and seldom much exceeds the diameter of the cylinder. Instead of a single beam, the center of which is elevated above the center of the shaft, two side-beams are used, working outside the side-frames, and having their centers as low down as the vibration of the beam will admit, the connecting-rod working upward instead of downward.

The shaft is considerably elevated above the top of the cylinder, and the frame is braced to the cylinder by a diagonal truss. The cold-water pump and cistern of land condensing-engines are dispensed with, injection water from overboard being freely used.

The illustration is a longitudinal section, and is taken from Hebert. *a* is the foundation plate on which the engine is erected; it is supported upon two deep sleepers of wood, which cross the floor timbers of the vessel, and to which they are firmly bolted. A portion of the bed-plate is formed into a channel, nearly as deep as the sleepers, and a part of this channel forms the bottom of the condenser, while another part receives the foot of the air-pump. *b* is the cylinder; *c* the slide-case, which is formed into three vertical compartments, connected at top and bottom by the apertures *d d*; the needle compart-

Fig. 5062.



Side-Beam Engine.

ment forms the steam-chamber, and the side compartments are the eduction-passages; *e* is the steam inlet; *f* the slide-valve, formed of two short slides, connected by a rod; the slides, which on the back form $1/3$ of a circle, are pressed up to the seats by screws at the back, acting upon a block of metal; f' is the valve-lever, working upon the shaft of the parallel motion as a fulcrum; the motion of the eccentric is communicated by the intermediate lever *g*; *h*, the parallel bar; *j*, the condenser, cast in one piece with *k*, the hot-well; *i*, the injection-pipe. A tube or cylindrical passage is cast in the condenser, through which pass the gudgeons *l* of the working-beams: these gudgeons are securely wedged into bosses cast on the sides of the condenser, and the brass bearings are fixed in a boss in the center of the beam. *m* is the air-pump; *n*, the foot-valve; *o*, the blow-through valve, through which the air and water are blown out of the condenser at starting the engine; *p*, the delivery-valve, through which the water passes into the hot-well; *r*, the connection with the relief-valve; *s*, the passage by which the waste water is carried into the sea; *t*, an air-vessel; *v*, the beam; *w*, the connecting-rod; *y*, the crank; *z*, the blow-through cock, connecting the

steam-chamber of the slide-chamber with the eduction-passage. This cock is opened before starting the engines, for the purpose of expelling air from the latter.

The feed-pump and bilge-pump are worked from the cross-head of the air-pump, and are not shown in the cut.

Side'board. 1. (*Carpentry.*) A vertical board at the side of a work-bench, and provided with holes or pins for supporting one end of a piece of work, the other being held by the bench screw or clamp.

2. (*Vehicle.*) An additional board on the side of a wagon, to increase its carrying capacity.

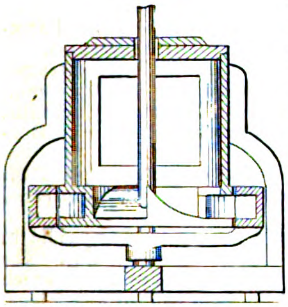
3. A piece of dining-room furniture with table and drawers.

Side-chain. (*Locomotive Engine.*) One of the chains uniting the sides of the tender and engine, as a safety arrangement in the event of the drag-bar giving way.

Side-cut'ting. (*Civil Engineering.*) Earth cut away on the side of a canal or railroad when there is not sufficient excavation on the line to form the embankments.

Side-dis-charge' Wa'ter-wheel. (*Hydraulics.*) A form of turbine in which the water, being received at the center, is discharged radially. In the example, the water falls vertically on central chutes, and is deflected outward and forward against the buckets, from which it has a side discharge.

Fig. 5063.



Side-Discharge Wheel.

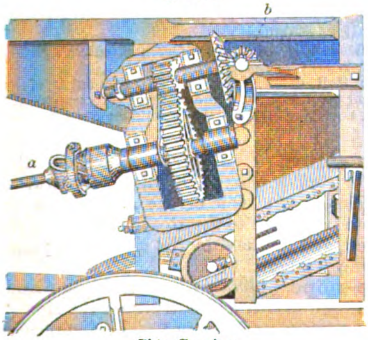
Side-drum. (*Music.*) A drum with a wooden body and somewhat longer than the ordinary drum; slung at the side of the performer. It gives a duller sound than the drum whose sides are of metal.

Side-fil'lis-ter. (*Joinery.*) A plane for making a rabbet. The width and depth is regulated by a movable stop. Much used in planing stuff for window-sash. See *h*, Fig. 3783, page 1724.

Side-flap. (*Saddlery.*) A piece of leather which hangs between the stirrup-strap and the skirting.

Side-gear'ing. The cog-wheels on the side of a thrashing-machine, receiving motion from the tumbling-rod *a*, which is driven by the horse-power, and communicating motion to the thrashing-cylinder, whose axis is shown at *b*.

Fig. 5064.

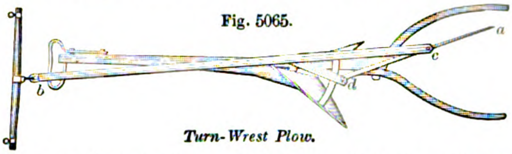


Side-Gearing.

Side-hill Plow. A plow whose cutting apparatus is reversible, so as to throw its furrow-slice to the right or left, as may be desired. This enables the lead horse of the team to return in the furrow just made, the plow throwing the soil down hill while traveling in either direction. This saves the time of going back empty with the ordinary plow when the hill is too steep to allow the furrow to be thrown up hill. It was originally invented by a Scotchman, a Mr. Gray, and was improved by Smith of Deanston and by Wilkie of Addington.

The English form of this plow has been in use for many years, being intended, as its name indicates, for plowing down hill with a back-and-forth furrow. It is called in England a *turn-wrest* plow.

Fig. 5065.



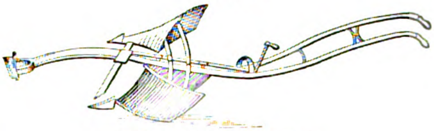
Turn-Wrest Plow.

"The beam, head, and sheath are placed in the direction of a line passing through their middle; and the two handles are placed equidistant on each side of that line. There are two mold-boards and two colters, and a mold-board is produced on either side at pleasure by moving the lever *a*, between the plow-handles, from one side to the other. The line of draft can be shifted with equal ease and expedition, and at the same time one of the colters raised up clear of the land, and placed along the side of the beam, whilst the other is put down and placed in a proper position for cutting off the furrow-slice from the land. These operations are performed by the plowman without changing his position between the stilts, by simply shifting two levers, *b c* and *d a*." — LOUDON.

Hay's *turn-wrest* (English) has a right-handed body and a left-handed one placed end to end, its beam and handles turning on a pivot at the center of the body. There are several United States patents of the same kind.

Huckvale's is so constructed that, by reversing the position of the handles, the body part is turned, and the sole becomes the landside, or *vice versa*; the share becoming the colter, or the colter the share, as the case may be.

Fig. 5066.



Wilkie's Turn-Wrest Plow.

Wilkie's *turn-wrest* plow (British) has two complete mold-boards and shares connected by bars to a rod, which form the axis on which they rotate when moved by an adjusting-rod between the handles. The same colter and landside answer for either the right or left hand plow. The rod extending to the colter, in moving the mold-board, moves also the colter one inch at the point, so as to give it the proper position in the line of draft. See also Fig. 2509, page 1103.

Fig. 5067.

Reversing-Movement.

The American form of the invention consists in making the share, mold-board, and landside upon a piece which moves on a horizontal axis at the lower edge. This is unlocked and partially rotated at the end of a furrow, converting the landside into a share and sole, and presenting the mold-board in the other direction.

Side-hook. (*Carpentry.*) A piece of wood having projections at the ends, used for holding a board fast while being operated on by the saw or plane.

Side-keel'son. (*Shipbuilding.*) An additional keelson on each side of and parallel to the main keelson, and secured to the floor timbers. Also called *sister keelson*.

Side-le'ver. (*Steam-engine.*) A heavy lever, working alongside the steam-cylinder and answering in its functions to the *working-beam*. The object is to economize hight and secure compactness (Fig. 5062).

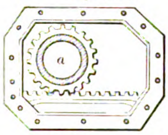
The *side-levers* communicate motion from the *cross-tail* to the side-rods, and they to the paddle-shaft.

Side-le′ver En′gine. (*Steam-engine.*) A marine engine having side-levers instead of a working-beam to turn the wheel-shaft. See SIDE-BEAM STEAM-ENGINE.

Side-light. (*Nautical.*) A plate of glass in a frame fitted to an air-port in a ship's side, to admit light. It is thrown open for ventilation, and closed when necessary to exclude water.

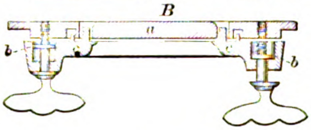
In Fig. 5068, *A*, the glass *a* is inclosed in a circular frame, having teeth gearing with a rack on the inside of a metallic box; it is rolled to one side to open the port, and is made water-tight, when closed, by an elastic packing in the frame.

Fig. 5068.


A

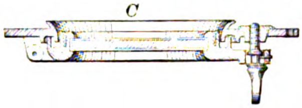
B. The light *a* is held in position by screws entering proper apertures in the vessel's side; the screws are provided with collars *b b*, which prevent them from falling out when the frame *c* inclosing the light is removed.

B



C. The light-frame *d* is hinged to the vessel's side, and is held when closed by a screw.

C

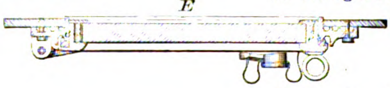


D. The frame is conical, fitting in an opening of corresponding shape, and is held in place by screws.


D

E. The face of the port-rim has one or more annular grooves *e e* corresponding to ridges on the light-frame, so fitting as to make a water-tight joint. It turns on a hinge, and is closed by a screw.

E



F

Side-Lights.

F. The frame turns on a hinge, and is held in closed position by a lever-catch *f*, having an interior screw by which the packing may be compressed as tightly as required.

Side-plane. (*Joinery.*) A plane whose bit is presented on the side, used to trim the edges of objects which are held upon a *shooting-board* while the plane traverses in a race. See SHOOTING-BOARD.

Side-plate. (*Saddlery.*) A wide leather trace-strap, which reaches back a little beyond the point at which it is connected to the breeching.

Side-pond. (*Hydraulic Engineering.*) A reservoir at the side of a canal-lock to economize the water in locking. A pond is placed on either side; each has the same horizontal area as the main chamber, is intended to contain one fourth of the *fill* of the latter, and connects with it by a sluice. The bottom of one pond is at half the hight or lift of the lock, so that when the valve is opened, it receives one quarter the contents of the main chamber; the sluice is then closed. The other chamber has its bottom at one quarter of the lift of the lock, and receives one quarter of the original contents of the main chamber. The lock is then discharged of the remaining one half and the boat floated in. To fill the lock, the contents of the *side-ponds* are discharged thereinto, which half fill the chamber, and save that amount from the upper level or pond. Thus half the amount is saved in locking up a canal-boat, which, passing up, finds the lock full, and allows a descending boat to be locked down with the expenditure of half a lockful of water. One lockful will carry a boat each way.

Side-rab′bet Plane. (*Joinery.*) A form of joiner's plane for working rabbets or sinkings on the sides of boards. The iron is vertical, and cuts at the side instead of at the bottom.

Side-rail. (*Railway Engineering.*) *a.* A short rail at a switch, to bear against the wheel-flange and keep the wheel on the track.

b. A hand-rail running alongside the boiler of a locomotive.

Si-de′re-al Clock. A clock regulated to keep regular time, *sidereal*, not *mean*. Sidereal time is reckoned by sidereal days of 23*h.* 56*m.* 4*s.* mean solar time, which are measured by the interval between two successive passages of any fixed star over the same meridian, and are divided into 24 sidereal hours.

Side-re-flect′or. (*Optics.*) A highly polished concave speculum placed at the side of an object, to direct an illuminating pencil of rays upon it.

Side-rib. (*Fire-arms.*) The rod at the side of a carbine to which the sling is fastened.

Side-rods. (*Steam-engine.*) Rods connecting the cross-head above the piston-rod with the side-levers of that form of marine steam-engine.

Sid′er-o-graph. (*Fine Arts.*) An engraving on steel. Specifically, the Perkins method. See BANK-NOTE ENGRAVING, page 228; TRANSFER-PRESS.

Sid′er-o-scope. An instrument for detecting minute degrees of magnetism by a delicate combination of magnetic needles. Invented by Lebaillif, and described by Brewster in his "Treatise on Magnetism."

Side-round. (*Joinery.*) A joiner's plane for making half-round moldings. They work in pairs, right and left.

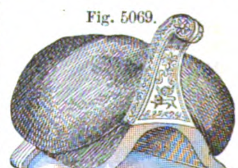
Side-sad′dle. (*Saddlery.*) A lady's saddle in which the feet are both presented on one side. The right knee is placed between the two horns, which are respectively called the *large* and the *small horn.*

Used by the Saxons in England; also in France, 1227. It was not very common, however. Riding like a man and on a pillion behind a man were the more usual practices till the seventeenth century; and even after that in places where the roads were too bad for wheeled vehicles.

The women in some parts of Europe still retain what we deem the masculine mode of riding.

The English ladies rode astride like men till the time of Richard II., when his Queen, Anne of Bohemia, introduced side-saddles (about 1380). Side-saddles had been occasionally used in some of the continental European countries for several centuries. What time the change was made does not seem to be known, but until 1540 ladies appear always to have ridden on the off side, whether on the side-saddle or pillion.

Fig. 5069.



Queen Elizabeth's Side-Saddle.

The side-saddle of Queen Elizabeth is still preserved at Horeham Hall, Essex, England. The pommel is of wrought-metal, and has been gilt. The seat is a velvet cushion.

"I did borrow a very fine side-saddle for my wife." — PEPYS, 1661.

Side-screw. 1. (*Joinery.*) A screw at the front edge of a work-bench, for holding the work.

2. (*Fire-arms.*) One of the screws by which the lockplate is secured to the stock. They pass through the stock, and are held by the side-screw plate or by side-screw washers.

Side-snipe. (*Joinery.*) A molding-plane made like a snipe's mouth and cutting on the side.

Side-space. (*Railway.*) The distance outside of each line of rails.

Side-stick. (*Printing.*) A tapering stick or bar at the side of a form in a chase. The matter is locked up by driving quoins between the stick and the chase.

Side-strap. (*Saddlery.*) A strap passing for-

ward from the breeching-rings, to unite with the tug at the back-band.

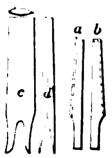
Side-tack'le. (*Gunnery.*) A purchase hooking in to an eye-bolt on a naval gun-carriage and an eye-bolt in the ship's side, and serving to train the gun to point forward or abaft the beam, and to run it out of the port. Each carriage has a side-tackle on each side.

Side-tool. (*Wood-turning.*) *a. Right-side* tool, cutting on the side and end. So beveled as to cut from the right hand to the left.

b, left-side tool, the reverse of the former.

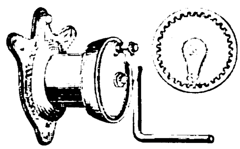
c d, for cutting insides of cylinders; sharp on the edge.

Fig. 5070.



Side-Tools.

Fig. 5071.



Side-Winch.

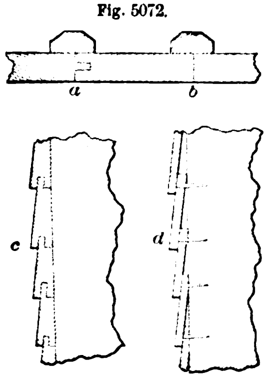
Side-tree. (*Shipwrighting.*) One of the principal or lower main pieces of a made mast.

Side'walk. A foot-pavement. A raised walk for pedestrians at the side of a road or street.

Side-winch. A hoisting device which may be secured to the side of a wall or a beam, for hoisting light weights. The motive apparatus is a crank whose shaft carries a pinion that meshes into an interior gear, to which the rope-carrying drum is attached.

Sid'ing. 1. (*Carpentry.*) The boarding of the sides of a frame building: it may be formed of boards nailed on flat with a plain butt-joint or tongued and grooved, the junction being covered with a cleat or strip (*a b*, Fig. 5072); the boards may be sawed beveling, and tongued and grooved (*c*), or plain weather-boarding (*d*) may be employed.

Fig. 5072.



Siding.

2. (*Shipbuilding.*) That part of the operation of *forming* or *trimming* ship's timbers, etc., which consists in giving them their correct breadths. It is one part of the operation of FORMING (which see).

3. (*Railway Engineering.*) A short line of additional track laid alongside of a railway, and connected therewith by switches. It is for a train to lie by while another is passing on the main line. A *turn-out, shunt*, or passing-place.

Sid'ing-ma-chine'. A machine for sawing timbers, or re-sawing boards into thin stuff for weather-boarding. See RE-SAWING MACHINE.

Siege. 1. The floor of a glass-furnace.

2. A workman's table or bench.

Siege-gun. (*Ordnance.*) A cannon sufficiently light to be conveniently transported, and throwing projectiles adapted for breeching walls in sieges. It is mounted on a siege-carriage, and forms part of the train of an army. The calibers employed in the United States service are the 18 and 24 pdr. smooth-bores and the 4½-inch rifled. A short 8-inch howitzer is also used for siege purposes. See CANNON.

Siege-gun Car'riage. (*Ordnance.*) Siege-gun carriages differ from those of ordinary field-pieces in being stronger and heavier, and in being destitute of the rings and hooks for carrying the implements. The limber has no ammunition-chest, the ammunition and implements being transported in wagons accompanying the train.

Three sizes of siege-gun carriages are used in the United States service: one for the 4½ rifled gun, model of 1861; one for the 18-pdr. smooth-bore gun, which also answers for the 30-pdr.; and one for the 24-pdr. Some peculiarities of construction and its mode of adaptation for transportation and service are described under GUN-CARRIAGE (which see).

Siege-train. (*Ordnance.*) The artillery, with its carriages and equipments, which is carried with an army for the purpose of attacking fortified places.

The guns are of sufficient caliber for breaching walls, but not too heavy for convenient transportation in the field. 18-pounder and 24-pounder smooth-bore guns, 8-inch howitzers, light 8-inch and 10-inch mortars, and, in the United States service, a rifled gun of 4½ inches caliber are employed. The gun-carriages are similar in general construction to those used for light artillery, and are unaccompanied by caissons. A peculiarly constructed wagon is employed for transporting the mortars. The ammunition and other supplies are carried in ordinary wagons, all of which are included in the general term *siege-train*.

Sieve. 1. A frame of wood or metal, having a meshed bottom, used for separating particles of different degrees of fineness.

The *sifter, strainer, riddle, colander*, are all forms of sieves, and have special applications rather than different functions.

The ancient Egyptian sieves were made of string, papyrus, or rushes, according to quality; and some were made of perforated metallic plates, as shown in a group where the public pounders are at work reducing to powder the materials brought to them. See MORTAR, Fig. 3226.

"The Gauls were the first to employ flour bolts made of horse-hair; the people of Spain made their sieves and meal-dressers of flax." — PLINY.

Sieves are of horse-hair, gauze, wire, silk (for pottery, porcelain, and flour), perforated parchment (for gunpowder), cloth, wooden slats, etc. See also SIFTER.

2. (*Founding.*) The hand-sieve is especially a molder's tool, in the use of which he becomes very expert. Brass-wire cloth of various degrees of fineness strained in circular hoops, three or four inches deep, is generally used.

3. A kind of coarse basket.

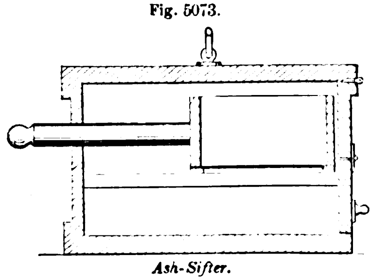
4. (*Calico-printing.*) A cloth extending over the vat which contains the color.

Sieve-cloth Loom. (*Weaving.*) A form of loom for weaving the fine goods known as bolting-cloth.

Sift'er. An implement with meshes, fine or coarse, according to circumstances, for separating materials according to size.

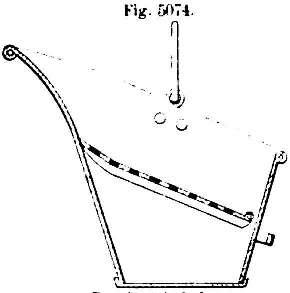
Sifters are used for sifting ashes from cinders; flour from lumps, etc.; sand from gravel; dust or smaller seeds from grain; and for various other purposes.

Fig. 5073.



Ash-Sifter.

Fig. 5074.



Scuttle Ash-Sifter.

Fig. 5073 is a reciprocating sifter for ashes; it is moved to and fro on slides in a box which confines the dust.

Fig. 5074 shows a hinged sifter in a coal-scuttle.

Fig. 5075 is a rotary ash-sifter.

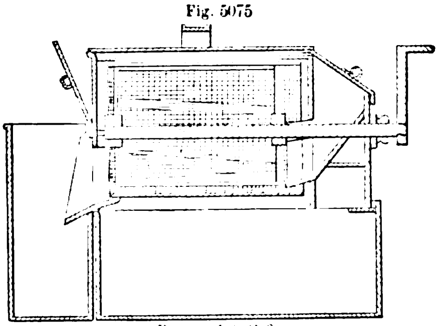
Fig. 389, page 169, shows an ash-sifter in a barrel.

Fig. 390, page 169, shows an ash-sifter in a deep stone hearth.

Fig. 388, page 169, is a rotary drum-sifter with a discharging trap.

Fig. 5076 is a scoop with a flour-sifter in the rear part.

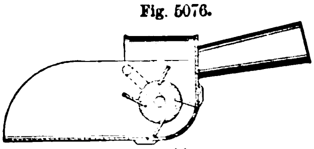
Fig. 5075



Rotary Ash-Sifter.

Fig. 5077 is a flour-sifter with a reciprocating scraper and a foraminous concave.

Fig. 5076.



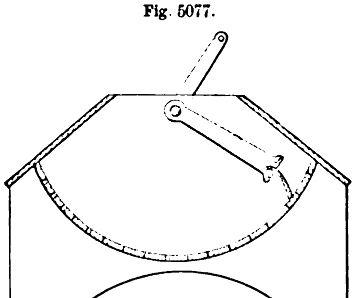
Flour-Sifter.

Fig. 5078 is a sand-sifter, having a series of sieves arranged with mechanism for imparting to it a rocking motion. The sand is raised by the cups of an elevator and discharged into the upper sieve.

Sift'ing-ma-chine'. See SIFTER; ASH-SIFTER; COAL-BREAKER.

Sight. 1. (*Ordnance.*) A piece of metal attached or applied to a fire-arm, and by which the

Fig. 5077.



Sifter.

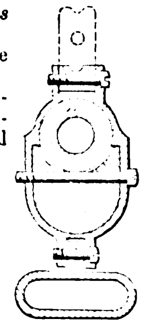
arm is pointed at the object. Small-arms have breech and front sights, the former usually notched and the latter pointed. See BREECH-SIGHT; LEAF-SIGHT; FRONT-SIGHT.

Sights for cannon include the breech-sight, front-sight, rimbase-sight, and PENDULUM-HAUSSE (which see). See BACK-SIGHT; MUZZLE-SIGHT; BREECH-SIGHT; TELESCOPIC SIGHT, etc.

The United States service rifle has a *notch* for 100 yards, and two *leaves* for 300 and 500 yards respectively.

Fig. 5079 shows a sight for service fire-arms.

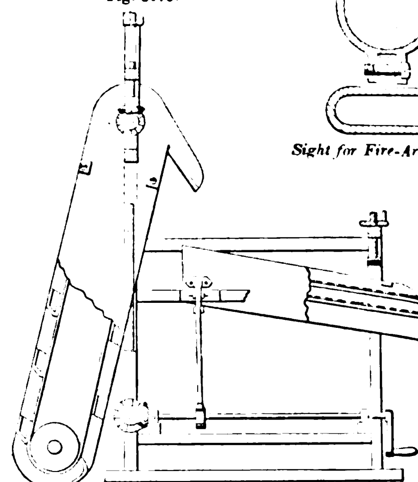
Fig. 5079.



Sight for Fire-Arms.

2. Some surveying and other instruments of precision have plain-sights, usually consisting of a vertical

Fig. 5078.



Sand-Sifting Machine.

piece with an opening divided by a spider's thread, hair, or fine wire.

3. (*Of a Drawing.*) The part within the border or margin lines. The *face* of the sheet consists of the *sight* and *margin*, the latter being the part outside of the border lines.

Sight'en-ing. (*Calico-printing.*) A fugitive color added to a paste to enable the printer to judge of the perfectness of the work.

Sig'nal. A means of communication by audible or visible signs between two distant points according to a preconcerted system.

The means of signaling are numerous. Among them may be cited: —

Balls.	Horns.
Bells.	Lanterns.
Bonfires.	Lights.
Electric sounders.	Rockets.
Flags.	Semaphores.
Guns.	Torpedoes.
Heliostats.	Whistles.

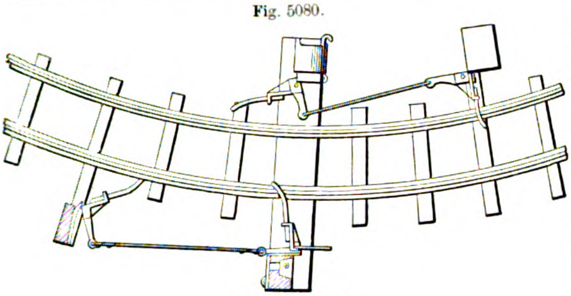
Flags are very generally employed for signaling, being equally well adapted for land or sea service. In the former case the various combinations are made by waving the flag to the right or left, or by holding it in a particular position. Nautical signals are formed by the different arrangements and combinations of several flags and pennants of different colors; each of these indicates a number, corresponding to a phrase or sentence, which is entered in a book. Every naval vessel is furnished with one of these books, by reference to which the number and signification of any combination displayed by another naval vessel of the same nation may be at once understood. The particular system used is termed a code. That of the British navy is capable of expressing about 14,000 words and phrases. Codes of more limited capability are employed in the merchant service.

Flashing-signals are made by intermittent flashes of lime light, of shorter or longer duration, so as to spell out a message.

Railway-signals are made for many purposes, usually to check speed or stop; but some signals indicate that the way is clear (see RAILWAY-SIGNAL). Fig. 5080 is a signal to be placed on curves, tunnels, or sidings. An adjustable hook on the cab of the locomotive strikes a trigger on a wayside post and sets a signal in advance.

Reconnoissances by signal-parties have been made by means of balloons on several occasions, the balloon in each case being

Fig. 5080.



Railway-Signal.

what is called *captive*, that is, being held by a rope to limit the ascension and prevent its escape.

The first occasion was at the battle of Fleurus, in 1794, when the French used it to ascertain the position and evolutions of the Austrians. It was fired at by the Austrians, but allowed to ascend out of range.

A captive balloon was again made use of by the French at Solferino, 1859.

A third use of balloons in this species of service was with the Army of the Potomac in the Peninsular campaign, and perhaps in other fields of action.

The search for the lamented Sir John Franklin gave rise to many ingenious schemes for signaling the party and giving them notice of succor.

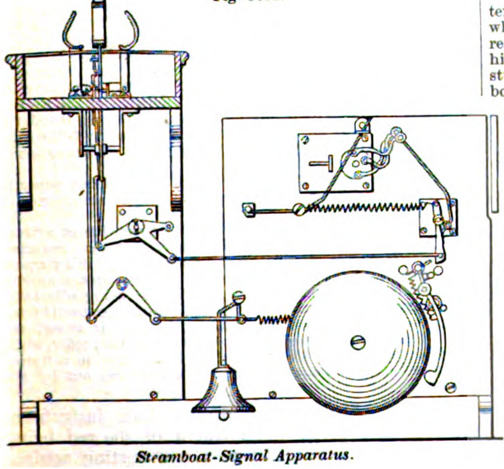
Mr. Wallace's plan was to make a survey with the assistance of a captive balloon, affording a means of distributing notices which might reach the party.

The plan understood to have been adopted was that of Mr. Shepherd. Balloons were inflated and set free, having printed packets of paper or oil-silk, which were distributed occasionally as the balloon traversed across the country. The papers contained directions, stating the latitude and longitude of the exploring ships, the direction in which they were proceeding, and the localities at which provisions had been left. These papers were attached at intervals to a long slow-match made of rope, dipped in niter, and the match, burning gradually away, released the notices consecutively, and thus distributed them over a wide expanse of country.

Mr. Darby constructed signals attached by a string to a hollow fuse, which released the *petard signal*, whose contact with the ground caused an explosion equal to that of a 6-pounder cannon, and released hundreds of little packets of printed notices wrapped in tin-foil. The petard called attention to the spot, and the bright little packages would be easily observed, and would be attractive to the natives by whom they might be discovered.

Mr. Darby had also a bill-distributor attached to his to deliver notices. A third of his devices was a hollow shell containing the information to be disseminated, and a vertical staff with a flag. The tripod base was so arranged as to stand erect on land or water. Our informant states that each of Mr. Darby's plans was tried and worked successfully. See lists under ALARMS; ELECTRICAL APPLIANCES; TELEGRAPH. See also SIREN; SEMAPHORE; RAILWAY-SIGNALS; FIRE-ALARM TELEGRAPH.

Fig. 5081.



Steamboat-Signal Apparatus.

Sig'nal-ap'pa-ra'tus. A device to operate or transmit a signal. It may be mechanical or electrical. Signal-apparatus of various kinds are cited under different heads.

Fig. 5081 is a steamboat-signal apparatus. The movement of a lever by the pilot actuates an indicator traversing the face of a marked dial coincidently with the sounding of a bell. The levers projecting through a plate having slots extending in different directions are caused, by means of wires, to move a lever connected to the shaft of the index by cord attached at different points on its periphery; thus, a greater or less extent of movement on the levers will move the index through a proportionate arc.

Sig'nal-box. A street box having a signaling apparatus connected by wires with a central apparatus for ringing alarms of fire. See FIRE-ALARM TELEGRAPH, page 849.

Sig'nal-lamp. 1. A lamp with white, red, and blue panes or bull's-eyes, for signaling trains. See RAILWAY-SIGNAL.

The signal-lamp of the English railway-service has a bull's-eye in front and a recess between it and the burner, for dropping in any particular colored glass, according to the light which is to be shown. The colored glasses are contained in a pocket, and a red, green, or blue glass can be placed in position by the engineer or signal-man as may be required.

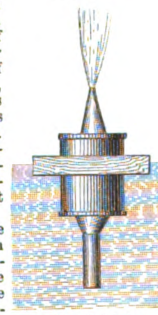
2. Marine signal-lamps or lanterns are displayed at night on board a ship, for the purpose of indicating her position to other vessels and preventing collisions. The United States Naval Regulations provide that a bright white light, sufficiently brilliant to be visible at least five miles, and showing over an arc of ten points on each bow, shall be carried at the foremast-head.

On the starboard side a green light, and on the port side a red light, each to be visible at least two miles, and showing over an arc of ten points, from straight ahead to two points abaft the beam, are to be carried.

Sig'nal-light.

A form of signal-light to be thrown into the water to direct attention of a man overboard, and of rescuing boats, consists of a tin cylinder with conical top, and a float by which it is sustained vertically in the water. The case is charged with phosphide of calcium, secured air-tight therein. For use, the top of the cylinder is cut off and the bottom end of the tube opened, so that water can enter, and evolve gas from the compound, which inflames as soon as it comes in contact with the air.

Fig. 5082.



Signal-Light.

In Fig. 5083, *A B* are side and end elevations of Cooke's apparatus for displaying the electric light from the clock-tower of the Parliament Houses at Westminster.

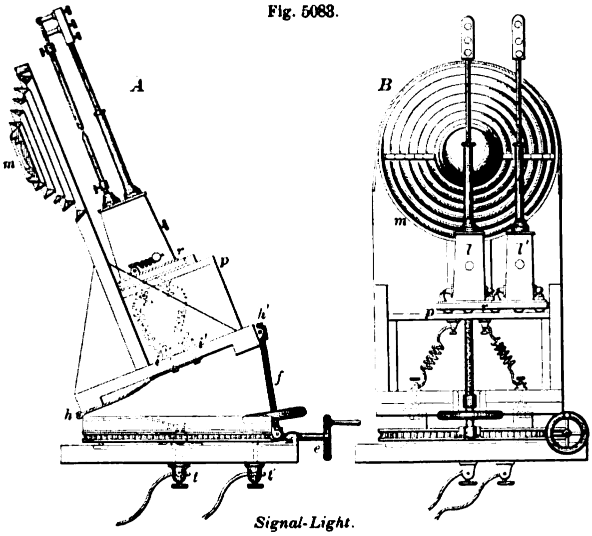
t t' are two screws which receive the terminals of the battery-wires, from whence the positive and negative currents are conducted respectively to the hinges *h h'* of the stand, and thence to the studs *i i'*, which transmit it to the carbon points in the regulators *l l'*; these are fixed upon a board *r*, which slides upon the table *p*, and each carries two copper strips, which make connection with the studs *i i'*, when either lamp is in proper position; when the carbon points of one lamp are near consumed, as *l* for example, it may be pushed over, so that *l'* occupies its place, the interruption of light being only instantaneous; fresh points are then placed in *l*, which in its turn replaces *l'*, the light being thus rendered practically continuous for as long a time as necessary.

By means of the elevating-screw *f* and hand-wheel *e* having a worm gearing with teeth around the periphery of the table *c*, the light, transmitted through a Fresnel lens *m*, may be thrown in any desired direction, either in altitude or azimuth.

Sig'nal-post. A staff for displaying flags or signal-lanterns.

Sig'nal-rock'et. Signal-rockets are composed of a *case*, charged with composition; a *pot* filled with *stars*, *gold-rain*, or *serpents*, and a stick. They are named from the interior diameter of the case, as $\frac{3}{4}$-inch, 1-inch, or $1\frac{1}{2}$-inch rockets.

Fig. 5083.



Signal-Light.

The case is formed of stout paper, which is cut into rectangles in width equal to the length of the case; these are rolled over a wooden former which is of the same diameter as that of the interior of the rocket, the paper is pasted after the first turn, and is drawn around the roller, keeping it perfectly taut as each turn is taken. This is done on a flat table, and successive sheets of paper are added until the required thickness is attained. It is then choked near one end by means of a stout cord wound once around it and drawn taut by means of a treadle, after which the choke is secured by several turns of twine, leaving an aperture large enough for the insertion of the spindle in driving; the case is now dried in the shade.

When dry, the composition may be driven into the case. For this purpose the choke end is cut off square to such a length that when the case is inserted in the mold, the choke shall fit closely over the nipple of the spindle, the end of the case resting on its base; being placed on the spindle, the case is driven firmly down, and the *mold* placed over the case. The mold is a metallic tube, bound with rings; or a block having a circular hole, into which the case fits, may be used for holding the case while driving. For driving, three or more *drifts* are used; these are of the same diameter as the rocket, but of different lengths, and all except the shortest are recessed to receive the spindle.

Fig. 5084.

a, Mold, or Block. b. Spindle. c, Drift. d, Case.

A ladleful of composition is poured into the case and driven down by 25 or 30 blows of a wooden mallet on the head of the drift, which is then withdrawn, and another ladleful of composition poured in, which is similarly treated: the operation is proceeded with in this way, using the longest hollow drift first, and afterward the shorter ones successively until the top of the spindle is reached. The case is then driven one diameter in hight with the solid drift, the composition covered with a paper wad cut to fit the case, over which is driven a wad of clay about ¼ of a diameter in hight.

Cases may be driven without a *mold*, being firmly fastened in an upright position.

The rocket is primed by a piece of quick-match, inserted in the choke-hole and coiled away at the bottom of the composition. A cap of strong paper is then pasted over this end.

The *pot* is a cylinder of rocket-paper, which is slipped over the case at the clay-wad end, projecting about 1½ diameters beyond the end of the case; it contains the ornaments and a bursting charge of powder, and is pasted on to the case.

The *cone* is made by a semicircular piece of thick paper wrapped around a conical wooden former and pasted. This is secured over the end of the pot by a similar cone of thin paper, one inch longer, whose bottom is cut into slips and pasted to the pot.

The stick tapers gradually, being of .6 to .8 of an inch at the large, and .35 to .5 of an inch square at the small end. The large end is that attached to the rocket, and is tied on by means of twine or iron wire. Its length is such that, when attached, the rocket should balance at from about 1 to 2 inches in rear of the case.

These dimensions apply for ¾ to 1½ inch rockets; for larger or smaller ones, they will be nearly in similar proportion to the size.

Marcus Græcus, who wrote about the close of the eighth century, gives the following directions: pulverize in a marble mortar 1 pound sulphur, 2 charcoal, and 6 of salter.; ram some of this powder tightly in a long narrow tube closed at one end, then set on fire, and the tube will fly through the air.

This is a veritable rocket.

Rockets from 3 to 4 inches in diameter ascend from 1,000 to 1,200 yards in from 7 to 10 seconds, and are visible 35 to 40 miles. Rockets of 1 or 2 inches diameter only ascend to from 450 to 600 yards.

Sig'nal-tow'er. An elevated structure, as a beacon, from which to display a semaphore or other signal.

Sig'na-ture. A distinguishing letter or number at the bottom of the first page of each sheet of a book, to indicate its order to the folder and binder.

Signatures are sometimes inserted at the bottoms of other pages, as the third, fifth, and seventh, in octavo, the third in quarto, and so on of the other styles.

The signature of the first sheet of matter is B, A being reserved for the title-page, index, contents, etc.; the next would be C, and so on. The old Roman alphabet, which is destitute of J V W, is adopted, so that the twenty-fourth sheet will be A A or 2 A, according to the custom of the office.

In the United States, numbers are very generally employed to indicate the signature.

About 1469-70, alphabetical tables of the first words of each chapter were introduced, as a guide to the binder. Catch-words (now generally abolished) were first used at Venice by Vindeline de Spire.

The name and residence of the inventor of signatures are doubtful; it appears they were inserted into an edition of "Terence," printed at Milan in 1470, by Anthony Zorat. And an edition of "Baldi Lectura super Codic," etc., was printed at Venice by John de Colonia and Jo. Manthen de Gherretzem, anno 1474: it is in folio, and the signatures are not introduced till the middle of the book, and then continued throughout. Abbé Reve ascribed the discovery to John Koelhof, at Cologne, in 1472. They were used at Paris in 1476, and by Caxton in 1480.

Si-le'si-a. (*Fabric.*) A linen made in Germany.

Si'lex. See SILICA.

Sil'hou-ette. A profile or outline representation of an object filled in with black. The inner parts are sometimes touched up with lines of lighter color, and shadows are indicated by a brightening of gum or other lustrous medium.

The invention has been ascribed to the daughter of Dibutades, a potter of Corinth, who drew the outline of the shadow of her lover's face cast by a lamp upon the wall, about 776 B.C. Her father, the legend relates, cut away the plaster within the outline of the profile, took an impression in clay, and baked it in his oven; this, it is said, was still preserved at Corinth when that city was sacked by Mummius, B. C. 146. Numerous and fine specimens are to be found on ancient Etruscan vases.

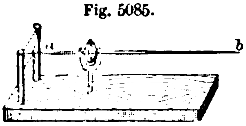
The first notice of the modern practice of the art was in regard to portraits made by Elizabeth Pyberg, who cut the profiles of William and Mary out of black paper, 1699. The name silhouette was given them, about 1757, in derision of the French Minister of Finance, Étienne Silhouette, he having vexed the people of Paris by many salutary and some rather trifling reforms; the wits, therefore, dubbed any very cheap article a silhouette.

It is frequently made by the eye, the artist having paper in one hand and scissors in the other, the subject standing with profile presented.

The portraits may be taken without the exertion of artistic skill, by tracing the shadow of the person and then reducing the portrait to the required size. A machine for this purpose is shown in the adjacent cut. The tracer moves upon a universal joint on the standard, the respective ends being adjustable as to length, so as to suit the required relative proportion between the large view and the miniature copy. In using, one end of the tracer is caused to follow the line of the profile, while the other marks upon the paper which is presented in a frame. The paper is then removed and the portrait cut out by the scissors.

Sil'hou-ette In'stru-ment. An instrument for tracing profiles. The end *a* of the rod being furnished with a lead-pencil and resting against

Fig. 5085.



Silhouette Instrument.

the sheet of paper, a person sits in position that the end *b* of the rod may be made to follow the profile of the features and head, the diminution in the size of the drawing being dependent upon the relative distances of the subject and the paper from the axis of oscillation of the rod. See TRACING-MACHINE; ENGRAVING-MACHINE; PANTOGRAPH.

Sil'i-ca. An oxide of silicon, having the formula Si_2O_4. It occurs nearly pure in quartz rock, chalcedony, flint, and in various other more or less impure forms constitutes an important part of the earth's crust.

Its economic uses are various and important, as in the form of sand, for making mortar, glass, and artificial stone. The sandstones, principally composed of silex, are largely employed in building, and, in combination with alumina and other minerals, it forms granite and many other rocks which are universally diffused over the earth's surface.

Sil'i-con. Equivalent, 21.2; symbol, *Si*. Next to oxygen it is stated to be the most abundant substance in nature. A brown, non-conducting substance; the base of silex or silica, whose formula is Si_2O_4.

Silk. 1. The fine glossy thread spun by the caterpillars of various moths of the genus *Phalæna*. That of the *Phalæna bombyx*, or common silk-worm, is most generally known and used.

The earliest notices of the use of silk are to be found in Chinese annals, as we might expect: these people had the worm, its products, and the means of recording. If we assume with one of the moderates that Hoang-to, who began the culture of silk in China, lived in 1703 B. C., he was contemporary with Joseph, the viceroy of Egypt. The wife of the Emperor, named Si-ling-chi, is particularly credited with the success of the domestication of the worm and the mode of availing its product.

The passage in Ezekiel rendered silk is believed to be a misnomer: probably fine flaxen goods.

Another reference to silk in the Bible is in Revelations xviii. 12, where it is mentioned as among the treasures of the typical Babylon.

For ages after its first importation into the West the Greeks and Romans remained ignorant of the manner in which it was produced. The Greeks, returning from their Persian conquests, 323 B. C., brought back wrought-silk.

One specimen of silk has been found in the Catacombs of Egypt. It is associated with some bead network taken from a mummy at Sakkarah.

The *serica* of the ancients, from whence the silk was derived, and whence its European name, has been identified probably with the modern Khotan.

Procopius calls it Serinda, which terminal denotes the India whence it was derived, or else an indication of the alliance of the two by race, position, or inter-commercial relation.

All the ancient and modern names of silk are derived from the Chinese *Se*, which in Corea becomes *Sir;* in Mandchou, *Sirghé;* was in Chaldee, Arabic, and Syriac, *Seric;* in Greek, *Sericon;* in Latin, *sericum;* in Anglo-Saxon, *seolc*, and so on.

The first ancient Western author who mentions it distinctly is Aristotle; in his time it is believed to have been imported in skeins from Asia and woven in Cos. The references to it in later authors are numerous. Crassus found that the Parthian troops had silken flags attached to gilt standards. The silken and embroidered robes of Cleopatra are celebrated by various authors, — Lucan, for instance. It long remained an expensive luxury: Heliogabalus, it is said, being the first Roman who had a complete silken garment; and silk was worth its weight in gold in the time of Aurelian. At the end of the third century it was worked with a warp of linen or wool, and became more common.

The history of the introduction of silk culture into Europe is thus related by Procopius ("De Bello Gothico," IV. 17): —

"About this time [A. D. 530] two monks having arrived from India, and learned that Justinian was desirous that his subjects should no longer purchase raw-silk from the Persians, went to him and offered to contrive means by which the Romans would no longer be under the necessity of importing this article from their enemies the Persians or any other nation. They said that they had long resided in the country called Serinda, one of those inhabited by the various Indian nations, and had accurately informed themselves how raw-silk might be produced in the country of the Romans. In reply to the repeated and minute inquiries of the emperor, they stated that the raw-silk is made by worms, which nature instructs and continually prompts to this labor; but that to bring the worms alive to Byzantium was impossible; that the breeding of them is quite easy; that each parent animal produces numerous eggs, which are hatched by the heat of manure. The emperor having promised the monks a handsome reward if they would put in execution what they had proposed, they returned to India and brought the eggs to Byzantium, where, having hatched them in the manner described, they fed them with the leaves of the black mulberry, and thus enabled the Romans thenceforth to obtain silk in their own country."

Western Europe was long supplied from this point. The manufacture was introduced into Spain by the Saracens.

In 780, the Emperor Charlemagne sent Offa, king of Mercia, a present of two silken vests, indicating the esteem in which the material was then held.

In 1147, Roger II. of Sicily, returning from Palestine, plundered Athens and Corinth, seized workmen who understood the silk manufacture, and introduced it into his own dominions. From thence it slowly spread to Italy and France. Louis XI., in 1480, obtained Italian workmen and established the manufacture at Tours, and in 1521 Francis I. established a colony of Milanese at Lyons.

The manufacture was encouraged in England by James I. in emulation of his "Brother the French King," as he styles him. The revocation of the Edict of Nantes by Louis XIV., in 1685, drove 50,000 Protestants from France, and materially aided in spreading the manufacture of silk, crystal glass, jewelry, and other fine goods, in which that nation of *émeutes* and artists so highly excelled.

In 1717, John Lombe obtained by stealth from Sardinia a model of the silk throwing-mill, and set up silk-works in Derby, England. The works afterward devolved upon his brother William, and then reverted to a cousin, who became Sir Thomas Lombe, whose name is also creditably associated with the pursuit of the enterprise.

Silk from spiders was spun, in 1710, by Bonn, a Frenchman, who manufactured with this material both stockings and gloves. He estimated 12 house-spiders = 1 silk-worm.

The Arachnidæ have engaged other artists not belonging to the great college of Laputa, and a patent of the United States was granted to some officers of the United States Army, January 9, 1866. They appear to have found in South Carolina some spiders of wondrous fibrous fecundity, and patented a machine in which the Arachnidæ are secured upon a frame, their spinnerets being so presented as to yield their webs to be associated and wound upon a spool. The legs are drawn back out of the way of interference while the reeling proceeds.

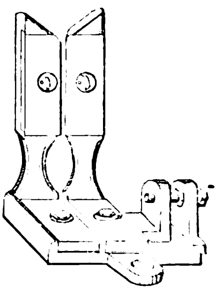
2. (*Fabric.*) A fabric woven from silk. There are many varieties, different in the fineness, density, and finish, such as —

Shot-silk.	Tissue.
Lutestring.	Gros.
Satin.	Moire-antique.
Satinet.	Ribbon, etc.

For specific list of appliances in the treatment and manufacture of silk and other fiber, see COTTON, FLAX, WOOL, HEMP, SILK, etc., APPLIANCES.

Silk-clean'ing Knife. An implement for freeing the fiber from gummy impurities and other dirt. It is drawn over or between knife-edged surfaces, which exercise a scraping action.

Fig. 5086.



Silk-Cleaning Knife.

Silk-cot'ton. A short silky and elastic fiber obtained from the *bombax* and some other trees. It is employed by the Hindoos for producing a coarse and loose yet warm kind of cloth, and has been used instead of silk for covering hat-bodies.

Silk-cul'ture. The series of operations in silk-culture is as follows: —

1. The insect, the *Bombyx mori*, deposits eggs smaller than a grain of mustard-seed.

2. Each egg hatches into a caterpillar less than one quarter of an inch long, acquiring a new skin as often as the old one becomes too small; four of these *molts* or renewals take place, at the end of which the worm is three inches long.

3. The full-grown worm, ceasing to eat, begins to expel the silk from two orifices in the head.

4. The silk, at first a glutinous gum, hardens into a thread or fiber, which the insect winds into a hollow ball around itself. This is the cocoon.

5. The body of the worm gradually lessens in bulk, while the cocoon becomes gradually larger as the silk is withdrawn from the body of the worm.

6. The cocoon being finished, the worm changes into a chrysalis.

7. In two or three weeks the chrysalis becomes a moth and eats out of its prison.

8. The moths of the respective sexes provide for a new generation of eggs, which are deposited, and then the parents die.

The silk-worm will flourish, with care, in moderately temperate climates, though tropical and subtropical regions are its peculiar habitat. The extreme east of Asia, — China and Japan, — which have a climate differing but little from that of the Southern United States, appear to be more favorable to the development of the insect than any other part of the world; at least, it seems to require less care there, though they are grown in great perfection in Italy and Southern France. There seems no reason, apart from the higher cost of labor, why our own country should not be able to produce all the raw-silk required for its own consumption. Previous to the Revolutionary War, large quantities were raised in Georgia; and during the *Morus multicaulis* mania of some thirty-five years ago, silk of unsurpassed quality, and fabrics therefrom which compared favorably with the products of foreign looms, were produced.

The worm, however, not being able to endure great atmospheric changes, requires, in our climate, careful attention. Its eggs, also, to prevent premature hatching, must be carefully kept in a cool place during the summer season.

When first hatched, which is done by exposing the eggs to a sufficient warmth, the young worms, then scarce one quarter of an inch long, are placed in contact with the food, mulberry-leaves generally, which is to form their future subsistence. The white mulberry (*Morus alba*) is largely used in Southern Europe, and it is claimed by some to produce a stronger, though coarser silk than that derived from worms fed on the *Morus multicaulis* (many-stemmed) or paper-mulberry, which is the favorite in China, and which was at one time very extensively planted in this country. The worm, however, can subsist on other leaves.

A writer in a French scientific periodical states that by feeding silk-worms on vine-leaves he has obtained cocoons of a magnificent red, and, by feeding them on lettuce, others of a very deep emerald green. Another silk-grower has obtained cocoons of a beautiful yellow, others of a fine green, and others again of violet, by feeding the silk-worms on lettuce or on white nettle. He says that the silk-worms must be fed on mulberry-leaves when young, and supplied with the vine, lettuce, or nettle leaves during the last twenty days of the larva stage of their life.

However this may be, the fact in practical silk-worm raising is that the worm, when placed on the leaves, eats continuously, with the exception of intervals when it lies by to molt, until it attains its full size, about three inches in length; it then selects a place about the frame where it is reared, in which to spin its cocoon. When the cocoon is spun it is necessary to kill the contained insect before it develops into a moth, reserving a certain proportion to lay the eggs which are to form a future supply.

This is done by baking at a low heat.

The filaments are then reeled off as described under SILK-REEL, and the various processes necessary for the completion of the fabric, whatever it may be, are proceeded with in the manner treated of under SILK-MANUFACTURE. See Figuier's "Insect World," pp. 214 - 250.

The cocoons are divided into nine qualities by the French.

1. *Good cocoons;* free from blemishes and well shaped.
2. *Calcined cocoons;* having worms which died after completing their work.
3. *Cocalons;* somewhat loose in texture.
4. *Choquettes;* having worms which died before finishing their work.
5. *Dupions;* double cocoons, difficult to detach.
6. *Soufflons;* loose cocoons, difficult to unwind.
7. *Pointed cocoons;* with a damaged point at which the thread breaks.
8. *Perforated cocoons;* at which the moth has escaped.
9. *Bad choquettes;* the silk spotted, rotten, blackish.

Silk-doub'ling Ma-chine'. A machine for twisting together two or more filaments of twisted silk. See DOUBLING, 5, page 731.

Silk-loom. (*Weaving.*) A loom specifically constructed for weaving silk. See WEAVING; LOOM.

Silk-man'u-fac-ture. The processes intervening between the making of the cocoon and the preparation of the silk for market.

1. The chrysalis is killed within the cocoon by the application of heat before it has developed into a moth.
2. The *floss silk* is stripped from the exterior of the cocoon.
3. The cocoons are placed in warm water, to loosen the gummy adherence of the filaments.
4. The filament ends are carried around a reel and wound into a skein.
5. The skeins are made up into hanks or bundles, forming the *raw silk* of commerce.

The length of each filament is usually about 300 yards; 250 average cocoons weigh about 1 pound; 12 pounds of cocoons yield 1 pound of silk = 3,000 cocoons to 1 pound of silk. — DODD.

6. The raw silk is wound from the hanks in which it is brought to market on to hexagonal frames, called swifts, and is thence transferred to bobbins.
7. *Clearing.* To remove irregularities from the surface, each thread is caused to pass under a steel scraper or between two rollers. This is done by the *clearing*-machine, where it is wound upon other bobbins.
8. *Spinning.* The spinning-machine is provided with a number of rapidly rotating spindles by which a twist is imparted to the filaments drawn from the bobbins taken from the clearing-machine, as they are transferred to another set of bobbins.
9. *Doubling.* Two or more of the filaments are twisted together, and at the same time wound upon bobbins by the *doubling*-machine.
10. *Throwing.* The *throwing*-machine twists and combines the threads in a manner nearly similar to that of the spinning-machine. For some purposes the two operations are combined; for others the throstle-frame is employed.
11. *Glossing.* After throwing, the silk is usually dyed, and is then transferred to the *glossing*-machine, where, by the combined action of steam and stretching, it is elongated and a glossy surface is imparted. The fibers may be stretched in length one tenth.
12. *Winding.* The various processes enumerated having been completed, the silk is again wound upon bobbins, and is ready to be woven.

The quality of silk is denoted by the number of yards to the *denier*, a weight equal to 24 grains.

Silken thread merely wound and cleaned is called *dumb singles;* when wound, cleaned, and thrown, *thrown singles;* if single-twisted, *tram;* if double-twisted, *organzine;* if the natural gum is left, *hard silk;* if removed, *soft silk*.

For silk gauze, *dumb singles* is employed.
For ribbons and common silks, *thrown singles*.
For the weft threads of the best silk, *tram*.
For the warp threads of the best goods, *organzine*.

Floss silk is the outer portion of the cocoon; it is worked up into yarn for cheap handkerchiefs, shawls, and other coarse fabrics, by processes somewhat resembling cotton spinning.

After sorting, the filaments are disentangled by a hackling process, being held firmly at one end while the other is drawn over a set of *gills*.

At the *filling-engine*, the silk, while passing between feeding-rollers, is subjected to the action of a series of moving combs.

The *drawing-frame* holds the filaments firmly by one end while a comb travels over their surface to remove impurities and short fibers.

The *cutting-engine* acts like a tobacco or chaff-cutting machine, and cuts the parallel filaments into lengths of about $1\frac{1}{4}$ inches.

The *scutcher* converts these short fibers into a sort of down, which is washed in soap and water, boiled in pure soft water, pressed, dried, scutched to loosen it up, carded, made into slivers, drawn, doubled, drawn, rove, and spun, like cotton.

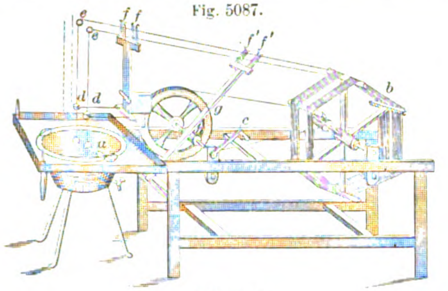
Silk-mill. A building where silk is reeled, spun, and woven.

Silk-reel. An apparatus for unwinding silk from the cocoon. The glutinous quality of the filament when first spun by the worm causes the threads forming the cocoon to adhere closely together, requiring the action of heat and moisture to effect their separation.

For this purpose the cocoons are placed in a shallow pan of water *a* heated by a furnace beneath. The ends of several filaments are united and attached to the reel *b*, to which motion is imparted by turning the crank *c*. The threads pass upward through glass eyes *d d* over rollers *e e*, by which a slight twist is imparted, and are guided by cylinders of porcelain *f f f' f'* to the reel. The shaft *g*, on which the latter pair of guides is placed, is caused to traverse from side to side by a pin on its under side working in a cam-groove in the roller *h*, so as to distribute the thread on the reel. Unless this be done it cannot be unwound, and is consequently unsalable.

One of the arms of the reel is provided with a screw, so that it may be shortened when desired to remove the skein. It is screwed out again for winding.

Fig. 5087.



Silk-Reel.

The automatic silk-reel is designed for unwinding the thread from the blocks of the throwing-mill and winding it into hanks.

Silk-shag. (*Fabric.*) A coarse, rough, woven silk with a shaggy nap.

Silk-siz'ing Ma-chine'. See SILK-SORTING MACHINE.

Silk-sort'ing Ma-chine'. A machine by which silken threads of various thicknesses are sorted into sizes between certain limits and wound upon separate bobbins, according to size.

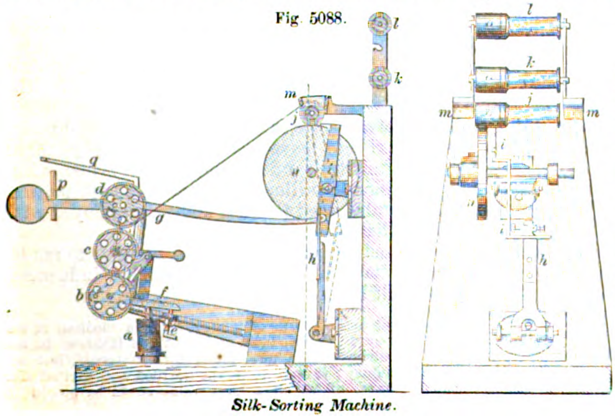
Fig. 5088 is Atwood and Leigh's machine. The thread from the bobbin *a* passes to and between the gage-rollers *b c d*, which have a certain bearing on each other, and are simultaneously raised or lowered by turning the adjusting-screw *e*, operating the pivoted lever *f*, on which the journals of the lower roller rest. The shaft of the upper roller is connected with a lever *g*, the shorter arm of which is weighted so as to nearly counterbalance the preponderance of the other arm, which is forked at the end, straddling the upper end of the lever *h*, which bears against the lower bent arm of the lever *i*, so that the two constitute a compound lever.

The silk is wound from the roller *d* on to one of the bobbins *j k l*, each of which receives a different sized thread between certain limits. Either of these bobbins, depending on the size of thread being delivered, is placed in bearings in the arms *m m*, where it is turned by the revolution of the drum *n* bearing against the cylindrical portion *o* of the bobbin. The upper end of the lever *h* has two notches on one side and one on the other, and the fork of the lever *g* has two inwardly projecting pins, one on each side. The lever *h* may be shifted from side to side, so that one of these pins may bear against either its front or back, for the purpose of adjusting the delivery of the thread. If this should vary from the prescribed limits, the lever *g* tilts, throwing backward the lever *h*, which, in turn, operates the lever *i*, causing its upper cam-shaped extremity to come in contact with the roller *o* on the end of the bobbin, and lift it out of contact with the drum *n*, so that it ceases to revolve. One of the bobbins *k l* is then substituted, the thread is broken, and its end is attached to the bobbin, and wound thereon so long as the bobbin continues to act, or until it is thrown out of contact with the drum *n*.

In case the thread becomes so thin as to endanger its breakage, the lever *g* drops until the adjustable set-screw *p* comes in contact with the stop *q*, throwing the middle and lower rollers out of frictional contact, and they cease to deliver.

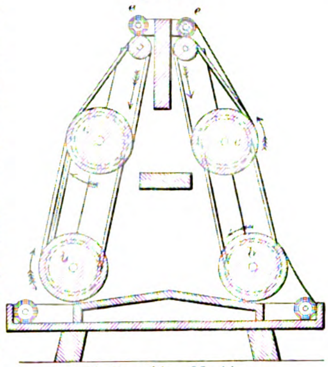
By having a larger number of rollers and slightly modifying the stop arrangements, the machine may be adapted to sort more than three sizes of thread.

Fig. 5088.



Silk-Sorting Machine.

Fig. 5089.

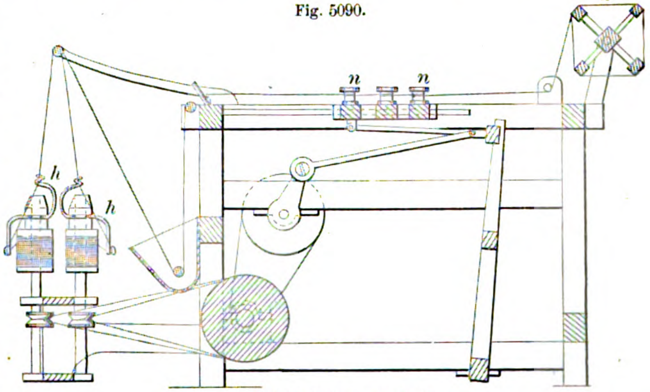


Silk-Stretching Machine.

Silk-stretch'ing Ma-chine'. An apparatus for imparting the proper tension to silk fibers.

In the example, the ends of the fibers, reeled on bobbins placed at the lower part of the frame, are moistened and attached to drums *B B*, whose motion unwinds them from the bobbins; when all is wound off on to the drums *B B*, the free ends of the fibers are similarly attached to the drums *C C*, which are set in motion, unwinding and stretching the fibers from the drums *B B* on to themselves. The final stretching is effected by the bobbins *E E*, which draw the silk from the drums *C C* and over a series of rollers, one for each thread. Winding from the lower bobbins on to the lower drums, and from the upper drums on to the upper bobbins, may be effected simultaneously.

Fig. 5090.



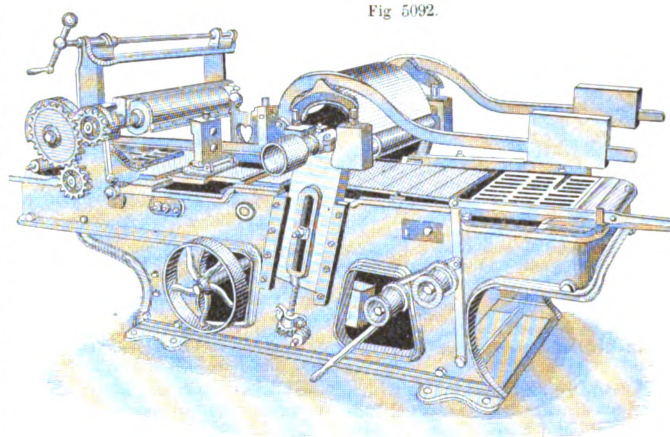
Silk Twisting and Reeling.

Silk-throw'ing Mill. At the commencement of the eighteenth century, silk machinery was so imperfect in England that the supply of thrown silk was chiefly derived from Italy. In 1717, John Lombe returned from Italy with drawings of the machinery employed in that country, where the process was kept as a profound secret. He obtained access to the mills by bribing the workmen, and committed the results of his observations to paper at night. Having been discovered, he with great difficulty made his escape. In 1718 he obtained patents for the improvements thus introduced, and in 1719 erected a mill on the Derwent at Derby, 5 stories high and $\frac{1}{8}$ of a mile

in length, which was considered one of the wonders of the age.

Silk Twist'ing and Reel'ing. In the apparatus (Fig. 5090), the silk previously wound upon spools is twisted by the flyers *h h*, then macerated in a trough, coiled upon the rollers *n n*, and finally wound upon the reel *u*.

Fig 5092.



Fay's Sill-Dressing Machine.

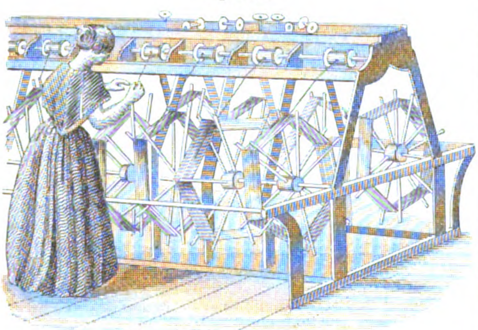
Silk-wind'-er. (*Silk-manufacture.*) *a.* The reel on which silk is wound from the cocoons. See SILK-REEL.

b. The machine on which raw silk in the *hank* is transferred to bobbins preparatory to spinning.

Each hank is extended upon a light six-sided reel, called a *swift*, a number of which are arranged on axes on each side of a frame. The bobbins, one for each swift, are arranged above them.

The ends of the filaments on the swifts are connected to the bobbins, and the swifts are set in motion, causing the bobbins to turn and deliver the silk.

Fig. 5091.



Silk-Winder.

The swifts are adjustable to receive hanks of varying sizes, and have a friction device on the axis, to prevent them from turning faster than the bobbins can take the silk. The filaments pass through eyes on a rod having an endwise traversing motion, which lay them spirally and evenly upon the bobbins.

Fanshaw's silk-winder, English patent, 1827, was designed to avoid the breakage of the filament in winding the skein silk on to bobbins. Instead of mounting the skein on a reel, which is rotated by drawing upon the thread, the reel is made stationary, and a revolving flyer passes around and lifts the thread, which passes over a roller, thence to the center of rotation, and is then wound upon a bobbin.

Silk-worm Gut. A fine cord for angling, made of the silk-gut of the worm.

Fine worms about to begin spinning, being selected, are killed by immersing in vinegar. After steeping for about twelve hours, a worm is removed and pulled apart, exposing two transparent yellowish-green cords. These are stretched to the required extent, and fastened in the elongated condition on a board to dry.

Sill. 1. (*Carpentry.*) The lower timber in a wooden structure, — in a building, a loom, a bridge, a door or window frame, etc., etc. Nearly synonymous with *sole*; but the latter refers more specially to moving objects, such as a plow, a shoe, a sled, etc.

Sometimes called *ground-sill.*

2. (*Fortification.*) The inner edge of the bottom or sole of an embrasure.

3. (*Mining.*) The floor of a gallery or passage in a mine.

Sill-dress'ing Ma-chine'. A special kind of wood-planing machine for dressing heavy timbers on two or more sides, for car-bodies or other structures. It has various adjustments for different thicknesses and widths of stuff.

Sil'lon. (*Fortification.*) A work raised in a ditch to defend it if too wide. It must be lower than the main works, but higher than the covered way.

Si'lo. A large shallow ditch protected by thatch or boards from rain, sun, and air, and used as a store-pit for potatoes or beets designed for starch-making or the manufacture of beet-root sugar.

Si-lom'e-ter. (*Nautical.*) An instrument for measuring, without the aid of the log-line, the distance passed over by a ship. Various forms have been proposed or actually constructed. See LOG; VELOCIMETER; and list under METER.

Sil'ver. Equivalent, 108; symbol, *Ag.* (*argentum*); specific gravity, 10.5; point of fusion, 1873° Fah. Generally occurs as a sulphide, and is often associated with other metals. The ore is ground and the silver separated by amalgamation. See AMALGAMATOR.

It is a clear white, malleable, ductile metal; may be extended into leaves not exceeding $\frac{1}{10000}$ of an inch in thickness and drawn into very fine wire; has considerable brilliancy and takes a high polish.

The metal is used for coin and plate, alloyed with copper to harden it.

It is used to coat metals (see PLATING) to render them less liable to change by atmospheric influences, but is itself liable to be attacked by sulphur.

Silver is the earliest form of money, being a medium of exchange in Assyria, Egypt, Tyre, and with the Hebrews in the time of Abraham. Gold was valued for ornaments, but not current as money; it was no doubt hoarded and carried like precious stones, of which a large value could be placed in a small compass.

Silver was also used for ornaments; "jewels of silver" and

"jewels of gold" were given by Abraham's servant to Rebecca; "a golden ear-ring of half a shekel weight, and bracelets for her hands of ten shekels weight of gold."

Vessels of various kinds and images were also made of it, and at a very early day.

It is generally allowed to be the best material for drinking-vessels and table-ware, and has been a favorite therefor in all historic ages. Joseph, who was viceroy of Egypt, speaks of "*my* cup, the *silver* cup."

The images (*terraphim*) which Rachel stole from her father Laban were no doubt of silver.

The ancient notices of silver are numerous, both as a medium of exchange and for articles of use, ornament, and luxury.

A traveler in Honduras describes the primitive mode in which silver ores are treated by the Indians in that country. "The man disappeared in a hole in the hillside, and presently appeared with a lump of ore. The man and woman then selected each a flat stone, and began pounding the ore, which was thus gradually reduced to the condition of a gravelly dust. The fire, meanwhile, was fed largely by the children; a small earthen pot, holding a portion of the *brosa*, was set deep in a bed of coals. The wood was piled over it, sulphurous vapors escaped, and when the whole had burned fiercely awhile and fallen to ashes, our son of Tubal Cain drew forth the pot and turned out upon the ground a mass of gray, black, and red slag and ash, out of which I drew with a stick a button of red-hot silver, weighing, perhaps, two ounces."

Fig. 5093.

Indian Silver-Miner.

An antique appearance may be given to silver by exposing it to the fumes of hydro-sulphuret of ammonia, or immersing it for a short time in the solution.

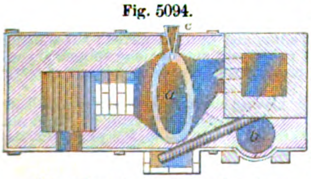
The salts of silver are much used in the arts, — the protoxide and nitrate in photography, the nitrate in hair-dyes and indelible ink.

Silver is separated from lead by repeated melting and crystallization of the lead; the crystals of lead being removed at each operation, the remainder becomes richer in silver, which is then removed by a process similar to that described under ASSAY.

The fact that the richer portion is less fusible than that containing a greater proportion of lead, is utilized in the Pattinson concentration process. See PATTINSON'S POTS, page 1638.

The silver-from-lead-extracting furnace, which may be considered as performing the process of cupellation on a large scale, employs the agency of heat and air-blast in the oxidation and removal of the lead, the alloy being exposed in a shallow pan of bone-dust aggregated in a basin-shape within an oval frame of iron, and forming the hearth of the reverberatory. This hearth is called a *test*, and is supported by a fixed iron ring, called the compass-bar, in the furnace.

Fig. 5094.



Silver-from-Lead-Extracting Furnace (Plan).

The alloy of lead and silver flows into the *test* *a* by a spout from the melting-pot *b*, and the lead on the surface becomes oxidized. The air-blast, entering at the tuyere *c*, blows the supernatant oxide toward the opposite end of the oval hearth, when it flows over the depressed portion of the wall of the cupel, and is collected in a pot below.

As the lead is thus removed, fresh alloy flows from the pot *b*, and the process is continued until a profitable concentration of the silver is attained. The charge is then withdrawn, and the process repeated on a new lot of alloy. The concentrated results of a number of charges are treated in a similar furnace, the dross of oxide being removed by skimming. The eventual refinement is known by the *lightening*, a peculiar brightness incident to the face of the molten metal when the last film of litharge is dissipated and before the cooling of the silver itself begins to take place.

Some beautiful similes have been drawn by the Hebrew writers from the silver-refining process, the *brightening*, which manifests the perfection of the process, being held to be a type of the condition of the human soul purified by trials and perfectly reflecting the face of Him who sits "as a refiner and purifier of silver."

In 1850, Mr. Alexander Parkes patented in England a process for extracting silver from lead by means of zinc. This is now employed in various works in Prussia and France; and it is claimed that ores containing but 8 ounces of silver to the ton can be profitably worked by it.

The process is conducted in large cast-iron Pattinson pots, holding from 10 to 12 tons of lead. The lead is melted and the zinc introduced in three portions, the first being $\frac{2}{3}$, the second $\frac{1}{4}$, and the third $^{1}/_{12}$ of the whole amount used. When the first portion is melted, it is mixed in by rabbles and perforated ladles, or by a mechanical stirrer, for 20 or 30 minutes, when the fire is withdrawn, the metal covered with wet coal-slack, and allowed to cool slowly; the zinc, having formed an alloy with the silver in the lead, rises to the surface. The spongy crust or silver sponge, which forms on top, is taken off to the depth of about two inches, when the lead begins to crystallize; it is again heated up, the second portion added, and treated in the same manner as before. After the second sponge is removed, some liquefied lead, which is subsequently removed from the sponge, and contains a little silver, is added, together with the last portion of the zinc, and the same operation again proceeded with. The whole process takes some 20 or 24 hours. The silver sponge takes up the copper and gold from the lead, leaving behind the antimony and bismuth.

In Balbach's method of using zinc for separating the precious metals from lead, a sufficient quantity of zinc to take up all the silver and gold, say 20 to 80 pounds to the ton of lead, is fused in a kettle, and the molten lead, slightly purified by the process of fusion, is allowed to flow into the kettle, while the zinc is thoroughly incorporated by stirring. The alloy is then cast into pigs, which are placed in a furnace having an inclined hearth, and heated sufficiently to melt the lead, but not the zinc, silver, and gold. The pure lead is drawn off, leaving an alloy of the latter metals in the furnace, to be afterward separated by farther reduction.

The silver processes of Freiberg, Saxony, are about as follows:

The *barrel-amalgamation* process, see page 77.

The *hot-water process*, in which the ores of silver are roasted, so as to give soluble sulphates of silver, which are dissolved out by hot water, and metallic silver is thrown down by copper.

The common *salt process*, in which the ores are roasted to a chloride, and the latter dissolved out by a strong solution of common salt, and the metallic silver thrown down by copper.

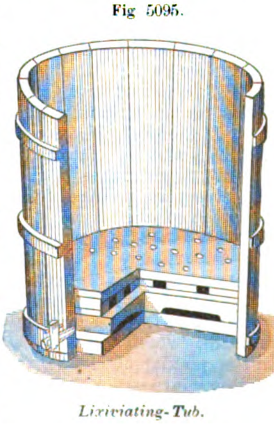
The extraction of silver from lead ores by fusing them with sulphurets of iron, forming a regulus or *matt*, which has the power of dissolving metallic silver and extracting it from the lead.

The solution and precipitation processes are more modern than the mechanical modes, and appear to be principally in vogue on the Continent of Europe. Great completeness and promptness are claimed for them. They are recommended especially for silver in which copper rather than lead predominates.

Augustin's process consists in roasting with salt, for the conversion of the silver into a chloride; lixiviation with hot brine to dissolve the chloride; and precipitation of the silver in a metallic state by exposure of the solution to copper.

The material operated on at Freiberg, in Saxony, is a matt containing about 70 per cent of copper and 0.0042 of silver. It is ground and bolted, and is then roasted for 8 hours to expel sulphur, being stirred during the operation to prevent caking. Being again ground, it is roasted for three hours with the addition of 5 per cent of salt. By the agency of the sulphuric acid of the metallic sulphates, the chloride of sodium is decomposed and the chlorine combines with the silver to form chloride of silver.

Fig 5095.



Lixiviating-Tub.

The material, after cooling, is placed in lixiviating-vats with

perforated false bottoms and filtering-cloths, and a stream of hot brine passed through it. The chloride of silver is thus dissolved and carried off in the hot chloride of sodium, and is conducted to tanks in which foreign matters are allowed to settle. The supernatant liquor is then drawn off into filters in which it passes through layers of *cement copper*, which precipitates the silver, the chlorine uniting with the copper and passing off therewith as a solution of chlorides of sodium and copper, leaving the silver behind. The solution is then filtered through scrap-iron, which causes a deposit of the copper, which is to be used again in the vats above. The brine is reboiled and re-used. The silver is removed occasionally from the lixiviating-vats.

Ziervogel's process supplanted the Augustin process in 1857. It consists in converting the silver into a sulphate and dissolving it out with hot water.

The operation is, briefly, as follows: A finely ground matt containing sulphides of copper, iron, and silver is roasted in a reverberatory furnace. The iron and copper first pass into sulphates, and then become oxides. The silver commences the same series, but subsequently to the other metals. The operation is arrested at the point when the iron and copper have become oxides, and the silver exists as a soluble sulphate removable by water; after which it is precipitated in a metallic state by being filtered through cement copper, and by the addition of chloride of sodium.

Von Patera's process consists (1) in roasting the ores with the addition of salt to convert the silver into a chloride; (2) dissolving out the chloride by means of a cold dilute solution of hyposulphite of soda; (3) precipitating the silver in the form of sulphide by the addition of polysulphide of sodium; (4) reducing the precipitated sulphide of silver to the metallic state, by exposing it in a muffle at a high temperature to the ordinary influences of atmospheric air.

The ore is roasted with addition of steam at the latter part of the process. It is then withdrawn, cooled, ground, and receives an addition of 6 to 12 per cent of salt and 1 to 3 per cent of sulphate of iron. This is introduced into a furnace where it is heated and stirred and receives jets of steam upon its surface. The heat is gradually increased, and may last 10 to 16 hours. The purpose of the addition of the sulphate of iron is to assist in the decomposition of the chloride of sodium if the metallic sulphate should prove to be present in only small quantity. The steam makes the chlorination of the silver more energetic, and assists in the condensation of the former in the chambers interposed between the furnace and chimney. The silver now exists as a chloride, insoluble in water, and the sulphates and chlorides of copper, zinc, nickel, cobalt, iron, etc., are removed by lixiviation.

The remaining pulverized ore is then lixiviated with a cold aqueous solution of hyposulphite of soda, which carries off the chloride of silver, which is precipitated from its menstruum by polysulphide of sodium. The clear liquor is decanted and used for fresh lixiviations of roasted ore; the residual sulphite of silver is drained, pressed, dried, washed, dried, and then heated to redness in a muffle, through which a current of air is passed to remove the sulphur. It is now melted in crucibles, traces of sulphur being removed by the addition of iron, which forms a ferruginous sulphide, and is skimmed off. A sprinkling of wood-ashes and bone-ash absorbs remaining impurities, and is scraped off, leaving the silver practically pure.

On pp. 71-88 of the first volume, AMALGAMATOR, are numerous examples of machinery for working silver ores and auriferous sand or quartz. The arrastra may or may not be an amalgamator, depending upon the presence or absence of mercury. In the latter case, it is a mechanical muller, and is used to perfect the work of the stamps by a more perfect trituration of the ore (see ARRASTRA). Other machines for the treatment of the ores of precious metal are described under ORE-STAMPS; ORE-GRINDING MILLS; ORE-CRUSHERS; CALCINING-FURNACE; REFINING-FURNACE; GOLD-WASHER; CHLORINATION OF GOLD; GOLD BY LEAD-BATH. See list under METALLURGY.

Sil'ver Al-loy'. See ALLOY, page 63; MOCK-SILVER, page 1457.

In 1873, a patent was granted to Mme. Baudoin of Paris for an imitation silver-alloy, composed of copper, 71; nickel, 16.5; cobalt, 1.75; tin, 2.5; iron, 1.25; zinc, 7. In some cases, a small proportion — say, ½ per cent — of aluminium is added.

The silvery appearance of this alloy is due principally to the cobalt.

Sil'ver, Im-i-ta'tion. See MOCK-SILVER, page 1457; ALLOY, page 63.

Sil'ver-ing. Covering the surface of baser metal or other material with silver. When the silver is in the form of leaf, the operation is analogous to that of GILDING (which see).

In the plating of metals, the principal steps are the following: —

The *smoothing down* and polishing the surface of the plate to be silvered.

Annealing. Heating the plate red hot and plunging it into dilute nitric acid until perfectly clean.

Pumicing. Cleaning the surface with pumice-stone and water.

Warming. Heating until the plate slightly hisses, when it touches water, after which it is dipped in dilute nitric acid, causing a slight roughness of the surface, which retains the silvering.

Hatching. When the surface is not thus rendered sufficiently rough, it is gone over with a graving tool; chased surfaces, however, need not be touched.

Bluing. Heating the piece until its surface assumes a bluish tint.

Charging. The workmen's term for silvering. The leaves of silver are placed on the piece while heated, and fixed to its surface by a burnisher. The workman operates on two pieces at once, so that while he is applying the leaf to one the other is being heated.

After applying two silver leaves, the piece is heated to the same degree as at first, and four more leaves are then laid on with the burnisher. He thus applies the leaves successively one over another until the required thickness is attained, and afterward burnishes the surface with a strong pressure.

In silvering with precipitated chloride of silver, a solution of common salt is added to a solution of nitrate of silver, and the resulting white mass is washed and dried; 1 part of this powder is mixed with 3 of good pearlash, 1 of washed whiting, and 1½ sea salt. After cleaning the surface of the brass, it is rubbed with soft leather or cork, moistened with water and dipped into the above powder. After silvering, the surface is washed with water, dried, and varnished. Some use a mixture of 1 part of the silver precipitate with 10 of cream of tartar.

Inferior plated buttons are silvered with a mixture of 1 ounce corrosive sublimate, 3 pounds common salt, and 3 pounds sulphate of zinc made into a paste with water; this is smeared over the buttons, which are then heated to expel the mercury, and afterward burnished.

Leather is silvered by applying a coating of parchment-size or spirit-varnish, and afterward coating with silver-leaf under pressure.

The silvering of glasses and mirrors by the electro-plating process is accomplished in the bath of silver solution in the usual way, the glass being perfectly clean. See next article. See also PLATINIZING, page 1741; LOOKING-GLASS, pages 1350, 1351; MIRROR, pages 1452, 1453; GLASS-SILVERING, pages 982, 983.

Sil'ver-ing Glass.

In Liebig's process (Wagner's "Jahresbericht," Vol. II. pp. 168-171), to an aqueous solution containing 10 grammes nitrate of silver in 200 cubic centimeters, is added sufficient ammonia to clear it, and afterward 450 cubic centimeters of a solution of soda (free from chlorides), specific gravity 1.035; the precipitate produced is dissolved by adding liquid ammonia, saturated with oxide of silver, until the volume is increased to 1,450 cubic centimeters, when dilute solution of nitrate of silver is added: a gray precipitate is formed, water sufficient to bring up the bulk of the liquid to 1,500 cubic centimeters is lastly added. Shortly before applying the silvering liquid it is mixed with $\frac{1}{6}$ to $\frac{1}{8}$ its volume of a solution of milk sugar. After the silver has become attached to the glass, it may be polished with fine rouge and a cloth, and varnished with an alcoholic solution of gum-dammar. Liebig finally, however, recommended the following: Dissolve 1 part nitrate of silver in 10 parts distilled water. Form solution of nitrate of ammonia, specific gravity 1.115; a sulphate of ammonia solution, specific gravity 1.105, may also be used. Prepare a lye of carbonate of soda, having a gravity of 1.035, and reduce three volumes to two by evaporation. The silvering liquid is composed of ammoniacal solution, 100 volumes; silver solution, 140 volumes; lye solution, 750 volumes. The reduction liquid is composed of: *a*, 50 grammes rock-candy, dissolved in water; 3 grammes tartaric acid are added, the liquid boiled for 1 hour, and diluted with water, forming a bulk of 500 cubic centimeters; *b*, 2.857 grammes tartrate of copper are covered with water, and soda lye is added until dissolved; the solution is diluted to form 500 cubic centimeters: one volume of each of these two liquids is mixed together, and 8 volumes of water added.

The glass is coated by placing a number of plates in a bath of liquid composed of 50 volumes of the silvering mixture, and 10 of the reducing mixture, to which 250 to 300 parts of water have been previously added.

In J. Loewe's process, 50 parts of sugar, prepared by being treated with dilute nitric acid, which is afterward neutralized by chalk, are dissolved in 5,000 parts distilled water, 20 parts pure fresh burnt lime are added, the solution is distilled, and kept in closely stopped vessels. In silvering, 6 parts of this liquid are mixed with 1 part of a solution composed of nitrate of silver (fused), 7; water, 150 to 160 parts; ammonia is then added until the precipitate formed is dissolved.

Several descriptions are given of the process of Petitjean of Paris. The following is from "Repertoire de Chimie Appliqué," Vol. I. p. 321: 100 grammes nitrate of silver are mixed with 62 grammes of ammoniacal liquid, specific gravity 870 to 880, and 500 grammes distilled water, and filtered. This solution is diluted with 15 times its bulk of distilled water, and 7½ grammes of tartaric acid dissolved in distilled water are added little by

little while the liquid is being strongly agitated. A similar liquid is prepared with twice the quantity of tartaric acid.

The first is applied by placing the glass plate, carefully cleansed, face downward, in a cast-iron trough, pouring and spreading the solution on the back to the thickness of $^1/_{10}$ inch, and raising the heat to 60° Cent.; when deposition has taken place, it is similarly treated with the second liquid, and afterward covered with a protecting varnish.

Delamotte's silvering liquid is prepared by dissolving 20 grammes gun-cotton and 100 of natron in 200 cubic centimeters of water; the liquid becomes warm and turns brown; when cold, it is diluted with water until it forms the bulk of a liter. With this is mixed a solution made by dissolving 100 parts nitrate of silver in 200 parts of water; 120 parts of this are mixed with an equal quantity of liquid ammonia; when the resulting precipitate is redissolved and the liquid becomes clear, it is mixed with the first solution, and after standing 12 hours, half the volume of distilled water is added, and the combined solution is ready for use.

It is poured on the plate, ledges coated with resinous varnish on the under side preventing it from running off, and subjected to a heat of 60° or 70° by a water bath, in which the face of the glass is immersed.

Masse employs 600 grammes citric acid dissolved in water, and neutralized by 320 grammes lime; the precipitate is mixed with 240 grammes sulphate of magnesia, in twice its weight of water, forming tartrate of magnesia in solution, which is filtered and evaporated in a porcelain dish to ⅔ its original volume; when cool, ammonia is added, and the liquid put away in closed vessels. For use, 100 grammes of oxide of silver are dissolved in 1 kilogramme of the above solution, three liters of water are added, and the whole is digested at a low heat.

A battery is employed for causing precipitation of the metallic silver on the article to be coated.

Nitrate of silver and alcoholic solution of tannin have been employed by Unger for silvering glass and porcelain.

Cimeg's process consists in moistening the cleansed glass with a solution of 1 part Rochelle salts (tartrate of soda and potassa) in 200 parts of water, and afterward pouring on it a solution containing nitrate of silver 20, Rochelle salts 40 parts, which is allowed to flow uniformly over the glass; the plate is then kept in a horizontal position for one half-hour, when it is washed: when dry, the silver is coated with a varnish composed of gum-dammar, 20 parts; asphaltum, 5; gutta-percha, 5; benzine, 75.

R. Bottger's process is based on those of Petitjean and Cimeg. He dissolves one drachm of nitrate of silver in an ounce of distilled water and pours this slowly into a boiling solution of tartrate of soda and potassa; a second liquid is prepared by dissolving one drachm nitrate of silver in one ounce of distilled water. These two solutions are mixed and applied to the glass, causing precipitation of the metal.

In the process of Martin four liquids are employed: —

1. 40 grammes nitrate of silver in 1 liter of water.
2. 70 cubic centimeters of ammonia of 24° in 1 liter of water.
3. 40 grammes caustic potash in 1 liter of water.

The above must be free from carbonic acid.

4. 25 grammes of sugar are dissolved in 250 grammes of water; 3 grammes of nitric acid are added. The liquid is boiled, allowed to cool, and sufficient of No. 3 to nearly neutralize the acid added; also 50 centimeters of alcohol, when it is diluted with water sufficient to bring its volume up to ½ liter.

Foucault's method is similar to the above, the proportions being somewhat varied and the nitrate of silver added last.

L. L. Hills dissolves 1 ounce nitrate of silver in 2 fluid ounces of water; liquid ammonia is added until the precipitate which at first forms is dissolved, care being taken to avoid excess of ammonia. A few grains of nitrate of silver, sufficient to cause a slight tarry odor, are then added; this odor indicates that the liquid is in proper condition for use. With this is mixed a compound of 5 gr. mannite, 1 dr. sulphuric ether, and 1 oz. sugar, treated with pure sulphuric acid and neutralized with pulverized chalk. It is applied to the glass in an india-rubber pan, heated by a water-bath at 212° Fah. temperature, a rocking motion being constantly maintained. A varnish composed of gum-dammar and sulphuric acid is preferred for covering the deposited silver.

Drayton proposed the use of essential oils, as oil of cassia, pink, etc., for separating silver from the ammoniacal solution. Resinous matters, produced by the oxidation of the oil, were found, however, to form spots on the silver surface.

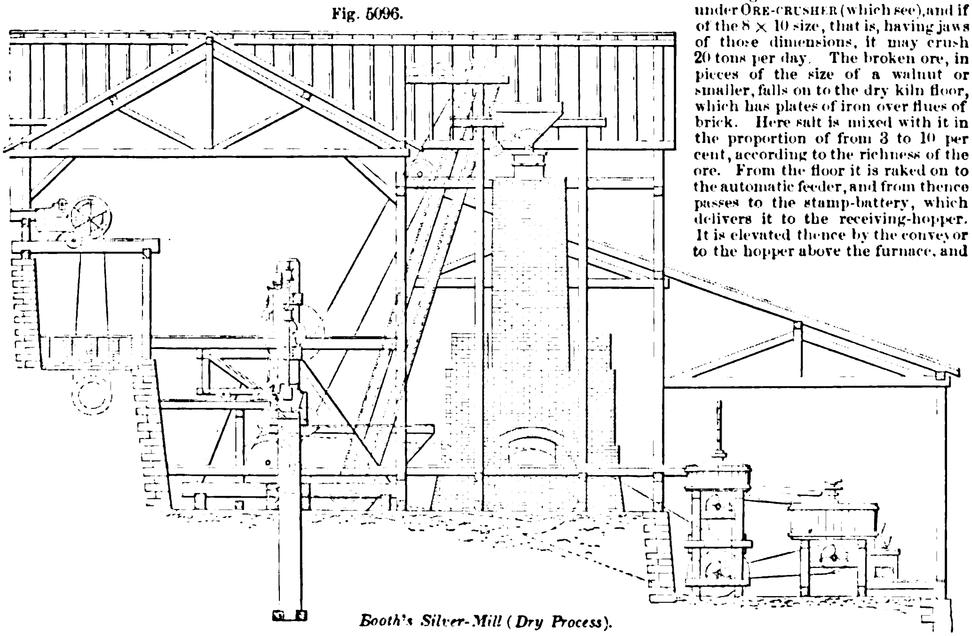
Wagner remarks that only those oils which contain aldehyde are adapted for silvering, and these must be freed from carbureted hydrogen. For this purpose oil of rue, for example, is agitated with a strong aqueous solution of double sulphite of potash. From the compound thus formed, the oil of rue is separated free from resinous matters by dilute sulphuric acid. The purified oil is dissolved in alcoholic ammoniacal liquid for precipitating the silver solution.

The process employed by R. Siemens, and described in the "Archiv der Pharmacie," is as follows: Aldehyde ammonia is first made by conducting dry ammonia gas through aldehyde. The aldehyde ammonia and the nitrate of silver are dissolved separately in distilled water, and the solutions mixed and filtered. The proportions used are, 4 grammes nitrate of silver, and 2.5 grammes aldehyde ammonia to one liter of water. The object to be silvered is first rinsed with a solution of sal-soda, then with alcohol, and lastly, with distilled water. When thoroughly clear, it is filled with the above solution and suspended in a water bath. The bath is heated gradually, and as soon as the temperature of 122° Fah. is reached, the silver mirror begins to form. Its formation is soon completed, at a temperature of about 130° to 140° Fah. At first, while the coating is thin, it looks black, but as it grows thicker it acquires more luster, and finally forms a beautiful silver surface. When this has taken place, the object is removed from the water bath, and its contents emptied out. It can now be rinsed out with distilled water and allowed to dry. See also GLASS-SILVERING, pages 982, 983.

Sil'ver-mill. A mill or set of machinery in which argentiferous ores are treated.

Fig. 5096 is a view of a silver-mill as arranged for working ores by the dry process. The ore is fed into the Blake crusher, which is shown at the upper portion and left-hand end of the building. This machine is described under ORE-CRUSHER (which see), and if of the 8 × 10 size, that is, having jaws of those dimensions, it may crush 20 tons per day. The broken ore, in pieces of the size of a walnut or smaller, falls on to the dry kiln floor, which has plates of iron over flues of brick. Here salt is mixed with it in the proportion of from 3 to 10 per cent, according to the richness of the ore. From the floor it is raked on to the automatic feeder, and from thence passes to the stamp-battery, which delivers it to the receiving-hopper. It is elevated thence by the conveyor to the hopper above the furnace, and

Fig. 5096.

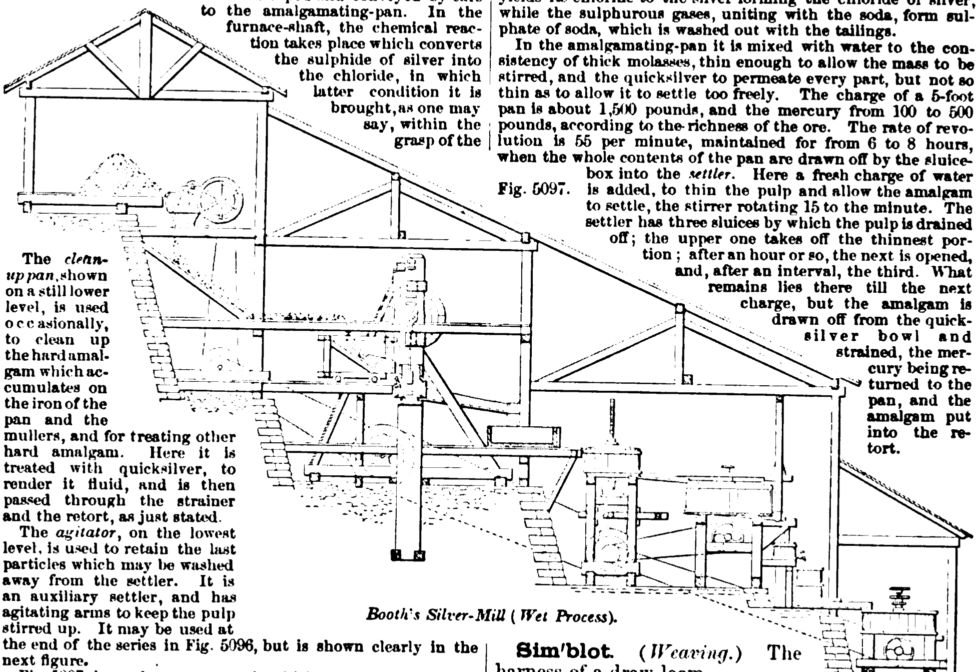


Booth's Silver-Mill (Dry Process).

is sifted down through the flame, being caught upon the furnace-bed, whence it is drawn about every hour on to the cooling-floor. Here it is damped and conveyed by cars to the amalgamating-pan. In the furnace-shaft, the chemical reaction takes place which converts the sulphide of silver into the chloride, in which latter condition it is brought, as one may say, within the grasp of the mercury. In the presence of the sulphurous gases from the sulphide of silver, the chloride of sodium is decomposed and yields its chlorine to the silver forming the chloride of silver, while the sulphurous gases, uniting with the soda, form sulphate of soda, which is washed out with the tailings.

In the amalgamating-pan it is mixed with water to the consistency of thick molasses, thin enough to allow the mass to be stirred, and the quicksilver to permeate every part, but not so thin as to allow it to settle too freely. The charge of a 5-foot pan is about 1,500 pounds, and the mercury from 100 to 500 pounds, according to the richness of the ore. The rate of revolution is 55 per minute, maintained for from 6 to 8 hours, when the whole contents of the pan are drawn off by the sluice-box into the *settler*. Here a fresh charge of water is added, to thin the pulp and allow the amalgam to settle, the stirrer rotating 15 to the minute. The settler has three sluices by which the pulp is drained off; the upper one takes off the thinnest portion; after an hour or so, the next is opened, and, after an interval, the third. What remains lies there till the next charge, but the amalgam is drawn off from the quicksilver bowl and strained, the mercury being returned to the pan, and the amalgam put into the retort.

Fig. 5097.



Booth's Silver-Mill (Wet Process).

The *clean-up pan*, shown on a still lower level, is used occasionally, to clean up the hard amalgam which accumulates on the iron of the pan and the mullers, and for treating other hard amalgam. Here it is treated with quicksilver, to render it fluid, and is then passed through the strainer and the retort, as just stated.

The *agitator*, on the lowest level, is used to retain the last particles which may be washed away from the settler. It is an auxiliary settler, and has agitating arms to keep the pulp stirred up. It may be used at the end of the series in Fig. 5096, but is shown clearly in the next figure.

Fig. 5097 shows the wet process, in which the dry-kiln floor and the Stetefeldt furnace are not used, the wet ore from the mines remaining wet throughout the whole process. The chemical changes for the reduction of the sulphide of silver to a salt of silver, upon which quicksilver will act, take place in the pan. The agents are chlorides of sodium or ammonia, sulphates of copper, iron, or ammonia. On the left, on the highest floor, is the Blake crusher, from which the broken ore falls on to a floor, and thence by a chute to the automatic feeder, which delivers it to the stamps. A sluice conducts the pulp to the *settler*, which is shown about midlength of the building. From this, the *slimes* are conducted by a sluice to the amalgamating-pan, where they are ground, as in the case of the dry process, excepting that in the former the duty of the mullers is principally to stir the pulp and keep it agitated, so that the quicksilver may come in contact with all of the silver. Below the *amalgamating-pan* are the *settler*, *clear-up pan*, and *agitator*, as previously described.

Sil'ver Pa'per. Paper covered with silver foil.

Sil'ver-plat'ing. See ELECTRO-PLATING; SILVERING, etc. See also Watts' "Electro-metallurgy."

Sil'ver-pow'der. For japanners, etc. Bismuth, 1; tin, 1; melted, and 1 part of mercury added. Cool, and powder.

Sil'ver Rain. (*Pyrotechny.*) Small cubes of a composition which emits a white light in burning; used as decorations for the pots of rockets, etc.

Sil'ver Sol'der. Hardest silver solder, 4 parts fine silver, 1 copper. Hard silver solder, 3 parts sterling silver, and 1 brass wire, added after melting the silver to avoid waste of zinc. Soft silver solder for general use, 2 parts fine silver, and 1 brass wire; occasionally $\frac{3}{4}$ part of arsenic is added, to render the solder more fusible and white, but it diminishes the malleability. The arsenic should be added at the last moment, and care taken to avoid its fumes.

Sil'ver-steel. An alloy of silver and steel, which seems to have been first made by Faraday and Stodart, about 1822, and which was soon taken up by the cuttlers of Sheffield for fine razors, surgical instruments, etc. The silver is only about the $\frac{1}{500}$ part.

Sim'blot. (*Weaving.*) The harness of a draw-loom.

Sim'i-lor. A gold-colored alloy of copper and zinc. See SEMILOR; ALLOY.

Sim'ple. (*Weaving.*) *a.* A draw-loom employed in fancy weaving.

b. A cord dependent from the tail of a harness cord in a draw-loom, having at its end a *bob*, by which it is pulled to work a certain portion of the harness.

Sinch (Spanish *cincho*, a girth). (*Harness.*) A strap whereby the loop on the end of the girth of a Spanish saddle is laced to the loop on the saddle. The Spaniards and Mexicans do not use a buckle, but pass a strap, rope, or raw-hide over and over around the loops, and tuck the end in.

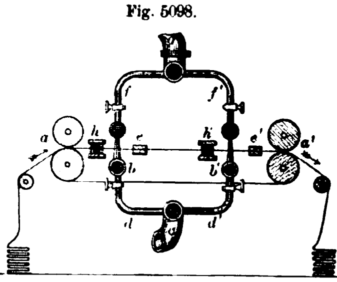
Sin'don. 1. (*Fabric.*) A fine East Indian cotton stuff.

2. (*Surgical.*) A pledget of lint introduced into the hole made by a trephine.

Singe'ing-ma-chine'. A machine in which the fibrous down is removed from the surface of cotton cloth by passing it through a gas flame.

In the longitudinal section (Fig. 5098), *a a'* are two pairs of wooden cylinders covered with fustian, between which the cloth is drawn and submitted to the action of a series of gas-jets

Fig. 5098.

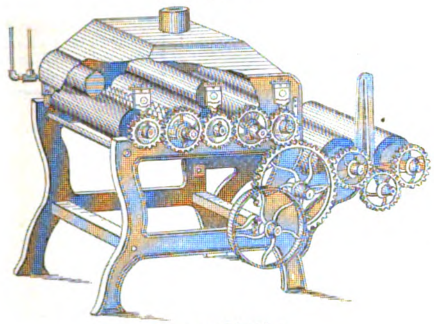


Singeing-Machine.

issuing from the pipes $b\ b'$ at distances of about one eighth of an inch apart. These are supplied from the main pipe c by the branches $d\ d'$ provided with cocks by which the flames from the jets are so regulated as to coalesce and form a continuous line of fire. Brushes $h\ h'$ remove the singed fiber, and any sparks occurring are extinguished by the blocks $e\ e'$. Above the cloth are two pipes $f\ f'$, each having a longitudinal slit at bottom and communicating with the large pipe g, which is exhausted by means of a fan.

Fig. 5099 shows Curtis and Marble's gas-singer for print-cloths and all other fabrics for bleaching and finishing. It has a Bunsen burner with fan-blower attached for supplying the air. It is made with from one to six sets of burners and a width to correspond to the shearing-machine.

Fig. 5099.



Singeing-Machine.

Singe'ing-lamp. A flat-bodied lamp with one open side to the light-chamber, used to singe the hair of horses as a substitute for clipping.

Sin'ger (*singe-r*). An apparatus through which cotton or woolen goods are passed to relieve them of their fluff, preparing them for the dyer. The capacity of a braid-singer is 10,000 yards per hour. See SINGEING-MACHINE.

Sing'ing-glass. A thin, sonorous glass vessel, which yields an echo when vibrated by a sound. It is referred to by Pepys in his Diary, 1669: "They are so thin that the very breath broke one or two of them." See Figs. 4059, 4270, 4271.

Sin'gle-act'ing En'gine. (*Steam-engine.*) An engine in which steam is admitted to one side only of the piston, in contradistinction to the *double-acting engine*, in which both motions of the piston are made by *live-steam*.

The Newcomen atmospheric engine is an example, and was the first successful steam-engine (see Fig. 406, page 177). This engine was working at the Cornish mines when Watt grasped the problem and made his engine (Fig. 406). See also Fig. 1467, and Plate XLIV. page 1829.

Steam is admitted below the piston, in order to displace air. The steam being condensed, the atmospheric pressure above the piston depresses the latter and elevates the other end of the walking-beam to which the pump-rod is attached.

In another form: —

Steam is admitted above the piston, to depress it and raise the pump-rod. The steam, being condensed, allows the weighted pump-rod to bear upon the column of water in the pump-stock, and the water is thereby *forced* up the eduction-pipe.

In another form: —

Steam is admitted above the piston, to depress it and raise the other end of the walking-beam to which the lift-rod of the pump is attached. In this instance, the steam stroke of the piston is the effective stroke of the pump-rod.

Watt was the inventor of the *double-acting steam-engine*. He placed a cover on the cylinder, and introduced steam to prevent the cooling of the cylinder by the access of air. He afterward used the steam above the piston, to give the positive downward motion, and thus originated the DOUBLE-ACTING STEAM-ENGINE (which see).

Sin'gle-block. A block having but a single sheave. A single sheave in a pair of cheeks.

Sin'gle-block Fur'nace. (*Metallurgy.*) An old form of iron-refining furnace.

Sin'gle-cut File. A file having but a single rank of teeth. A *float*. In contradistinction to the *double-cut* file, which has two crossing ranks of teeth.

The horizontal obliquity of the teeth, relatively to the central line of double-cut files, is about 55°, but in *single-cut* files the inclination is much less, and in some *floats* the teeth are square across the face of the file.

Fig. 5100.

Single-Cut File.

Sin'gle-flu'id Bat'ter-y. (*Electro-magnetism.*) A galvanic battery, having but a single fluid, in which the elements are submerged, or by which they are wetted. The original Voltaic pile was the first of this class. Cruikshank was the first to submerge the elements. Babbington and Wollaston had also submerged elements. See GRAVITY-BATTERY; CALLAUD-BATTERY.

The term is in contradistinction to the *double-fluid battery*, invented by Daniell.

Sin'gle-line. (*Saddlery.*) A single rein leading from the hand of the driver to a strap forked a little behind the hames, and proceeding thence to the bit-rings.

This is the favorite mode in most parts of the West of driving horses at work on the farm, or when hauling on the roads with more than a single span or pair. A steady pull brings the horse *haw*, or to the left, the *near* side; and a jerk turns him *gee*, or to the right, the *off* side. The *off* horse is fastened to the near one by a *jockey-stick* and a *hitch-back* strap. The former makes him keep his distance, and the latter keeps him from going too fast. The system was made familiar to many by its being introduced into the United States Army. The heavy six-mule teams of the transportation trains, especially those of the West, were thus driven. The driver rides the near wheel-horse, and the single line passes through a runner on the head-stall of the near horse of the middle pair and thence to the bit of the near leader. The off leader is *jockeyed off* by the stick which is attached to his bit and to the hame of the near leader. The middle pair of horses are on each side of the fifth chain, and have no choice but to submit and go with the others.

Sin'gle Mi'cro-scope. A microscope consisting of a single lens. Some of those on the principle of the Stanhope lens are very powerful.

Sin'gle-reed Plane. A bead-plane with but one hollow in its sole. Bead-planes are also made for planing several beads at once.

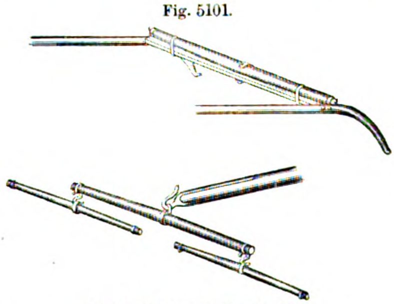
Sin'gles. (*Silk-manufacture.*) Silk thread formed of one of the reel-threads twisted.

Several singles are united, and twisted in a direction contrary to that of the *singles*, to make *thrown* silk.

Sin'gle-shov'el Plow. A corn-plow with but one shovel, in contradistinction to a double-shovel plow. See SHOVEL-PLOW, Fig. 5042.

Sin'gle-stick. (*Weapon.*) A long stick, formerly used in a certain description of fencing.

Fig. 5101.



Single-Trees and Double-Tree.

Sin'gle-tree. A bar secured by its center to the cross-bar of the thills or shafts, and to whose end the traces are attached. The single-trees are connected to the ends of the double-tree when the horses are hitched in pairs. A *whiffle-tree.*

Fig. 5102.

Single-Tree Hook.

Sin'gle-tree Hook. A hook on each arm of the single-tree, to which the traces are attached.

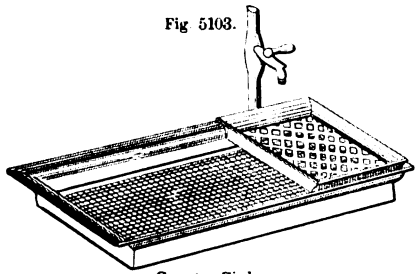
Sin'i-cal Quad'rant. (*Nautical.*) An instrument formerly used for working out courses and distances.

Sink. A tray into which slops or wash-water are poured, to get rid of them by means of a pipe which carries them to a drain.

Sinks are used in kitchens, wash-houses, bar-rooms, etc.

In Fig. 5103, the sink has near the bottom a grating, and its grooved sides furnish support to movable metallic baskets.

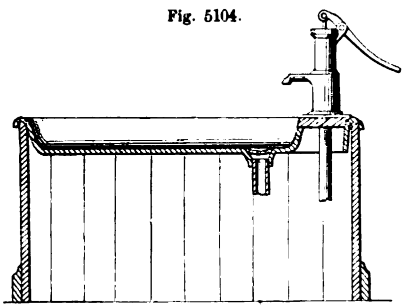
Fig 5103.



Counter-Sink.

In Fig. 5104, the sink-top is of cast-iron, rectangular outside and rounded within. It has a down-curved edge to receive the top of its supporting wooden frame, and an extension at one end to hold a wooden shelf for the support of a pump.

Fig. 5104.



Kitchen-Sink.

Sink'er. 1. (*Knitting-machine.*) A wheel with thin plates or projections, called *wings*, inclined to its axis and used to depress (sink) the yarn between the needles and below the beards.

A is a top view, and *B* an elevation of a knitting-machine, in which *a a* is the sinker, and *b b* the knocking-off wheel. The *sinker* depresses the yarn between the needles below the points of the beards. The *landing-wheel* raises the loops just above the points of the beards. The *knocking-over* wheel raises the loop over the head of the needle.

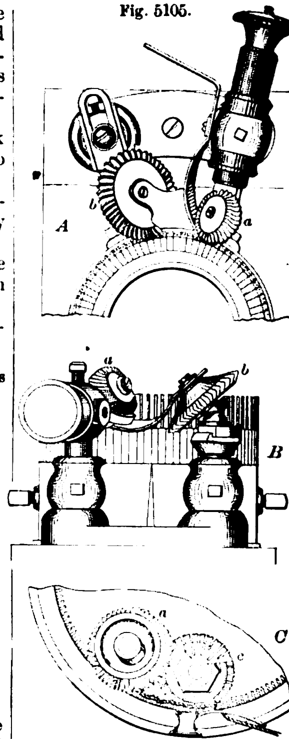
C is for a peculiar kind of machine in which a weft-thread is introduced. The wheel *c* is for pressing out every alternate needle, so that a yarn-carrier can lay in the weft-thread. The *sinker-wheel a* presses down the weft-yarn between the needles, and down on the loops already formed.

In the stocking-frame, the *jack-sinkers* and *lead-sinkers* alternate with each other. The jack-sinkers are suspended from the ends of the jacks, and are separately movable; the *lead-sinkers* are fixed to a bar called the *sinker-bar*, and all move together.

2. A leaden weight for a fishing line, net, or seine.

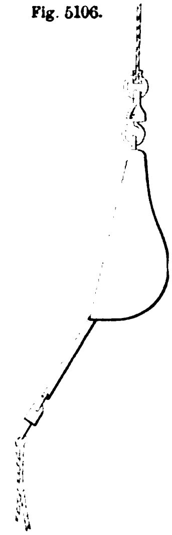
Sink'er-bar. A bar in a knitting-machine to which the *lead-sinkers* are attached.

Fig. 5105.



Sinker.

Fig. 5106.



Fish-Line Sinker.

Sink'er-wheel. (*Knitting-machine.*) One with a series of oblique wings to depress the yarn between the needles. See SINKER.

Sink'ing. 1. (*Joinery.*) A rabbet or angular recess in the corner of a board. See RABBET.

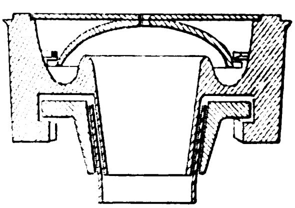
2. (*Mining.*) The digging of a vertical shaft from above downward.

A *rising* shaft is one excavated from below upward.

Sink'ing-head. (*Founding.*) The molten metal in the ingate of a mold to supply metal to the casting during shrinking.

Sink-trap. (*Hydraulics.*) A trap for a kitchen sink, so constructed as to allow water to pass down, but not allow reflow of air or gases.

Fig. 5107.



Sink-Trap.

Sin'net. Spun-yarn. Plaited hempen yarn or straw. *Sennet.*

Sin-um'bra-lamp. A form of astral lamp in which the exterior edge of the circular oil-vessel is beveled off at the top so that the rays of light proceeding from the wick reach the surface on which the lamp is supported at a less distance from the center than in the ordinary construction. The light is also diffused by a ground-glass shade surrounding the chimney, so that the shadow is rendered imperceptible. (*Sine umbra.*)

Si'phoid. (*Hydraulics.*) Soda-water apparatus.

Si'phon. 1. A curved tube having one branch longer than the other; used for transferring liquids from higher to lower levels. It acts by atmospheric pressure, and consequently cannot be depended on for overcoming hights greater than about 30 feet near the level of the sea, and a less hight at great elevations.

Siphons are shown in the Egyptian tombs of the dates of 1450 B. C. and 1355 B. C.

At *A*, in Fig. 5108, two men are engaged in mixing and decanting; wine probably. One is exhausting the air from a siphon preparatory to placing the lower end of the long leg in the vase into which the ends of two other siphons are already placed.

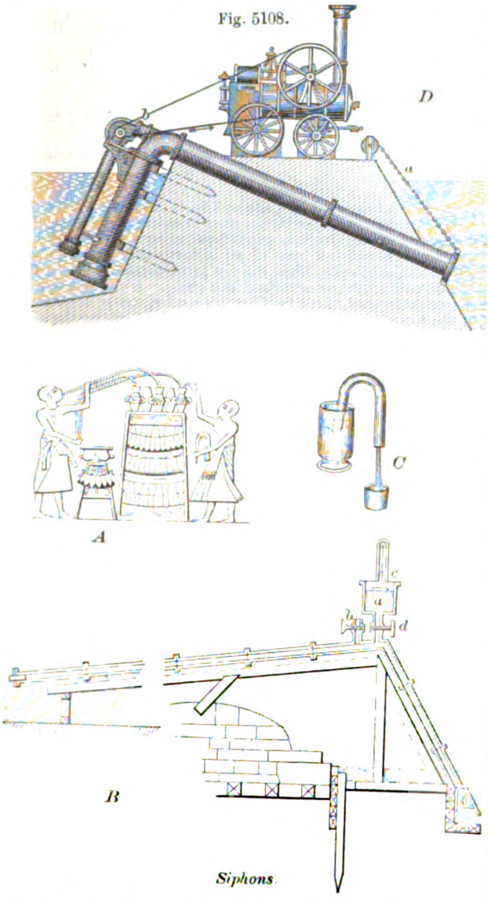
The siphon and its name are Greek. How much older than the Greeks as an intellectual nation, we know not.

It was a favorite contrivance with Hero of Alexandria, 150 B. C., in his various toys and automata, of which the cup of Tantalus is a favorite instance, and has been reproduced in modern times. See the "Spiritalia Heronis."

C shows the ordinary siphon; it is filled with liquid, the ends stopped, and the shorter leg immersed in the vessel from which the liquid is to be drawn; the longer leg being placed in or over the receiving vessel. On opening the ends a continuous flow is maintained until the level of the liquid in the upper vessel reaches that of the orifice in the shorter leg of the siphon.

B shows a large siphon used at Metz, in repairing a dike on the Moselle. To put it in operation, the ends were stopped with

Fig. 5108.



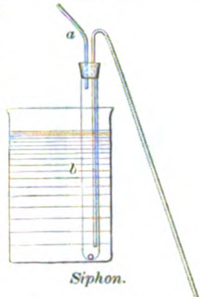
Siphons.

plugs and the siphon filled with water through a funnel *a*, the air being permitted to escape through the cock *b*. When full of water, this was closed with a cover *c*, provided with a tubular glass top, which permitted a view of an indicator-needle on a float, which showed at what hight the water stood as its level became gradually lowered in consequence of the air contained in the water accumulating at the bend of the tube. When the siphon required refilling from this cause, the cock *d* was closed, the cover removed, and the funnel filled with water, after which the cover was replaced and the cock *d* reopened. The flow was thus rendered continuous.

Gwynne's drainage siphon, *D*, is of ordinary construction, but has a flap-valve, opening inward or upward, attached to the inner end, which prevents the water flowing back again. At the other end of the siphon another valve is fixed, which opens outward, and is closed by the chain *a*. Attached to the siphon is a centrifugal pump, having a separate suction-pipe and valve dipping into the water, and its discharge-pipe *b* secured to and emptying into the siphon. To start the siphon, the pump is put in motion by the portable engine, the air-cock is opened, and as the siphon fills with water, all the air is quickly displaced. The air-valve is then closed, and on the chain *a* being unfastened, the outer valve will open, and the siphon will discharge water in the usual way and at the ordinary velocity. By keeping the pump at work, however, an increased discharge of water is obtained through the siphon, in proportion to the velocity with which the water is discharged by the pump.

By the arrangement shown in Fig. 5109, a siphon may be filled without danger of the liquid being brought in contact with the mouth or hands. It and the tube *a* are passed through the stopper of the tube *b*, which has an aperture at bottom provided with a ball-valve; on blowing through the tube *a*, the aperture is closed by the ball, the liquid is forced upward through the short leg of the siphon, and when the flow is established, the mouth is withdrawn, and the ball, ceasing to close the aperture, allows the liquid in the vessel to run freely into the tube.

Fig. 5109.



Siphon.

The term siphon has been employed with some impropriety to bent tubes used for conducting water from one hill to another across an intervening valley. An instance of these is found in the old Roman Aqueduct at Lyons (Fig. 290, page 129). See AQUEDUCT; SOUTERAZICI.

One of the largest siphons of this kind in the world is that of the iron pipe which conducts the water under Feather River, California. It has a vertical depression of 856 feet. The receiving arm has a head of 180 feet; the length of the inverted siphon is 2½ miles; its diameter 30 inches. It supplies the Spring Valley Mining and Canal Company, Cherokee Flat, Butte County, California.

The Bedonal siphon of the Madrid Aqueduct is an inverted siphon for crossing a valley, and is 4,600 feet in length. It consists of 4 cast-iron pipes, each 3 feet in diameter, and laid parallel.

It forms one portion of the chain of works which brings the water of the river Lozoya to Madrid. At the point where the river emerges from the Guadarama Mountains a cut stone dam 98 feet high is erected, its wings abutting against the rocks on each side of the ravine. This artificial lake contains 100,000,000 cubic feet of water. It was constructed under the supervision of Lucio del Vallé, and is 47 miles in length. The transverse section of the canal is about 20 square feet, and it discharges 6,600,000 cubic feet of water per day. Its cost was 57,897,368 francs, and it was built between the years 1851 and 1858. It has 31 tunnels, 32 aqueducts, and 3 large siphons for crossing valleys. See "Scientific American," November 13, 1869.

2. A bottle for dispensing aërated liquids, having a spring faucet and a discharge-pipe, which reaches nearly to the bottom of the bottle. See SIPHON-BOTTLE.

Si′phon-ba-rom′e-ter. An instrument consisting of a tube doubled upon itself twice and nearly filled with mercury. It is used as a manometer in showing the dilatations of the air in the receiver of an air-pump.

Fig. 5110.

Siphon-Bottle.

Si′phon-bot′tle. A flask for containing aërated waters, which may be discharged without uncorking. The bent tube *a* is provided with a downwardly opening valve operated by the lever *b*, and kept to its seat by pressure of the contained gas, which, when the valve is displaced by pressure on the lever, forces out the liquid until all is discharged.

Si′phon-cup. (*Machinery.*) A form of lubricator in which the oil is led over the edge of the vessel by capillary action, ascending and descending in a cotton wick and dropping on the journal.

Si′phon-fill′ing Ap′pa-ra′tus. An apparatus for filling siphon-bottles with aërated liquids.

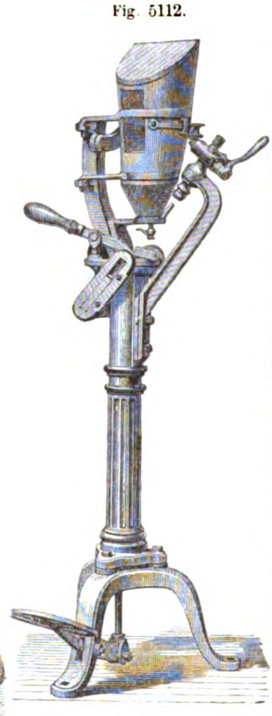
In Matthews' (Fig. 5111), the bottle is placed in the holder at the head of the machine, and inclosed by a rocking screen to protect the operator in case of explosion of the siphon. By pressure on the treadle, the bottle is elevated, the spout of the siphon is inserted into the filling-head, and the siphon-lever is

pressed so as to open the siphon-valve; the lever of the filling-head is then drawn toward the operator, causing the aërated water to fill the bottle. By reversing the movement of this lever the aërated liquid is shut off, and a vent-valve opened, by which some of the gas compressed above the liquid in the bottle is allowed to escape, so that more of the aërated liquid may enter the bottle when the liquid-valve is opened.

In Fig. 5112, the bottle is placed in a vertical position, and, by means of the foot-lever, is moved upon the inclined guides,

Fig. 5111.

Fig. 5112.



Matthews' Siphon-Filling Apparatus.

so that the spout of the siphon is caused to enter the filling-head, a three-way cock provided with a packing to receive the siphon-spout. The siphon-valve is opened by pressing on the hand-lever (on the left), and the siphon is filled by operating the three-way cock, which alternately permits liquid to enter the siphon and surplus of gas to escape from it to facilitate the filling. The swinging screen, when latched in position, protects the operator.

Si′phon-gage. A bent glass tube partially filled with mercury, used for ascertaining the degree of exhaustion effected by an air-pump.

Si′phon Re-cord′ing-tel′e-graph. An invention of Sir William Thomson. It is used at Duxbury for recording in the Morse alphabet the signals of the French Atlantic Cable. A light tube or perforated needle or a bristle dipping into an ink-reservoir is connected directly or by a thread to the device moved by the received current, and is caused to eject a thin stream of liquid at each pulsation of the current. The marking device or the paper is caused to vibrate, so as to produce the marks either by direct electrical or pneumatic action.

In the former case, the paper is drawn over a metallic plate electrified either positively or negatively; the tube being oppositely electrified, a difference of potential is maintained sufficient to create a tendency to cause a discharge as they approach each other, and to eject at each impulse a minute quantity of the liquid, proportioned to the length of the pulsation.

It has been found most convenient in practice to cause the paper to move in a vertical plane, and to use a small glass siphon with its short leg dipping in the ink, and the long leg pointing downward in close proximity to the paper. It is connected with a coil of fine wire suspended between the poles of a horseshoe-magnet. The deflections of the coil to the right or left by the passage of a positive or negative current of the line wire causes the siphon to leave a record on the paper strip, forming, apparently, a zigzag line, but in reality made up of a series of dots and dashes, which indicate the letters of the alphabet, after the manner of the Wheatstone system.

Si′ren. An instrument for producing musical tones and for measuring the number of sound waves or vibrations per second which produce a note of given pitch. The production of these tympanic shocks by puffs of air was first realized by Dr. Robinson, and his device was the first and simplest form of the siren. A stop-cock was so constructed that it opened and shut the passage of a pipe 720 times in a second. Air from the wind-chest of an organ being allowed to pass along the pipe during the rotation of the cock, a musical sound was smoothly uttered.

It was much improved by Cagniard de la Tour in 1827, who gave it its present name, and it has since been improved by Opelt, Seebeck, and Dové. In its original form it consists of a cylindrical box, into which a blast of air is introduced through an aperture in the bottom, while the top is perforated by a series of equidistant apertures arranged in a circle. A circular plate, similarly perforated, turns freely on its center, nearly in contact with the top of the box, alternately opening and closing the air-passages in the latter. The apertures are so inclined as to most effectually impart a rotary motion to the disk; and when air under pressure is admitted to the box, its escape through these apertures produces musical tones rising in pitch according to the velocity of the disk's rotation. The axis of the disk carries a screw-thread, operating a set of toothed wheels, by means of which the number of revolutions made in a given time is shown on a series of dials. This may be thrown in and out of gear. When it is desired to ascertain the number of impulses per second required to produce a note of given pitch, the wind pressure must be maintained at a uniform degree. The recording apparatus is thrown into gear and allowed to run for a given time; when it is detached, the register indicates the number of revolutions of the disk, which, multiplied by the number of perforations, gives the total number of impulses; this being divided by the number of seconds during which the observation was made, shows the number of vibrations or sound-waves per second corresponding to the given pitch.

In the siren of Seebeck the rotation is produced by mechanism, and not by the blast.

The double siren of Helmholtz consists of two sirens, one placed in inverted position over the other. The upper one may be rotated on its axis, while the instrument is in operation, by means of a crank. This instrument is adapted for the investigation of the interferences of unequal sound-waves, of combination tones, and many other acoustic phenomena.

Fig. 5113.

Siren.

In its most elementary form the siren is simply a perforated rotating disk, against which a current of air is directed, producing sounds of higher or lower pitch, according to the velocity of rotation. The limits of audible sound are the rates of vibration of 16 and 38,000 in a second, which embrace more than 11 octaves; but the range of effective musical sounds is much less. The sounds used in music are almost never lower than 32 vibrations in a second (the lowest C on the piano-forte), thus comprising seven octaves.

From the deep, piercing nature of the sound which the siren emits, it is well adapted for fog signals or alarms. In this case two disks rotating with great velocity in opposite directions are employed. They are driven by a steam-engine, which also forces a blast of steam through their apertures, when those in the two disks come in apposition. The device is placed at the smaller extremity of a large trumpet, which intensifies the sound. The rate of rotation of the disks is about 1,000 per minute, and the cost of the device is about $ 3,500.

The doctrine of the different sounds of vibrating strings of different lengths, and the communication of sounds to the ear by the vibration of the atmosphere, is ascribed to Pythagoras, about 500 B. C.; mentioned by Aristotle, 300 B. C.; explained by Galileo, A. D. 1600; investigated by Newton, 1700.

"Discoursed with Mr. Hooke about the nature of sounds, and he did make me understand the nature of musical sounds made

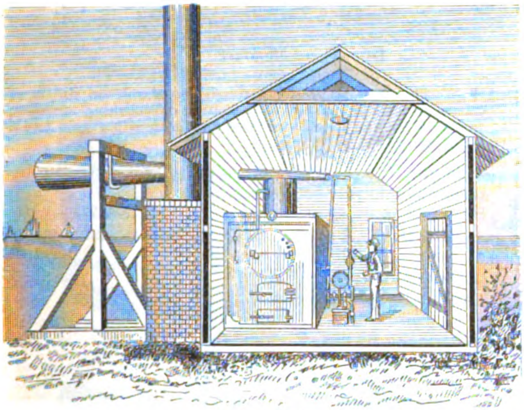
by strings, mighty prettily; and told me that having come to a certain number of vibrations proper to make any tone, he is able to tell how many strokes a fly makes with her wings, by the note that it answers to in musique. This I suppose is a little too much refined; but his discourse in general of sound was mighty fine." — PEPYS' *Diary*, 1668.

It has been ascertained by means of the siren that the wings of the mosquito move at the rate of 15,000 times a second.

An ingenious method of registering the vibrations of the wings of insects was adopted by E. J. Marey, and is described in the "Comptes Rendus."

The author of the article sought for a mode of exhibiting, in an unmistakable manner, each of the beats of the wing of an insect, and the graphic method answers very well for determining their frequency.

Fig. 5114.

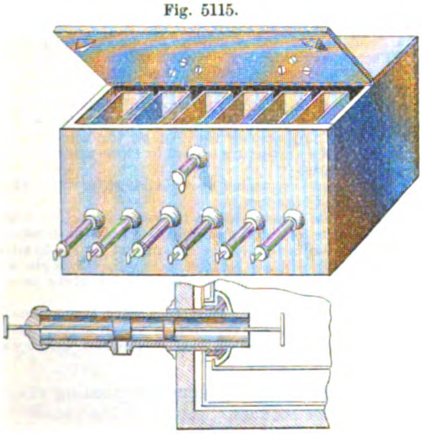


Steam-Siren.

He grasped, with a fine pair of nippers, the hind part of the abdomen of an insect, and when it sought to fly, directed one of its wings in such a way that it rubbed by its point against the surface of a smoked cylinder, which revolved with a known velocity. The wing, at each of these revolutions, carried away a little of the black of the smoke which covered the cylinder, and left a trace of its passage. This experiment gives a diagram exhibiting the varied forms that are periodically reproduced with the same characteristics, and, consequently, correspond to one revolution of the wing. By means of a chronographic diapason, the exact number of the revolutions of the wing which are effected in a second were precisely determined. That which he used gave a graphic delineation of five hundred simple vibrations per second.

A continual rubbing of the wing on the cylinder presents a resistance to this organ, which retards its frequency; so in order to have the nearest approach to the truth, those drawings were selected in which the contact of the wing with the cylinder was at a minimum, so that the diagrams were reduced to a series of points. The following results were obtained: Common fly, 330; drone, 240; bee, 190; wasp, 110; hawk-moth, 72; dragon-fly, 28; cabbage-butterfly, 9.

Fig. 5115.



Sirup-Stand.

Experiments with the *siren* show that the extreme limits of the human voice in males vary from 384 to 1,266 vibrations per second, and in females from 1,152 to 3,240. The highest note in music is about the 14th C (five octaves above the middle C of the piano-forte), and this is due to 8,192 vibrations per second; but much higher tones can still be heard. Savart has produced tones due to 48,000 vibrations per second.

Sir′up-stand. An attachment to a soda-water apparatus, to supply the tumblers with sirups. Some have faucets connecting with the separate sirup reservoirs; others have pistons acting as miniature pumps. In the example, the case has a hinged cover, kept in place by projections, and contains earthen sirup-jars and a cooling-chamber for the soda-water, each surrounded by ice. The sirup-faucets are lined with glass, and secured to the jars by a screw and rubber packing.

Sis′ter-block. (*Nautical.*) A kind of double block which has two sheave-holes, one above the other; a score at each end, and one between the sheaves. It is used as a topsail-lift and reef-tackle block, and is hollowed out on each side of the shell, so as to lay between the shrouds. The name is from *cithern*, signifying its *fiddle* shape.

Fig. 5116.

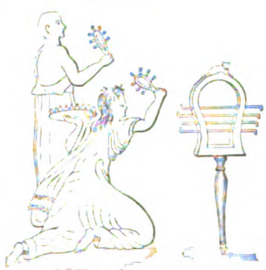
Sister-Block.

Sis′ter-hook. A double hook in which the shanks of the respective portions form *mousings* for the fellow portions. A *match-hook*. See MOUSING-HOOK.

Sis′ter-keel′son. (*Shipbuilding.*) An additional keelson secured on each side of and parallel to the main keelson. The sister-keelsons are bolted to the floor-timbers. A *side keelson*.

Sis′trum. (*Music.*) A jingling instrument of ancient Egypt. It had four loose rods in a lyre-shaped metallic head. It was, in fact, a rattle made of bronze or silver, according to ability. It was used in the services of Isis or Athor, which were introduced into Rome before the Christian era. It is still used in Christian churches in Nubia and Abyssinia.

Fig. 5117.



Sistrum.

Sitz-bath. A hip-bath in which a person assumes a sitting posture.

Six-shoot′er. (*Weapon.*) A colloquial name for the six-chambered revolver.

Size. 1. A gelatinous solution made by boiling the skin and membraneous tissues of animals to a jelly.

The finest is made in Russia from the sounds and air-bladders of sturgeon, and is called *isinglass*.

A coarser quality is made from scraps and clippings of hides, hoofs, horns, etc., and the jelly or size resulting is molded, cut into flakes, and dried, forming glue.

A quality made from clean scraps of the above-mentioned material is sold as isinglass, which it nearly resembles.

Bones and feet of animals also yield a glutinous, viscid solution or jelly, which may be considered a size.

Size is used in calico-printing, paper-making, paper-hanging, bookbinding, whitewashing, painting, gilding, and in other arts and trades.

In some cases, it stands in the place of or is used interchangeably with *dextrine* or British gum, paste, starch, gum-water, varnish, or other viscid solution, whose particles become hard when their water of solution evaporates.

The sizes used in gilding are as follows: *gold-size* for *oil-gilding*, linseed-oil or fat oil and ocher.

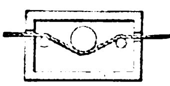
That used for *burnish-gilding* is composed of pipe-clay, red chalk, black-lead, suet, bullock's blood, brought to a proper consistence by a solution of gelatine.

Bookbinder's size is a fine glue made of parchment shavings. Another material used by the gilder is *glaire*, white of egg.

2. A gage for measuring. An instrument for measuring pearls. A number of perforated gages are fastened together by a rivet at one end.

Size-box. (*Rope-making.*) One through which cordage is drawn in the process of sizing. The cordage having been drawn through the size-box and partially dried is drawn slowly between closely pressing reciprocating *rubbers* and *snuggers*, which are stationary relatively to the slowly moving carriage to which they are attached. The size is flour-paste mixed with other ingredients, and the operation on the rope is called *snugging, slicking*, or *finishing*. It smooths down the *sleezy* and *fuzzy* fibers of the twisted rope.

Fig. 5118.



Size-Box.

Si'zel. (*Coining.*) Strips of metal from which planchets have been removed. *Scissel.*

Siz'er. 1. A machine of perforated plates to sort articles of varying sizes, as the *coffee-sizers* of Ceylon and Rio.

2. A gage, as the *bullet-sizer*, which has holes to determine the sizes of bullets. See also SHELL-GAGE.

Size-stick. The shoemaker's measuring-stick to determine the length of feet.

Siz'ing. A glue or paste used in manufactures. See SIZE.

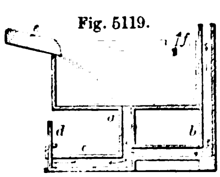
Siz'ing-ap'pa-ra'tus. (*Mining.*) Machinery for sorting ore into grades according to size, for treatment by the appropriate means.

Hand-sieves, swing-sieves, and *shaking* and *cylindrical riddles* are the usual means employed.

Jigging-sieves are not for sizing, but for sorting by gravity. See JIGGER.

Siz'ing-cis'tern. A form of ore-separator which acts upon the metalliferous slime from the stamping-mill.

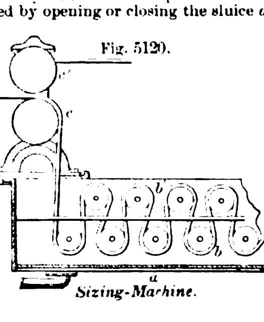
Fig. 5119.



Sizing-Cistern.

It consists of a wooden box, having an opening *a* at the bottom, which communicates with a pressure-pipe *b* and an outlet *c* provided with a small regulating sluice *d*. The lighter stuff from the buddles *e* is carried upward and conducted off by the opening *f*, while the heavier descends. The strength of the upward current, and consequently the quantity and size of the particles conveyed away at *f*, is regulated by opening or closing the sluice *d*.

Fig. 5120.



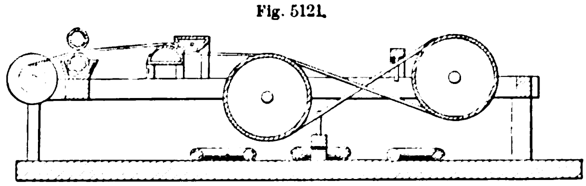
Sizing-Machine.

Siz'ing-ma-chine'. An apparatus for sizing cotton warp-threads.

The trough *a* is provided with a steam jacket, and contains a number of rollers *b b'*, etc.; it is nearly filled with liquid paste, and the warp is drawn alternately under one and over another of the rollers until it passes between the rolls *c c'*, which express the superfluous paste. For woolen, a sizing of glue is employed. The yarn is drawn backward and forward through trumpet-shaped openings, and passes beneath a roller at each end of the box; repeated compression and immersion is necessary to expel the air and saturate the fiber.

Fig. 5121 is a machine for sizing and finishing covered skirt-

Fig. 5121.

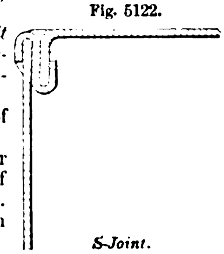


Wire-Sizing Machine.

wire. The wire is passed through the starch or size, and thence directly in contact with ironers or polishing surfaces, whence it may be passed over rolls and heaters previous to its being reeled.

S-joint. A mode of joining two surfaces by means of a doubly bent strip, S-shaped in cross-section.

Fig. 5122.



S-Joint.

Skain. 1. A shaved *split* of osier. A split is a quarter of the osier, divided longitudinally down the pith.

2. (*Spinning.*) A knot of yarn. See SKEIN, 1.

3. (*Vehicle.*) A strap or tube of metal on the arm of a wagon-axle. See SKEIN, 2.

4. (*Weapon.*) An Irish short-sword. A *skean.*

Skate. 1. A runner fastened to the boot-sole, by which a person may propel himself upon the ice.

2. In an in-door sport suggested by skating, the sole has rollers instead of a runner. A *parlor-skate.*

Fitz-Stephen informs us that it was customary for the English, in the thirteenth century, to amuse themselves on the ice by fastening bones of animals to the soles and pushing themselves forward by means of a stick, shod with an iron spike. Wooden skates, shod with iron and steel, were introduced into England from the Netherlands, about 1650.

"It being a great frost, did see people sliding with their skeates, which is a very pretty art." — PEPYS' *Diary*, November, 1662.

Fig. 5123 illustrates various recent patterns of skates, with their modes of attachment to the shoe.

a may be arranged so as to be secured either by clamps or straps.

b is secured by adjustable clamps.

c is fastened at the heel by three spurs, adjustable by a screw, a strap being employed for the front.

d by a lip at the toe, and a clamp, moved backward or forward by a screw, at the heel.

e has toe and heel clamps, which are caused to approach or recede by a screw.

f, the skate-iron is pivoted and provided with a spring, so that the heel and toe clamps are opened by releasing and depressing the iron; by placing the foot on the sole-plate and raising the iron, the clamps are caused to close upon the shoe and secure the skate.

g has two runners, connected by a flexible strip, which yields to the movements of the foot.

h is a parlor-skate constructed on the same plan.

i is a parlor-skate in which the rollers are fastened in hangers beneath the sole; runners may be substituted for the hangers.

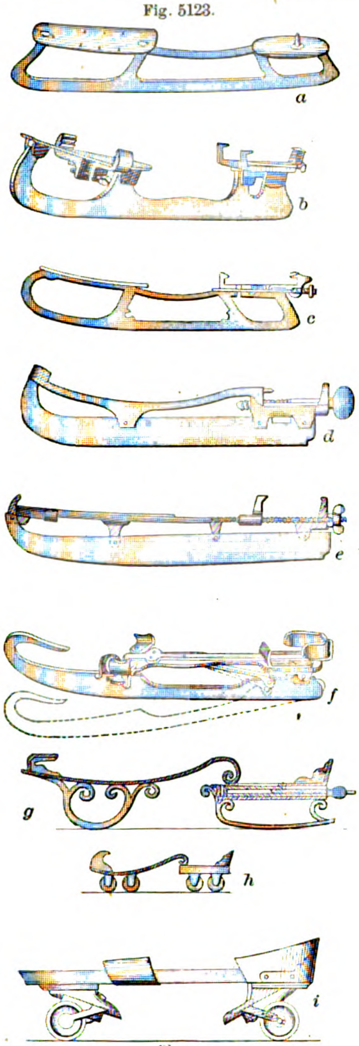
The skate (*a*, Fig. 5124) is secured to the boot by a pin with pointed enlarged end in the heel-plate, and a strap passing through the sole-plate and over the foot.

In *b* both the heel and sole plates are divided longitudinally, one of each being hinged; the clamps are adjustable to the width of the foot, and are, when fixed to the boot, held by the pressure.

Skate-grinder. A machine for grinding skates, straight-edged or rockers.

The loose skate-holder and the table have each a plane or bevel-bearing surface, forming, when resting on each other, two corresponding plane or bevel surfaces. The rotary grinding-wheel dresses the running edge of the blade. The holder is

Fig. 5123.

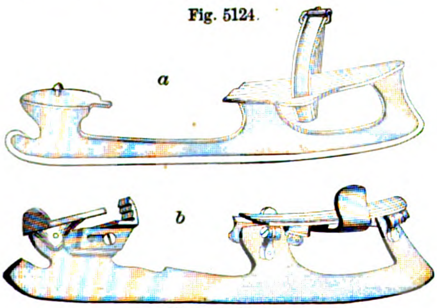


Skates.

attached with adjustable clamps, and has rests for securing the work.

Skean (Irish, *Scian*). (*Weapon.*) An Irish

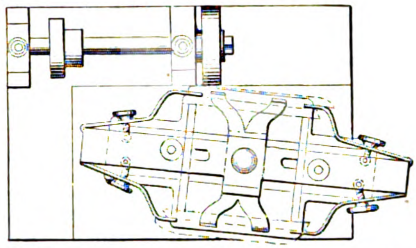
Fig. 5124.



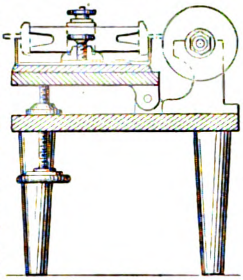
Florence Skates.

weapon. A large knife molded like a sword. A *skain.*

Fig. 5125.



Skeet. (*Nautical.*) A scoop used for throwing water on the sails and decks.



Skate-Grinder.

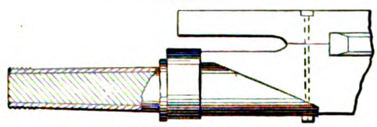
Skeg. (*Boat-building.*) A knee which unites and braces the stern-post and keel of a boat.

Skein. 1. (*Spinning.*) A quantity of yarn from the reel, of silk, wool, cotton, or flax. Of cotton it contains 80 threads of 54 inches ; 17 *skeins* make a *hank ;* 18 *hanks* a *spindle* (English). See also HANK.

The word *skein* is derived from the Greek word σχοῖνος, a *rope* or a *rush ;* indicating the material from which the ropes of Egypt were formerly made.

2. (*Vehicle.*) A metallic strengthening band or thimble on the wooden arm of an axle.

Fig. 5126.



Thimble-Skein.

The ordinary *skein* consists of three straps, let into slots in the arm.

The *thimble-skein* is a conical metallic sheath which envelops the wooden arm, and has a flanged nut on the end to hold the wheel on the arm. See AXLE.

Skel'e-ton-frame. (*Spinning.*) A kind of frame in which the usual can is replaced by a skeleton.

Skel'e-ton-key. A key of skeleton form, a large portion of the web being removed to adapt it to avoid the wards and impediments in a lock. See MASTER-KEY.

Skel'e-ton-plow. (*Agriculture.*) A plow in which the parts bearing against the soil are made in skeleton form to lessen friction. See PLOW.

Skelp. A strip of iron which is bent and welded into a tube to form a gun-barrel, or pipe.

Skelps for gun-barrels were formerly forged, the strip being about 3 feet long and 4 inches wide, thicker at the end for the butt than at the end which forms the muzzle. These *skelps* were afterward bent, lapped at the edges, and welded at several heats.

These forging operations were superseded some years since at Birmingham, England, by rolling processes, which have become general.

For rolling, the circumference of the roller is equal to the length of the skelp, and the shape of the groove is adapted in width and depth to the width and thickness of the skelp.

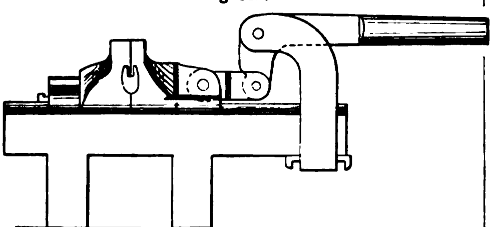
Welding was performed by running the skelp with lapping edges through the circular aperture formed by the semicircular grooves of adjacent rollers. The skelp was brought to a welding heat and placed on a mandrel.

This plan has been modified by making a blank of an extra thickness and combining a drawing and welding action.

A bar of iron about a foot long is bent into a cylindrical shape, the edges overlapping; being raised to a welding heat, it is then slipped over a triblet and passed between a pair of rollers, which weld the edges and draw the cylinder to the length and proportions of a gun-barrel at a single heat.

Skelp-bend′er. A die of required form is made in two parts, so arranged on a slide as to open for the admission of the end of the sheet and be closed

Fig. 5127



Skelp-Bending Machine.

by a lever. The end is then bent up, when it is seized by the proper apparatus and drawn through the die.

Skene-arch. (*Architecture.*) A segmental arch having a curve not exceeding 180°.

Skep. (*Husbandry.*) *a.* A farmer's basket for gathering corn or roots.

b. A beehive; a *gum.*

Skew. A term applied to an arch, vault, or bridge in which the front of the arch is oblique with the face of the abutment, instead of being at right angles thereto.

As originally built, the voussoirs were laid parallel to the abutments. In 1787, Chapman, in constructing a bridge over the Kildare Canal, was led to the invention of the correct principle, making the joints of the voussoirs rectangular with the face of the arch instead of being parallel with the abutments.

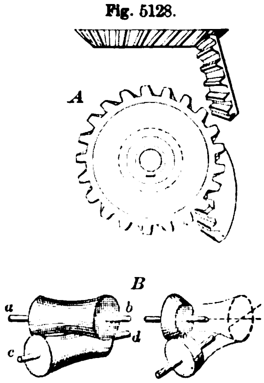
Skew-arch. (*Architecture.*) One having its faces oblique to the piers or abutments.

Skew-back. (*Architecture.*) *a.* The upper course of an abutment which receives the spring of an arch. An *impost.*

b. A bedding-stone.

Skew-bev′el Wheel. (*Machinery.*) A form of wheel employed to transmit a uniform velocity ratio between two axes which are neither parallel nor intersecting. The pitch surface of a skew-bevel wheel is a frustum or zone of a hyperboloid of revolution. In one of the figures (*B*), a pair of large portions of such hyperboloids are shown rotating about axes *a b c d.* In the other figure are shown a pair of narrow zones of the same figures, such as are employed in practice.

Fig. 5128.



Skew-Gearing and Skew-Bevel Wheels.

Skew-bridge. (*Architecture.*) One having an oblique arch or arches with spiral courses.

Skew-chis′el. 1. A chisel for wood working or turning, having the basil on both sides and an oblique edge.

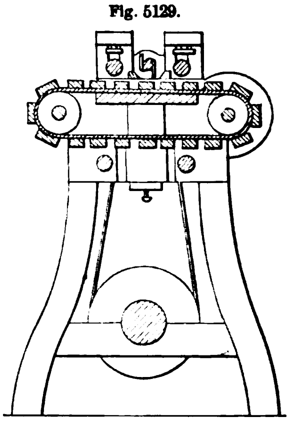
2. A carver's chisel, whose shank is bent to allow the edge to reach a sunken surface.

Skew′er. 1. (*Fiber.*) A bobbin-spindle fixed by its blunt end into a shelf or bar in the creel.

2. A spindle-shaped piece of wood inserted into meat, to hold the layers of muscle or muscle and fat together.

Skew′er-ma-chine′. The blocks are sawed into little slabs of the size and double the length of the skewer desired. They are then passed through a machine, which shapes them into little cylinders, looking like unpointed lead-pencils. The machine has a grooved endless floor-feeder, and a revolving grooved feed-roller and cutters, which are shaped to cut the cylindrical shape of the skewer. They are now ready for sharpening.

Fig. 5129.



Skewer-Machine.

Fig. 5130 is a machine to point, cut to a length, and count the skewers after they have been made round. The sticks, of double skewer-length, are fed from a hopper into a grooved cylinder, which presents them to a revolving cutter that points each stick, and cuts in two at the center, and at the same time is cut to a length by two revolving saws on the same shaft with the cutter. Not

Fig. 5130.

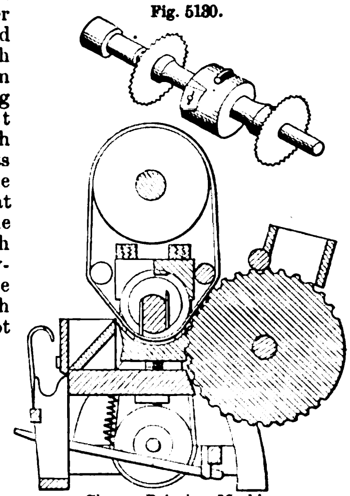


Fig. 5131.

Skew-Gearing.

Skewer-Pointing Machine.

until fifty are completed does the machine drop them into the pan below, from whence the bunches are taken and deposited in a tray preparatory to their transfer to the drying-room, the skewers being made from unseasoned wood.

Skew-gear′ing. Cog-wheels with teeth placed obliquely, so as to slide into each other and avoid clashing. They serve to transmit motion from one shaft to another when the two form an angle, but would not intersect if prolonged. *A*, Fig. 5128, SKEW-BEVEL WHEEL.

Skew′ing. (*Gilding.*) The process of removing superfluous leaf from portions of a surface and patching pieces upon spots where it has not adhered. It is performed by means of a brush and precedes burnishing. See GILDING.

Skew-plane. (*Joinery.*) One in which the

mouth of the plane and the edge of the iron are obliquely across the face.

Skew-rab'bet Plane. (*Joinery.*) A plane for cutting rabbets; the edge of the bit obliquely across the sole of the plane.

Skew-wheel. See SKEW-BEVEL WHEEL.

Skid. 1. (*Nautical.*) *a.* A strut or post to sustain a beam or deck, or to throw the weight of a heavy object upon a part of the structure able to bear the burden.

b. A pair of timbers in the waist, to support the larger boats when aboard.

c. Timbers acting as fenders against a ship's side when raising or lowering heavy bodies inboard or overboard.

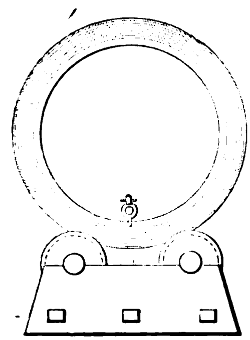
2. Slanting timbers forming an inclined plane in loading or unloading heavy articles from a truck or wagon.

3. Timbers resting on blocks on which a structure is built, such as a boat.

4. (*Ordnance.*) An oaken timber 6 feet long by 8 inches square, used for the temporary support of a cannon. These and the other implements are all made to given sizes with reference to their more convenient use and transportation together.

Skids of cast-iron are used for supporting cannon in store at the arsenals.

Fig. 5132.



Barrel-Skid.

5. A chain with a shoe to drag a wheel.

6. A log, forming a track for a heavy moving object.

7. (*Crane.*) An iron brake-piece.

8. A pair of parallel timbers for supporting a barrel, a row of casks, etc.

Skiff. (*Nautical.*) A small flat-bottomed boat, usually without a keel. In some parts of the United States, as the waters of the Chesapeake, the term is particularly applied to a small boat of this description, sharp at both ends, generally having a center-board, and provided with a small triangular sail.

Skif'fling. (*Masonry.*) *Knobbing.* Knocking off the rough corners of ashlar in the preliminary dressing.

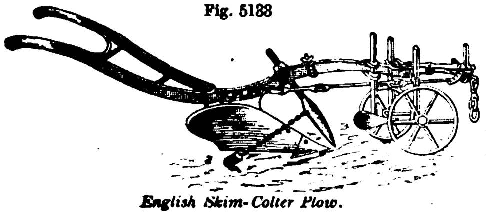
Skil'let. An iron stew or baking pan with a handle.

Skill'ing. A bay of a barn.

Skim-col'ter Plow. A plow having a small share in advance of the main one, the object being to pare and turn into the furrow the surface herbage and manure, so that the main furrow-slice may cover it over entirely.

The illustration shows Howard's improvement (English), with the furrow and land wheel, draft-chain, and *drag-chain*, to pull the weeds into the furrow. Called also a DOUBLE PLOW (which see).

Fig. 5133.

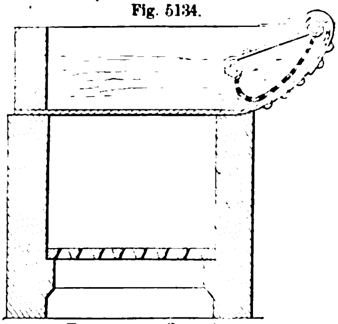


English Skim-Colter Plow.

It was invented about 1775, by Mr. Ducket, a farmer of Surry, England. As contrived by him, it was a "thin plate of iron, with a sharp edge fixed horizontally to a common colter, and its use is to pare off the sward in plowing up grass land or meadow, and to turn it to the bottom of the furrow, where the wrest or mold-board completely buries it with earth; it is likewise useful in plowing rough ground, where mud, stubble, roots, or weeds are on the surface, because it sweeps all floating matter to the bottom of the furrow." — *Monthly Magazine* of December, 1797.

Skim'mer. A perforated ladle or flat dish with a handle for taking the scum from a boiling solution, or from the water in which an object is boiled.

Fig. 5134.



Evaporating-Pan Skimmer.

Cane-juice and that of sorghum, the latter especially, abound in feculencies which rise as a scum as the liquid approaches a boiling temperature, the albumen becoming coagulated and carrying with it to the surface some of the mucilaginous matters. Fig. 5134 shows a provision in a sorghum-evaporator of a skimming-dish hinged to the side and retaining the scum, which tends to collect upon the cooler side of the pan which projects outside of the furnace wall. The scum is discharged by tipping the skimmer.

2. (*Founding.*) A stiff bar of iron, the end of which for a few inches is flattened and curved slightly, like the blade of a saber. It is used at the time of pouring, to keep back the slag or *sullage* which floats on the metal in the ladle. The flat end of the skimmer is coated with loam, and dried to keep the metal from burning to the wrought-iron. Skimmers are usually about 4 feet long, but for crane-ladles they are often 12 to 16 feet.

Skimp'ing-roll'er. A roller of cylindrical brush for removing superfluous paste, etc., as in sizing, calico-printing, and other machines.

Skin. 1. (*Shipbuilding.*) The planking of a ship. The inside, *skin* or *ceiling;* the outside, *skin* or *case.* When of wood, it may be laid on in *carvel, clinker,* or *diagonal* style. When of iron, it consists of iron plates laid in alternate inside and outside strakes.

2. (*Nautical.*) That part of a sail when furled which remains outside and covers the whole. To "furl with a smooth skin" or "skin the sail up smooth" is to turn it well up, and so as to cover the sail neatly.

3. The pelt or hide of an animal, useful as a fur or for making leather. For the latter, see LEATHER; TANNING; TAWING, etc.

The great fur-trade of Leipsic is described by Consul-General Tauchnitz in his report on the Leipsic Easter Fair in 1873. To this fair were brought the produce of Siberia, Russia, Norway, and Sweden, of all Central Europe, of the United States of America, Canada, the Hudson's Bay Territory, Northwest America, Alaska, the Aleutian Isles, and of China. The goods are exported to America, Russia, China, Turkey, to Hungary and the Austrian States, to England, France, and Italy, a considerable quantity also remaining for use in Germany.

The productions of Central Europe were, in round numbers, 120,000 foxes, 200,000 polecats, 50,000 rock-martens, 20,000 pine-martens, 20,000 badger-skins, 6,500 otter-skins, and 125,000 black cats. Foxes fetched from 16 to 22 thalers, according to quality, — on an average, about 18 thalers, — per ten skins. Polecats from 60 to 100 thalers per lot of 40 skins, according to country. Rock-martens reached 6 thalers per skin for German, 7½ thalers for Bosnian and Greek goods; pine-martens, 6 to 7½ thalers per skin. Black cats were sold for 9 to 15 thalers per dozen.

Of Russian and Siberian furs were offered 2,000,000 squirrels of all sorts, 160,000 ermine, 30,000 kolinsky, and 8,000 Siberian sables. Of the productions of North America, about 1,800 sea-

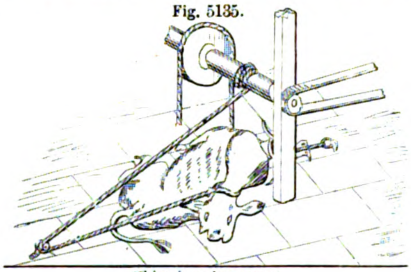
otters were quickly bought up by several Russian merchants. About 80,000 beavers, 40,000 of which were reserved for the demand in England. There were also 3,000 Virginian polecats, 6,000 bear-skins, 220,000 raccoon-skins, 950,000 skunks, 800 silver foxes, 3,500 cross foxes, 45,000 red foxes, 3,000 gray foxes, and 9,000 kitt foxes, 2,500,000 musk-rats, 16,000 sables, and 60,000 small otter-skins.

Of the most important European goods are especially mentioned dyed seal-skins; this fur is in general favor in England and America, and also in Germany and France. Prepared squirrel backs and squirrel bellies, colored Persian and Astrakhan furs, French and Belgian rabbit-skins, Dutch swans and geese, polished rabbit-skin goods and marmot lining, were also exhibited.

Skin'ning-ap'pa-ra'tus. A mechanical appliance for removing the hides from animals.

The hide is ripped as usual, and the head laid bare; the horns being attached to a ring in the floor, a rope is fastened round the neck of the hide, and, running over the pulley on the floor,

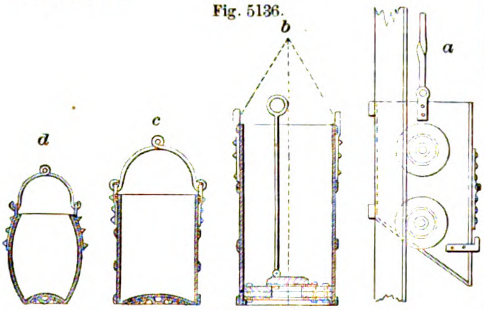
Fig. 5135.



Skinning-Apparatus.

passes round the adjustable drum on the horizontal shaft, which is secured by a clutch. An endless rope on a grooved wheel works the shaft.

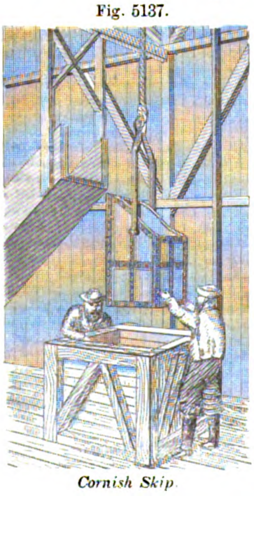
Fig. 5136.



Skips.

Skin-wool. Wool pulled from the dead animal.

Fig. 5137.



Cornish Skip.

Skip. 1. (*Mining.*) A kind of bucket (*a*, Fig. 5136) employed in narrow or inclined shafts where the hoisting-device has to be confined between guides.

It is held to the guides by friction-rollers and flanges, which bear against them, and is provided with a hinged door for discharging material.

b is a water-bucket, used in mines where the quantity to be raised is small, or previous to putting down a pump. On striking the water, the valve *e* rises; it falls by the weight of the superincumbent water when the downward motion is stopped.

c is a *rock-bucket*, frequently used in vertical shafts, and *d* a *kibble*. The latter is adapted for use in shafts that are irregular, or not perfectly vertical. Each has a becket and ring at the bottom, by which it is inverted for dumping.

One ordinary form, used in raising ore to the surface, is a square tube of boiler-iron, having a capacity of about 20 bushels. It has a lip to direct the stuff in discharging.

2. (*Sugar-making.*) A charge of sirup in the pans.

3. (*Fiber.*) A wicker basket mounted on wheels and employed to convey cops, etc., about a factory.

Skip'ping-teache. (*Sugar-making.*) A dipping-pan used in a sugar-boiling house for lifting the concentrated saccharine solution from the open evaporating-pan and conveying it to the cooler.

It is a pan-shaped vessel with a valve in the bottom, worked by a handle. It is lowered by a crane into the pan, the bottom being open; the valve is then closed, the vessel raised, and with its contents removed to the coolers, where the sirup is discharged by moving the handle of the valve.

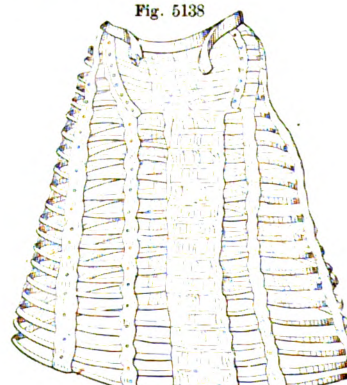
Skip-shaft. (*Mining.*) One boxed off by itself for the skip to ascend and descend in.

Skip-tooth Saw. A saw in which alternate teeth are cut out.

Skip-wheel. (*Carding.*) A wheel in a self-stripping carding-machine to govern the order in which the *top flats* are lifted to be cleaned. In most cases, the action of the *stripper* is upon every other *flat* in order, at the next motion taking the alternate *flats* left on the former passage. In other cases, the action is more frequent upon the flats nearer to the feeding-cylinder, and which become the soonest choked and inoperative, and less frequent upon those nearer to the *doffer*. See CARDING-MACHINE.

Skirt. 1. (*Milling.*) The margin: as the *skirt* or external periphery of a mill-stone; *e. g.* from the *eye* to the *skirt* the *leader-furrows* run.

Fig. 5138



Hoop-Skirt.

2. (*Dress.*) *a.* The hanging portion of a garment below the waist, as of a gown or coat.

b. A petticoat.

Ingenuity is exerted in —

Skirt-clasps.	Skirt-supporters.
Skirt-elevators.	Skirt-springs.
Skirt-metal binding.	Skirt-tapes.
Skirt-protectors.	Skirt-waistbands.

Skirt'ing. 1. (*Building.*) A *wash-board* or *plinth* laid around the wall of a room next to the floor.

2. (*Saddlery.*) A padded lining beneath the flaps of a saddle.

Skirt'ing-board. (*Carpentry.*) A narrow board around the wall next to the floor.

Skit'tle-pot. (*Metallurgy.*) A kind of tall cru-

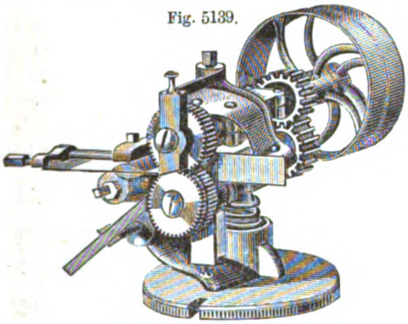
cible swelled toward the middle, used for reducing jeweler's sweepings.

Skive. (*Lapidary Work.*) The revolving table or *lap* charged with diamond-powder, and on which diamonds are polished and other gems are ground.

Ski'ver. (*Leather.*) *a.* A paring tool for leather. *Skiving-knife; skiving-tool.*

b. A machine (Fig. 5139) adjustable to skiver

Fig. 5139.



Tripp's Counter-Skiver.

counters to any desired width of scarf. The knife is held by steel gages at each side of the edge, and is adjusted to any thickness of stock by an automatic feed-roll. A *rand* is produced from any thickness of stock by the same movement. For this purpose, a blade is arranged to strip the stock as the rands are split.

c. A leather prepared from sheepskin with sumac, like imitation morocco, only the skins are split by machinery. The skins are spread out in the ooze and not sewn into bags, as in the morocco process.

Skiv'ing-ma-chine'. (*Leather.*) A machine for splitting skins. See LEATHER-SKIVING MACHINE; LEATHER-SPLITTING MACHINE, page 1281.

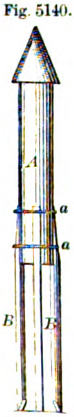
Skute. (*Nautical.*) A kind of large flat-bottomed boat. A scow.

Sky'light. A glazed frame covering an opening in a roof or ship's deck.

A *plane skylight* is about even with, and has the slope of, the roof.
A *raised skylight* is set upon an elevated curb.
A *double skylight* has an outer window for protection, and an inner one, of stained glass, for ornament.

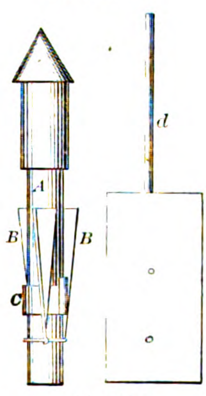
Sky-rock'et. (*Pyrotechny.*) A species of firework — composed of a mixture of niter, sulphur, and charcoal, tightly rammed in a stout paper case —

Fig. 5140.



Sky-rocket.

Fig. 5141.



Sky-rocket.

which is caused to ascend when the compound is ignited at the lower end. It is provided with a stick which is attached to the case at one side.

In Fig. 5140, the case *A* has three short sticks *B B* placed equidistantly around it, and attached by wires *a a*.
In Fig. 5141, the case *A* is provided with wings *B B*, which may be folded down when the rocket is packed for transportation. When erected to serve as guides, they are held by a sliding-collar *C*, which is notched to receive them. A rod *d* passing through a loop in the collar serves to hold them in position for being discharged. The stick is dispensed with. See SIGNAL-ROCKET.

Sky'sail. (*Nautical.*) A square sail set above the *royal.* A triangular sail above the *skysail* is a *sky-scraper* or *flying kite.* If square, it is a *moonsail.* A sail above the moonsail is a *star-gazer.*

Sky-scrap'er. (*Nautical.*) A triangular skysail.

Slab. 1. The outside piece sawn from a log in squaring the side.

2. A thin flat piece of stone or marble for a step, mantel, etc.

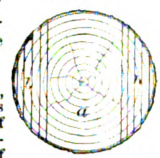
3. (*Fiber.*) A thick web or bat of fiber. See SLUBBING.

Slab'ber. 1. (*Metal-working.*) A quick-motion machine for dressing the sides of nuts or heads of bolts.

2. (*Wood-working.*) A saw for removing a portion from the outside of a log to square it for use as a timber, or that it may be sawn into boards with square edges.

Slab'bing-gang. (*Saw.*) An arrangement of saws in a gate by which a log is cut into a central balk of the required width, and the slab simultaneously ripped into boards of the desired thickness.

Fig. 5142.



The End of a Log ripped by the Slabbing-Gang.

a is the balk which embraces the *heart*, and may be 12, 14, or 16 or more inches wide, according to the desired width of lumber. The other saws are gaged to distance apart, so as to reduce the whole of the slabs into boards by one passage of the log. The *waney* portions of the slab-boards are removed by the EDGER (which see).

Slab'bing-saw. (*Saw.*) A saw specifically used in slabbing logs. In the Ottawa Mills, Chaudiere Falls, these are used in gangs, are of No. 9 gage (Stubs' wire-gage), and 5, 6½, or 7 feet long, according to the size of log.

Slab-board. (*Saw.*) A board cut off the rounding portion of a log; off the *sides* as the log stands on the ways. The log is thereby squared. The boards have sapwood and bark on their edges, which are removed by an edger, making the edges square.

Slab-grind'er. (*Saw-mill.*) A machine used for grinding up the refuse slabs in a water-driven saw-mill, in order to allow them to pass off with the sawdust. This is where refuse stuff is a drug, and the authorities do not allow it to be pitched into the river, as it tends to obstruct navigation, as, for instance, at the Chaudiere Mills, Ottawa, Canada.

Slab-line. (*Nautical.*) A rope fastened to the foot of a sail and used to truss it up after hauling upon the *leech* and *bunt* lines.

Slack. 1. (*Nautical.*) The loose part of a fixed rope.

2. Small coal screened at the mines from household or furnace fire-coal of good quality.

Slack-course. (*Knitting-machine.*) A range of loops or stitches more open than those which precede them.

Slack-wa'ter Nav'i-ga'tion. *Slack-water* or *still-water navigation* has been adopted on several European rivers, but to a greater extent in the United States than elsewhere.

It consists in the erection of dams in the stream, by which the water is dammed back, and its depth is increased. If the fall be moderate, a single dam may produce a stagnation in the run of the water, extending for many miles up the river, and forming a spacious navigable canal. The tow-path is formed along the margin of the river, and is elevated above the reach of flood-water. The dams are passed by means of locks, such as are used in canals. One of the most extensive works on this principle in the country was constructed by the Schuylkill Navigation Company, in the State of Pennsylvania, and consisted in damming up the water of the river Schuylkill. It extends from Philadelphia to Reading, and is situate in the heart of a coal country. It is 108 miles in length, and its construction cost about $2,500,000. This line of navigation is formed by 34 dams thrown across the stream, with 29 locks, which overcome a fall of 610 feet. It is navigated by boats from 50 to 60 tons burden.

Slack-water navigation also occurs at intervals on many of the great lines of canals. About 78 miles of the Rideau Canal, in Canada, are formed in this way, and it is met with on the Erie, Oswego, Pennsylvania, Lycoming, and Lehigh Canals.

The same mode is adopted on the river Severn in England, the dams being made of masonry.

Slade. The *sole* of a plow.

Slag. 1. (*Metallurgy.*) Vitreous mineral matter removed in the reduction of metals. The scoria from a smelting-furnace.

At some furnaces on the Continent of Europe the slag is sold. It is run directly into wagons, or prepared by granulation in water, and is used for making cement and artificial stone, and in the manufacture of alum and crown glass.

At the iron-works of Aulnoye, in Belgium, the slag is cast into slabs for pavements, garden-rollers, and other things. For the former purpose, molds are excavated in the ground around the furnace, and trenches cut to conduct the liquid slag to them. The material is allowed to cool very slowly; its interior is then found to be compact and homogeneous, the exterior consisting of a vitreous crust. The masses are often divided by fissures, but may be cut and dressed into smaller blocks.

Mr. Woodward, of Darlington, England, has patented a method of manufacturing bricks from slag.

The slag from the furnace is run into a series of molds on a revolving table. After removal from the molds, the bricks are annealed in a kiln or furnace, and are ready to be used for any of the purposes to which common brick are applied.

The fracture is said to be close and firm, and they are capable of standing an intense heat. They resist a crushing force of 3 to 4 tons to the inch, and it is claimed can be made at less than half the cost of common brick, though there is considerable loss by breakage.

In another process, invented by Hartmann in Hanover, the slag is granulated by allowing it to flow into a shallow pit, through which a stream of water runs. The material may then be ground fine and used as a building sand. For making bricks, it is mixed, in its coarsely granular state, with half its bulk of water, in a kind of pug-mill. The bricks are molded by machinery, and dried in the open air; in about six weeks they are ready for use. They are said to be stronger than ordinary bricks, and peculiarly adapted for receiving mortar, owing to their rough surface. Their cohesiveness is, however, impaired by the absorption of moisture.

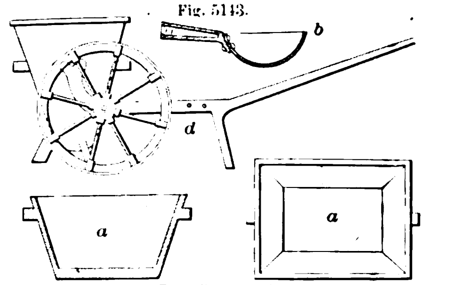
An incombustible non-conducting fibrous material is also prepared by blowing a jet of steam, at a pressure of about 50 pounds, through a thin stream of slag as it falls from a narrow gutter leading from the furnace. By this process it is solidified in the form of delicate fibers resembling asbestus or spun glass. From the appearance of the mass it has received the name of *slag-wool*. It is used as a covering for steam-pipes, boilers, etc. See SLAG-WOOL.

2. (*Founding.*) The fused sullage and dross which accompanies the metal in a furnace, and which it is the business of the skimmer to hold back from the ingate. It is essentially a *very base* silicate of iron. *Cinder; scoriæ; clinker.*

Slag-brick. See SLAG.

Slag-car. A wrought-iron car (*d*) on two wheels, used to contain and carry off the slag of a furnace to a place where it may be dumped.

Fig. 5143.



Slag Pot, Car, and Ladle.

Two pedestals project up in front of the axis of the wheels, so that they may be elevated by depressing the handles and thus lift the slag-pot by its trunnions clear of the ground. *a* shows the slag-pot separately; *b* is the wrought-iron ladle for filling it. A handle, formed of a piece of gas-pipe, is screwed into the socket of the ladle. The slag-pots are of cast-iron, tapering to a flat bottom, as at *a*, or are made conical with three legs to stand on, as in the one on the car.

Slag-fur'nace. (*Metallurgy.*) A furnace for extracting the lead from slags, and from ores containing a small proportion of that metal.

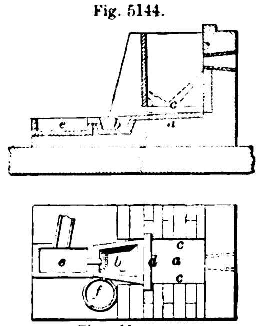
It has a prismatic chamber and an iron sole-plate inclining from the back where the tuyere enters, to the front.

The bottom is covered to the depth of 15 inches with small spongy cinders closely beaten. The rectangular chamber is then filled with turf, which is fired, and alternate layers of coke and slag placed in the furnace. The reduced metal filters through the lower layer of cinders, and is received in a pot also filled with cinders. The slag, being too viscid to penetrate these, flows off above.

Slag-hearth. (*Metallurgy.*) A furnace for treating slags run from the surface of lead in a smelting-furnace.

The shaft is a parallelopipedon 26 × 22 inches at the base, and 3 feet high. The sole-plate *a* is of cast-iron, and slopes down to the receiving-basin or fore-hearth *b*; cast-iron beams, called bearers, *c c*, on each side of the sole-plate, support the side walls of sandstone, and also the cast-iron plate *d*, called the *fore-stone*, forming the front of the shaft. The back is of cast-iron up to the tuyere-hole, above which it is of sandstone. In front of the fore-hearth *b* is a cistern *e*, through which water flows, so that slags which flow over the fore-hearth may be shattered, and the lead contained in them be readily washed out.

Fig. 5144.



Slag-Hearth.

The lead itself flows over the fore-hearth into an iron pot *f*, which is kept hot over a fire.

The metal obtained in this way is less pure than that extracted directly from the ore.

Slag-wool. A non-combustible and non-conducting material made from the slag of a cupola-furnace, by directing upon the slag in its fluid state, as it runs from the furnace, a strong jet of steam. By this the slag is thrown, in a condition of fine fibers, into a cast-iron chamber or receptacle prepared and placed for the purpose, from which it is gathered in a form resembling wool. It was shown at the Vienna Exhibition by an establishment at Osnabrueck.

Slaie. (*Weaving.*) A *reed*. See SLEY.

Slake-trough. (*Blacksmithing.*) The water-trough in which a blacksmith *slakes* or cools his tools or his forging.

Sla'kin. (*Metallurgy.*) A spongy, semi-vitrified substance mixed by smelters with the ores of metal to prevent their fusion. It is the scoria or scum separated from the surface of a former fusion of the same metal.

Slam. The refuse of alum-works, used as a manure.

Slap'ping. (*Pottery.*) The process of working clay by dividing a block and slapping the halves together. This develops the plasticity, makes the mass homogeneous, and expels air-bubbles. The *grain* of the mass is preserved, the pieces being dashed parallel upon each other. The process is repeated again, the dividing instrument being a wire. See SLOPING; WEDGING; SLICING-MACHINE.

Slash'er. A sizing-machine for warp-yarns. The yarns are received from a number of rollers on the right, but two of which are shown in the engraving. They are then sized, brushed, and dried, the latter by passing over and under large heated cylinders. The name *slasher* originated as a playful term to indicate the much greater rapidity of the machine as compared with the ordinary *warp-dresser*.

The extra amount of work is done by having a much greater drying surface for the yarn to pass over after being sized. In the slasher, also, the yarn runs through boiling size; in the dresser it is cold or only moderately warm.

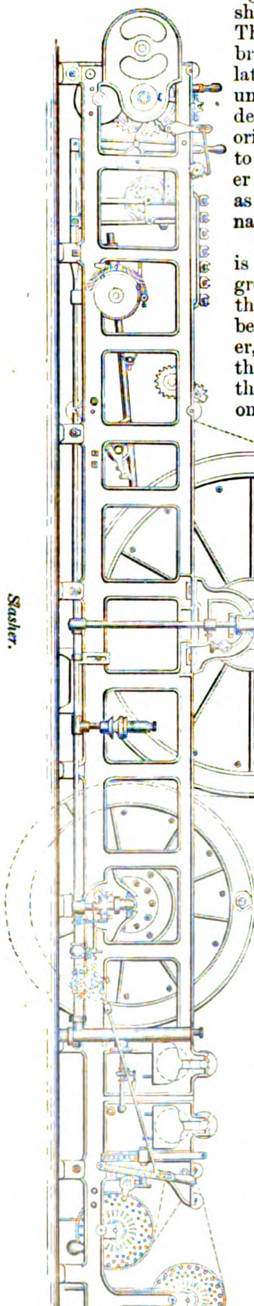


Fig. 5145.

Slasher.

The name is perpetuated in other succeeding machines and appliances, as *slasher-warpers, slasher-combs, slasher-cloth*, etc. See also official catalogue of the English Exhibition for 1862, Class VII. pages 6, 7.

Slat. A thin strip or flat bar.

1. In a bedstead, the *slats* are transverse pieces, resting at their ends upon the *side-rails*.

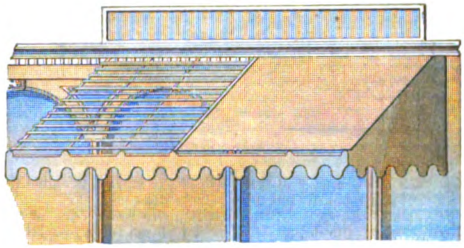
2. (*Vehicle.*) *a.* A bent strip which bows over the seat and forms one of the ribs of the canopy. A *bow*.

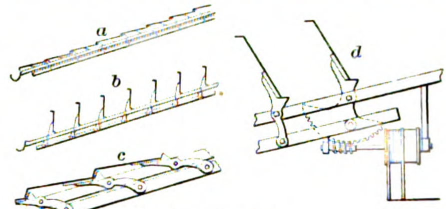
b. The *sloats* or rounds of a kind of cart or wagon bed.

3. The foundation of a basket, consisting of crossing sets of parallel rods interlaced and forming a nucleus for the commencement of the spiral courses of which the bottom is made.

Slat-awn'ing. Fig. 5146 shows a corrugated iron slat-awning. The slats are pivoted and are raised and lowered, those of each set being connected by bars by means of segment-racks engaging with worms upon the shafts of drums which are turned by

Fig. 5146.





Slat-Awning.

cords leading to the footway beneath. When closed, as at *a*, their down-turned edges overlap. *b* shows the slats raised; *c d* illustrate the mechanism for raising and lowering them.

Slate. A metamorphic clay rock, frequently fossiliferous. It is readily divisible into thin plates, and, being easily worked and smoothed, is much employed for roofing and in the manufacture of mantels, billiard-tables, and other similar objects. In the quarry, the direction of these cleavage planes is usually vertical or nearly so, but never coincident with those of the beds and joints. The masses are, therefore, removed by cutting trenches in the side of the hill and splitting the rock in vertical layers. As the perpendicular breast becomes too high for convenient working, say 40 feet, a second trench is cut above the first; then a third, and so on.

In the great slate quarries of Ybron, six miles southeast of Bangor in N. Wales, sixteen of these stages are in progress together, the lower ones being gradually widened by the getting of the slates as the upper ones are advanced. In the upper part of the quarry the slates are removed with crow-bars; but the slates become harder as they are lower from the surface, and require the use of gunpowder to detach the main masses. The miners engaged in drilling the holes for the powder are suspended by ropes from the upper parts of the rock, and are liable to many and severe accidents. After the slates are detached by powder or otherwise, they consume considerable labor in splitting them with wedges and mallets into marketable sizes, and reducing them to the several grades required for roofing and other purposes.

Slate adapted for ordinary economic uses is not very common. A number of varieties are, however, found in Cornwall, Wales, Scotland, and Ireland, and also on the Continent of Europe.

Those from the Ardennes, from Angers on the Loire, and from Nassau, are largely exported.

In this country, Vermont furnishes slates of unsurpassed quality and beauty. Their quarrying and manufacture are beginning to constitute an important feature of national industry, promising large increase in the future.

Aluminous slate yields alum.

Adhesive slate is porous and adheres readily to the tongue.

Bituminous slate yields coal-oil.

Whet slate has a fine grain and makes hones.

A tough kind, *hornblende* slate, is used for flagging and sidewalks.

A soft kind, containing carbon, — *drawing* slate or *graphic* slate, — is used for pencils.

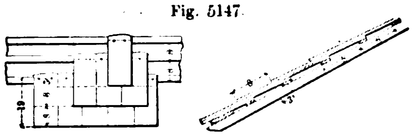
Polishing slate has a peculiarly fine grain, and is found in Bohemia. It is used in slips and in powder.

Slate clay consists of alumina and silica, and, from the absence of fluxes, makes a refractory fire-brick.

2. A thin riven slab of slate used in roofing.

The upper surface of a slate is called its *back*, the under surface the *bed*, the lower edge the *tail*, the upper edge the *head*. The part of each course of slates exposed to view is called the

Fig. 5147.



"*Countess*" *Slating.*

margin of the course, and the width of the margin is called the *gage*. The portion hidden from view is the *cover*.

The *bond* or *lap* is the distance which the lower edge of any course overlaps the slates of the second course below, measuring from the nail-hole, and may be from 2 to 4 inches.

In preparing slates for use, the sides and bottom edges are trimmed and the nail-holes punched as near the head as can be done without risk of breaking the slate, and at a uniform distance from the tail, regard being had to the spring of the laths. Slates are laid on *laths*, *battens*, or sheathing, and must break joint. The nails are of copper, zinc, or tinned iron. In England, 1,200 slates constitute a thousand, common sizes, as follows: —

Description.	Size. Length. Ft.	Size. Length. In.	Size. Breadth. Ft.	Size. Breadth. In.	Average Gage in Inches.	No. of Squares 1,200 will cover.	Weight per 1,200 in Tons.	No. required to cover one Square.	No. of Nails required to one Square.
Doubles	1	1	0	6	5½	2	¾	480	480
Ladies	1	4	0	8	7	4½	1¼	280	280
Countesses	1	8	0	10	9	7	2	176	352
Duchesses	2	0	1	0	10½	10	3	127	254
Imperials	2	6	2	0	A ton will cover 2¼ to 2½ squares.				
Rags and Queens	3	0	2	0					

Other denominations and sizes are —

	Ins.		Ins.
Small	11 × 7	Viscountess	18 × 10
Plantations	12 × 10 13 × 10 14 × 12	Marchioness	22 × 12

A *square* of slate or slating is 100 superficial feet.

The *pitch* of a slate roof should not be less than 1 in hight to 4 of length.

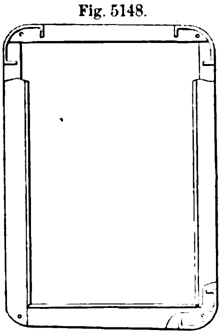
Dimensions of Slates (American).

Ins.	Ins.	Ins.	Ins.	Ins.	Ins.
14 × 7	16 × 8	18 × 10	20 × 11	22 × 12	24 × 13
14 × 8	16 × 9	18 × 11	20 × 12	22 × 13	24 × 14
14 × 9	16 × 10	18 × 12	22 × 11	24 × 12	24 × 16
14 × 10	18 × 9	20 × 10			

The thickness of slates ranges from 3/16 to 5/16 of an inch, and their weight varies from 2.6 to 4.53 pounds per square foot.

3. A tablet for writing upon, formed of slate, or of an imitation of slate.

Fig. 5148.



Slate.

School-slates are made from a fine and soft quality of slate. The great demand for them has led to various improvements in the manner of making and uniting the frames, and to the invention of special machines for this purpose. Slate-frames are now generally made with rounded angles, and one invention consists in securing the parts together more firmly by wires entering grooves at the corners, and having bent ends, which are inserted into holes in the side and end pieces.

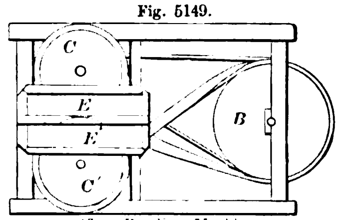
Artificial slates are prepared by coating the surface of wood or paper with a fine gritty substance, as pulverized emery or pumice, mixed with black size or paint; or the surface is painted black, and dusted with the powder before it becomes dry.

Slate-axe. A slater's tool. It has a blade for trimming the edges and a spike for making nail-holes in the slate. A *sax* or *zax*.

Slate-bev'el-ing Ma-chine'. A machine for beveling the edges of school or other slates.

The slate is held in the opening between the two adjustable guides *E E'*, its edge being presented to the two bevel-edged

Fig. 5149.



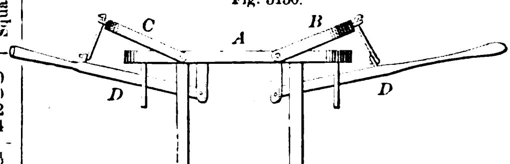
Slate-Beveling Machine.

wheels *C C'*, which are rotated in opposite directions, so that their acting surfaces move in the same direction, by a crossed belt passing around the pulley *B*.

Slate-cut'ter. A machine for cutting the edges of roofing or other slates, to give them a rectangular or other regular form.

In Fig. 5150, the slate is laid on the table *A*, and its ends

Fig. 5150.

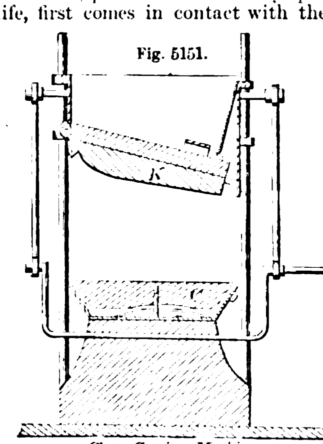


Slate-Cutter.

trimmed by hinged knives *B C* of curved or other suitable shape, depressed by the levers *D D*.

Slate-cut'ting Ma-chine'. A cushion *K* within the box-knife, pressed downward by springs below the knife, first comes in contact with the slate on

Fig. 5151.

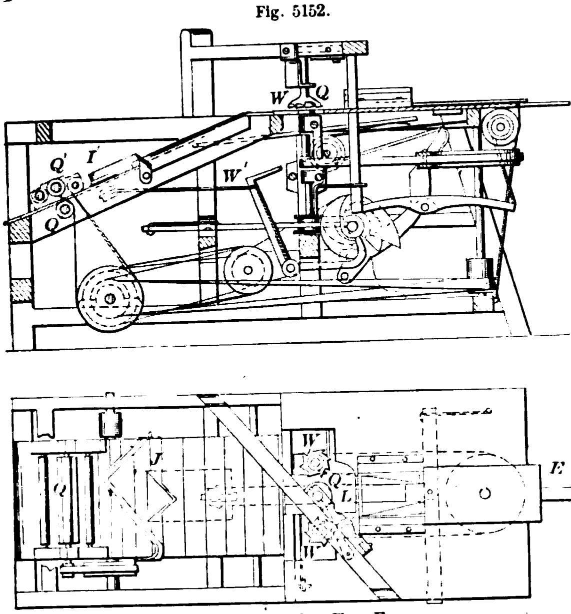


Slate-Cutting Machine.

the cushioned bed *C*, and rises as the knife descends, allowing the slate to be adjusted between the beds so as not to be broken.

Slate-frame. In the machine for dressing slate-frames (Fig. 5152), the frames are arranged in a pile, and are fed forward one by one by the action of the pusher *E* on to the revolving table *L*, where the corners are rounded off and edges dressed by the rotary knives *W W*. It is then advanced by the pusher *J'*, which, with the angular stop *I'*, presents it corner-

Fig. 5152.



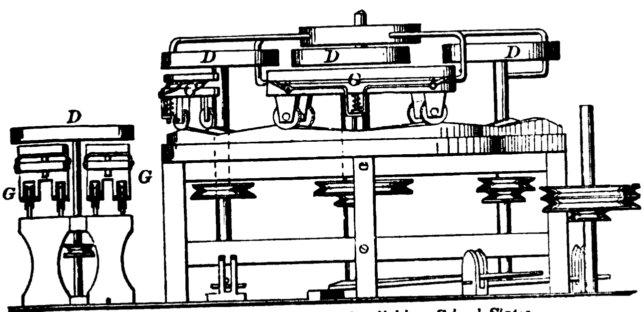
Machine for dressing Slate-Frames.

wise to the cutters Q Q', by which the sides are planed.

Slate-mak'ing Ma-chine'. Fig. 5153 is a machine for grinding and polishing school-slates. The slates are supported on cars G, which are connected by arms with a vertical shaft, by which they are caused to move slowly around in a circular track, having a series of inclines. The distance apart of the corresponding parts of each similar incline is exactly equal to that between the front and hind wheels of the car, which is thus caused to remain perfectly level as it rises to present the slate to the grindstones D, and falls during its forward movement.

Slate-peg. A kind of nail used in securing slates on a roof. A slater's nail.

Fig. 5153.



Machine for grinding and polishing School-Slates.

Slate-pen'cil. The common irregularly shaped black slate-pencils, once the only kind known, are made in Germany. These have been pretty much superseded in this country by the softer, neater, and greatly superior article, known as soapstone pencils, made from a peculiar stone found near Castleton, Vt. This stone contains over 50 per cent of silica, a large proportion of alumina, and also some potash and iron; and, while having some resemblance to soapstone, more nearly resembles slate in texture and capability of being split readily into plates.

In the manufacture of pencils, it is first split into slabs 1 to 2 inches thick, which are then sawn into blocks 6 to 7 inches long and 4 or 5 inches wide. With a thin blade of steel and a hammer these are split into plates about one third of an inch thick, which are next passed between two flat-edged knives to plane them. The plate is then fed to a machine in which it is passed successively beneath a series of grooved cutters, each of which cuts a row of deeper incisions into the slab, until, on emerging from the machine, its upper side is covered with convex flutings, the channels between which penetrate half through the stone. It is then transferred to a second machine, where its other side is subjected to the action of a series of similar cutters, by which the pencils are completely rounded and separated from each other. They are next sawed to uniform lengths, the sizes varying from $3\frac{1}{2}$ to 6 inches; and, finally, pointed on a grindstone. In some cases they are afterward painted.

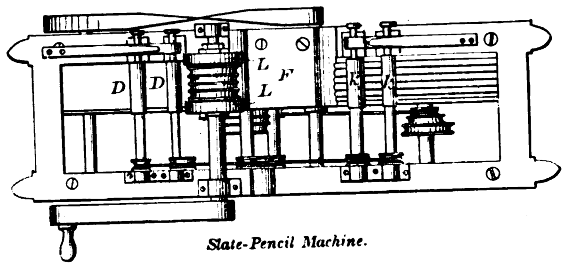
The dust and waste, which is said to amount to 90 per cent of the original material, is utilized by grinding to an impalpable powder, which is used for mixing with paper-pulp to give it body and enable it to receive a *satin* surface.

As the stone contains over 30 per cent of alumina, the refuse is also available for the manufacture of alum.

Slate-pen'cil Ma-chine'. A machine for forming pencils at one continuous operation.

The slate is fed by the rollers D D to the grooved rotary cutter L L, which shapes their upper sides; other rollers convey them beneath the plate F, which is grooved to correspond with the upper halves of the pencils, and their lower sides are shaped by a similar rotary cutter beneath the plate. They then pass beneath the rollers k k, which convey them away.

Fig. 5154



Slate-Pencil Machine.

Slate-saw. A machine for trimming the edges of slate-slabs to shape. In the example, the slab is laid on a traversing bed and passes beneath two circular saws which are gaged such a distance apart as the proportions of the slab may warrant or the width of the piece required may justify. The blades are made of diameters from 2 feet up to 13 feet, and the machine is used for other varieties of stone beside slate.

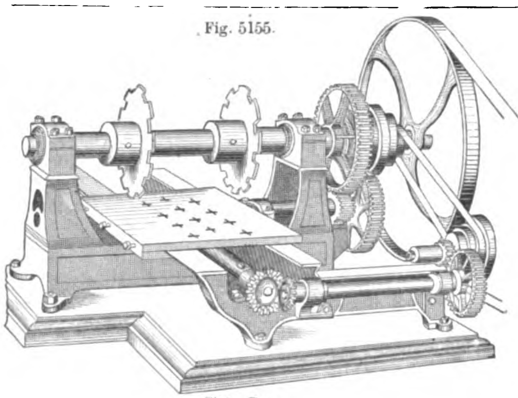
Slate-trim'ming Ma-chine'. See SLATE-CUTTER.

Slate-wip'er. A sponge-holder for wetting and wiping school-slates. It has a sponge on the end moistened by water oozing from the interior.

Slat'ing. The slate covering of a roof, taken as a whole. See SLATE.

Slat-ir'on. (*Vehicle.*) The iron shoe or ter-

Fig. 5155.

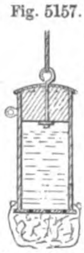


Slate-Saw.

mination of the *bow* or *slat* of a carriage-top. The shoe is hinged to the stem by a pivot-pin and has an envelope of leather. In the example, the ends of the bows are fitted into ferrules, having semi-circular extensions upward and longitudinal screw-threaded holes for the reception of screws in the end pieces.

Fig. 5156. Fig. 5157.

Slat-Iron.



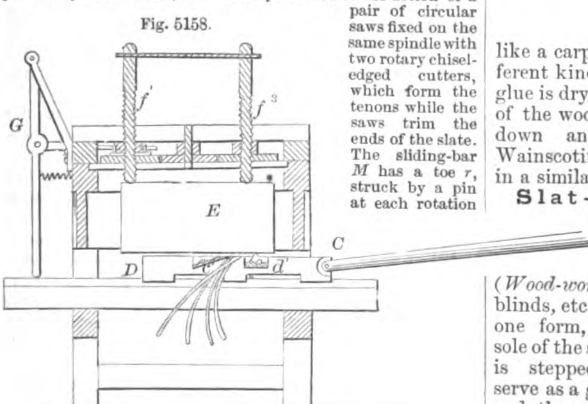
Slate-Wiper.

Slat-ma-chine′. A machine for tenoning and automatically inserting the staples in Venetian-blind slats.

The machine (Fig. 5158) has a carriage *D C* reciprocated by a pitman. A series of vertical cutters *d′* on the carriage make longitudinal incisions in front of the broad inclined cutter *c*, which follows and severs the whole row of slats simultaneously from the block. The block *E* is pressed down to the cutters by screws f^1 f^3, advanced downwardly by gear-wheels operated by a pawl movement from the lever *G*, which is vibrated at each reciprocation of the carriage. The several splints pass downwardly through a throat in the carriage-stock.

In Fig. 5159, the slat is held between the revolving heads *I I* on the extremities of the arms *H H′* attached to the shaft *G*, and raised or depressed by the lever *J′*, so as to be presented to the action of a pair of circular saws fixed on the same spindle with two rotary chisel-edged cutters, which form the tenons while the saws trim the ends of the slats. The sliding-bar *M* has a toe *r*, struck by a pin at each rotation of the wheel *Q*, causing a forward movement of the bar, which drives a staple, escaping from the receptacle *P* into the side of the slat.

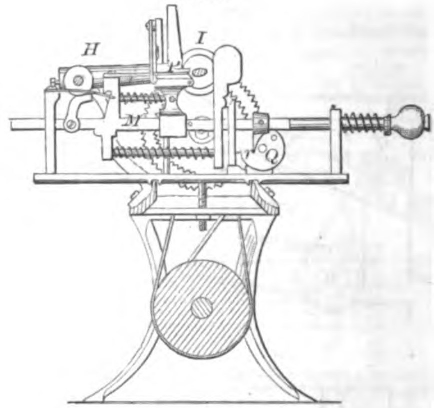
Fig. 5158.

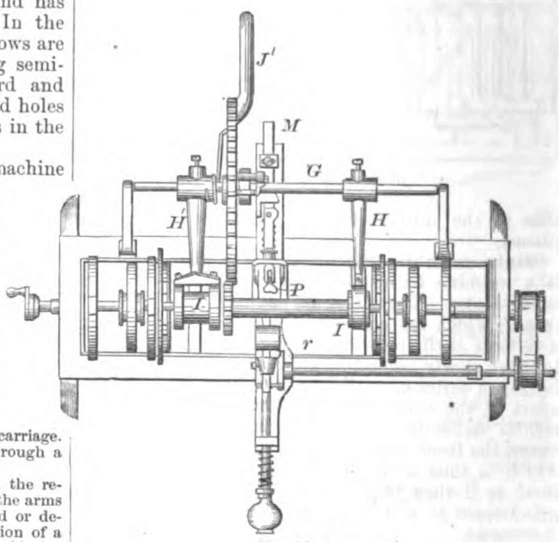


Machine for cutting Slats for Blinds.

Slat-mat′ting. A floor covering of wooden slats or veneers on a flexible fabric, which may be rolled like a carpet. In the example, narrow strips of different kinds of wood are glued upon cloth. After the glue is dry, the surface of the wood is planed down and finished. Wainscoting is made in a similar manner.

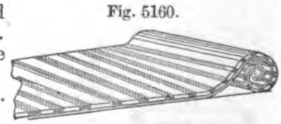
Fig. 5159.





Slat-Machine.

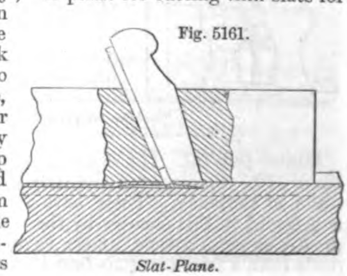
Fig. 5160.



Slat-Matting.

Slat-plane. (*Wood-working.*) A plane for cutting thin slats for blinds, etc. In one form, the sole of the stock is stepped to serve as a gage, and the cutter has a forwardly projecting lip which cuts and lifts the bottom of the slat while a vertical cutting-edge severs

Fig. 5161.



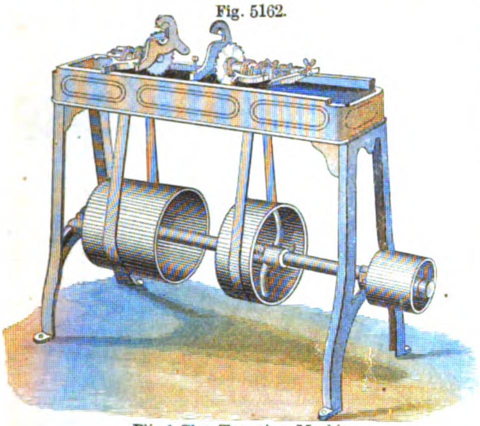
Slat-Plane.

it at the side. The splint passes to the rear through an opening in the cutter. Several cutters may be arranged in the stock so as to cut several slats at once.

Slatt. (*Masonry.*) A thin slab of stone used to cover rougher or less expensive masonry or brick-work (not *slate*).

Slat-ten′on-ing Ma-chine′. A machine for cutting circular tenons on the ends of blind-slats.

Fig. 5162.

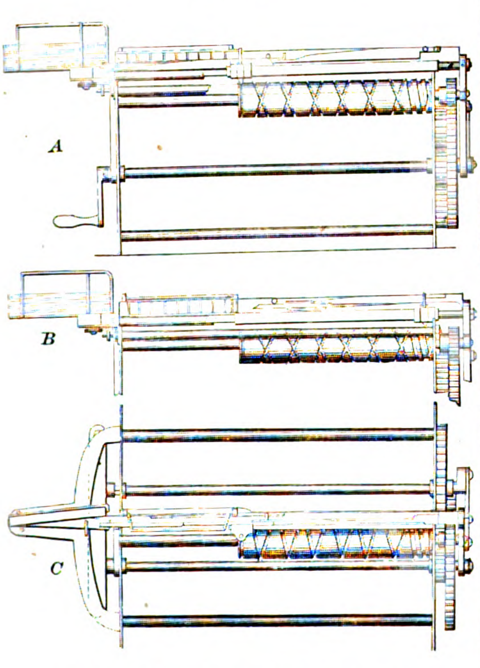


Blind-Slat Tenoning-Machine.

The slat is placed within two revolving disks, by turning which it is brought in contact with two sets of circular saws. These cut the shoulder and round the tenon at one operation.

Slat-weav′ing Loom. A loom for making woven goods, in which the warp consists of slats, palm-leaf, whalebone, straw, or other material, which

Fig. 5163.



Baldwin's Loom for weaving Palm-Leaf, etc.

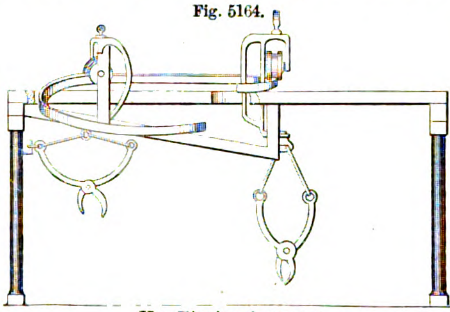
is cut in lengths equal to the width of the goods, and laid into the shed piece by piece, instead, as in other looms, of being fed off continuously from a bobbin or spool.

Fig. 5163 represents a machine of this kind; *A* being a front view, *B* a sectional view of the upper part detached, *C* a top view. The slats are arranged in a pile in such position on the side of the loom, that a pin on a sliding frame operated by the lay pushes out the inner end of the under slat, so that it can be seized by the reciprocating nippers and drawn into the shed. The slat, when in place to be beaten up, is held by a pressure-bar hinged on the lay.

Patent No. 135,427 has devices to support the strips of wood while being introduced into the shed, to prevent their coming in contact with the threads of the warp. The strips composing the woof are fed into a slotted lay by a pair of feed-rolls, the lay having a cap which serves as a guide to keep the slat in place while it is being fed into the lay, and is raised to release the strip from its slot when the lay is beating forward. See also PALM-LEAF LOOM, page 1600, and list of patents under STRAW-FABRIC LOOM.

Slaugh′ter-ing-ap′pa-ra′tus. Machinery for slinging slaughtered animals, to assist in skinning, gutting, cleaning, as the case may be. For beeves,

Fig. 5164.



Hog-Slinging Apparatus.

it usually consists of a mode of hauling the animal up to the place where it is stunned by a pole-axe and then bled; also of a hoisting tackle by which it is lifted while the skin and viscera are removed, and then swung clear of the floor to be washed and left to cool.

Hog-slaughtering apparatus consists of scalding-tubs and slinging devices, the latter shown in the cut. The swiveled clutch is supported upon a grooved roller which travels on a helical track to gradually elevate the load. The hog from the scalding-tub is slung by its gambrels from the clutch and passed in succession to the gutters and the cleaners; it is then passed on and transferred to the hooks where the hogs hang over night to cool.

Slay. (*Weaving.*) A weaver's reed. A *sley.*

Sleave. The knotted and entangled part of silk or thread.

Sled. A vehicle on runners, used for hauling loads. It corresponds to the wagon as the sleigh does to the carriage among wheeled vehicles, the two latter being intended for passengers.

The sleds of the Esquimaux vary in their materials and shape. According to Captain Lyon, the best are made of the jawbones of the whale sawn to about two inches of thickness and from six inches to a foot in depth. These are the runners, and are shod with a thin strip of the same material. The sides are connected by pieces of bone, horn, or wood, firmly lashed together. In Boothia, Captain Ross saw sleds in which the runners were made of salmon, packed into a cylinder, rolled up in skins, and frozen together. In spring the skins are made into bags and the fish eaten.

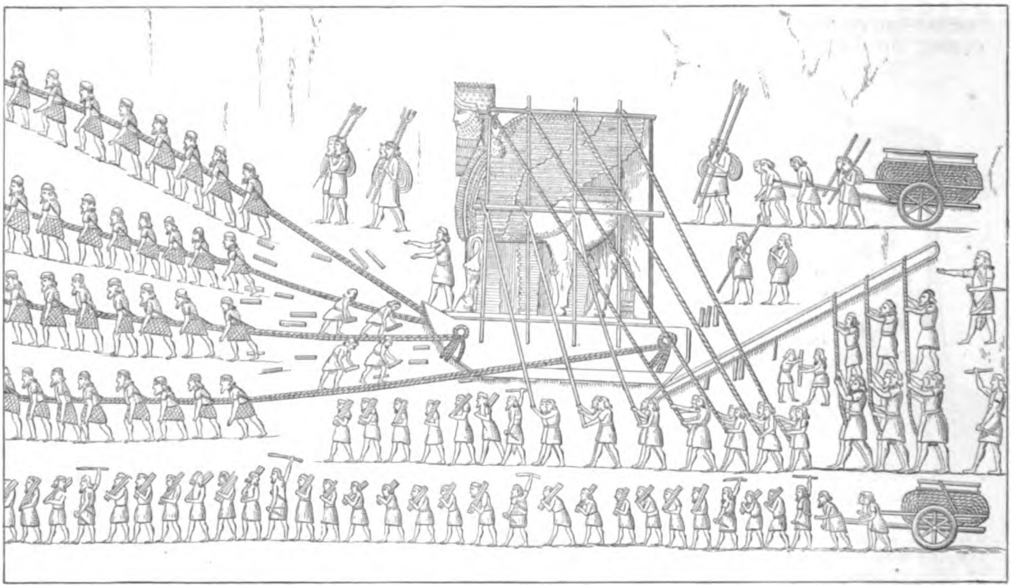
Fig. 5165, from a bas-relief at Koyunjik, illustrates the mode

adopted by the ancient Assyrians for removing colossal figures from the quarry, where they were hewn, to the place which they were intended to occupy.

The figure was mounted on a sled and protected by a framework of spars or beams, crossing each other at right angles, and tightened by means of wedges. To prevent the colossus from upsetting, ropes attached to the top of the framework were held by men at each side. Wooden forks or props, held by men, were also applied to the second cross-pieces to steady it.

Rollers were placed beneath the upwardly curved front of the sled as it advanced, and were collected by men at the rear. It was drawn by four gangs of men by means of four large ropes attached to projecting pins, two at the front and two at the rear of the sled, and secured by a knot which could not slip.

Fig. 5165.



Assyrians removing a Human-Headed Bull (from a Bas-Relief at Koyunjik).

To impart the first impulse to the mass and to start it again after stopping, a long lever, with wooden wedges beneath to form a fulcrum, was applied at the rear end of the sled, and was worked by ropes extending from near the extremity of its long arm to the ground and drawn upon by men.

A man standing on the front of the sled controlled the movements of the laborers engaged in pulling; others, supervised by foremen, carried the spare rollers and forks, and drew cars containing extra hauling ropes, while a superintendent at the rear directed the whole operation.

The sled was also employed by the Egyptians in transporting large masses of stone, as is illustrated in their sculptures. In a grotto behind E'Dayr, a village between Antinoë and El Bersheh, is the representation of a colossus on a sled drawn by 172 men in four rows of 43 each; a man standing on the pedestal at the front of the sledge pours a liquid, probably grease, from a vase, for the purpose of lubricating the planks or ways, though these are not shown, over which it slid. A superintendent, standing on the knee of the statue, appears as if clapping his hands as a signal for a simultaneous pull; or is, perhaps, preparing to catch something which a person on the ground appears to be about to throw. Men carrying vases containing grease, or perhaps water, and others with implements of some kind follow, while supervisors or taskmasters bring up the rear. Relays of drawers walk behind the sledge. The ropes are all attached to the front of the sled. The number of men employed may have been much larger than that actually shown. This sculpture is of the age of Osirtasen II., the contemporary of Joseph, between 1651–1636 B. C. See Wilkinson's "Ancient Egyptians," First Series, Vol. III. p. 328.

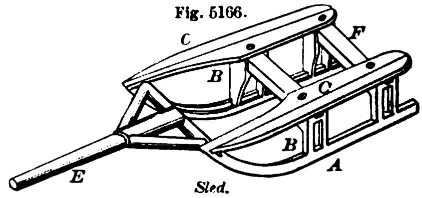
Country sleds are made in various ways The *Yankee* sled has wide runners which elevate the benches sufficiently. The *knee*-sled has knee-pieces which rest on the runners and support the benches. *Bob*-sleds are short. *Log*-sleds are short and have a heavy hind bench to support the log.

Fig. 5166 is a view of a sled, showing the runners *A*, knees *B*, fenders *C*, benches *F*, roller, hounds, and tongue *E*.

Fig. 5167 is a pair of bob-sleds (*bob*, short), used instead of a single long sled of equal length, on account of the facility of turning and greater handiness in other respects.

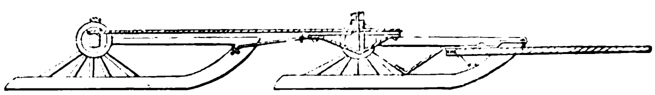
Fig. 5168 is a reversible dumping-sled. On arriving at the place to dump a load, the sled is upset and is ready for reloading. The sled projects above and below the floor, and the runners are rounded at each end. It is drawn by a chain looped on to a hook, which is disengaged to bring the dumping-chain into action.

Fig. 5166.



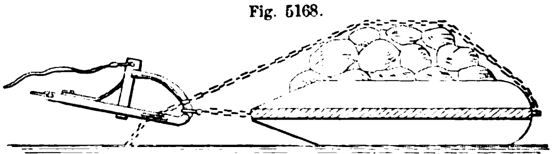
Sled.

Fig. 5167.



Bob-Sleds.

Fig. 5168.



Reversible Dumping-Sled.

Sleds for children and youth are made in many forms. Two may be cited.

Fig. 5169 has a pair of rudders behind the runners for guiders, the two being simultaneously acted on by cords connected to a tiller-lever.

Fig. 5169

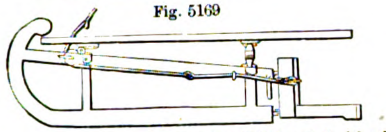
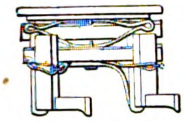


Fig. 5170 is a sled with a brake.

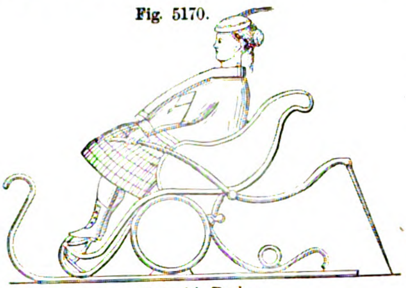


Sled with Rudders.

Sled-brake. (*Vehicle.*) A device to prevent too rapid motion of a sled. It is usually a prong brought into contact with the ice.

Fig. 5171 shows one in which the brake is operated by the driver, who turns a lever projecting upwardly from the front end gate of the wagon-bed and thereby depresses the scraper.

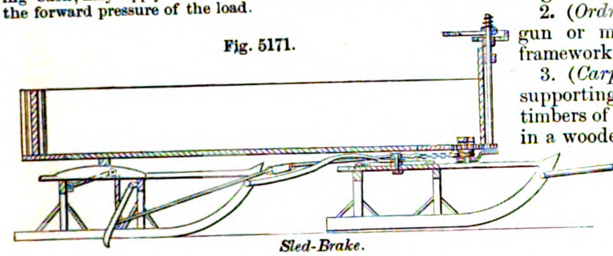
Fig. 5170.



Sled with Brake.

In Fig. 5172, the brake is so arranged that the team, in holding back, may apply the brake with a force proportioned to the forward pressure of the load.

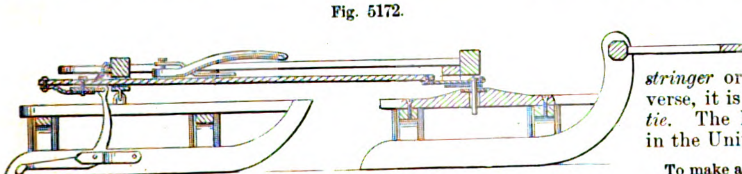
Fig. 5171.



Sled-Brake.

In Fig. 5173, depressing the lever *a* causes the parts *b*, to which the pivoted brakes *c* are hooked, to assume a vertical

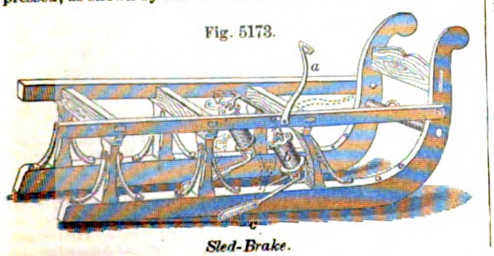
Fig. 5172.



Automatic Sled-Brake.

position, the points of the brakes being at the same time depressed, as shown by the dotted lines.

Fig. 5173.



Sled-Brake.

Sledge. 1. (*Vehicle.*) A vehicle on runners is called a *sledge* in England, where such things are but little used. The true word, *sled*, is used in America, and is derived from the Anglo-Saxon word *slidan*, to slide. See SLED.

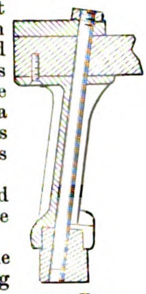
2. The heavy hammer of a smith, wielded by both hands. A *sledge-hammer.*

The *up-hand* sledge is used for comparatively light work, and seldom lifted above the head.

The *about* sledge is grasped by both hands at the end of the handle and swung at arm's length over the head, giving the heaviest possible blow.

Sled-knee. (*Vehicle.*) One of those portions of the frame of a sled or sleigh which rest on the runners and raise the fenders and benches a sufficient hight above the ground. (See SLED.) In the example, a rod passes through and is made fast to the sleigh-runner, its upper end protruding through the bottom board and provided with a nut for tightening. A shield protects the rod, and forms suitable bearings for the runner and cross-piece.

Fig. 5174.



Sled-Knee.

Sled-run′ner. One of the curved pieces on which a sled slides. (See SLED.) Sleigh-runner.

Slee. (*Shipwrighting.*) A cradle placed beneath a ship when hauling her up for repairs.

Sleep′er. 1. (*Shipbuilding.*) *a.* A fore-and-aft floor-timber in a ship's bottom.

b. A knee-piece connecting the transom and after-timbers to strengthen the counter. Similar timbers strengthen the bows of whalers.

2. (*Ordnance.*) The undermost timbers of a gun or mortar platform, or, generally, of any framework.

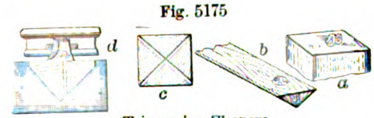
3. (*Carpentry.*) *a.* One of the set of timbers supporting the lower floor of the building. The timbers of the upper floors are *joists.* The sleepers, in a wooden frame, rest on the sills. In a brick or stone house they rest in the walls. This distinction is not always maintained, and they are indifferently called *joists.*

b. One of a set of logs or scantling laid beneath a rough floor, as of a pen, shed, or temporary stable.

4. (*Railway Engineering.*) One of the timbers supporting a railway-track. When it is longitudinal with the track, it is called a *stringer* or *sill*; when it is transverse, it is called a *cross-sleeper* or *tie.* The latter is the usual term in the United States.

To make a super-excellent job, some of the best English railways first used hewn blocks of stone for sleepers (*a*, Fig. 5175). Brunel adopted them on the Great Western Railway, England. It was found that they were too solid and unyielding, and wood is now preferred. It is sometimes *kyanized*, or treated by

Fig. 5175



Triangular Sleepers.

equivalent processes, to render it less liable to decay. See WOOD, PRESERVATION OF. The blocks contained about four cubic feet. Triangular cross-ties *b c d* are *got out* of square balks by ripping diagonally, and are made to rest in longitudinal sills.

This mode looks well on paper, but is costly and subject to decay.

The usual mode is to set cross sleepers beneath the rails, imbedded in a ballast of broken stone. To these *ties* the rails are secured by chairs or spikes; sometimes by chairs at the joints and spikes at intervening points.

The ordinary English sleeper is 9 feet long, 10 inches wide, and 5 inches thick; the distance apart is from $2\frac{1}{2}$ to 3 feet.

On some of the English railways, triangular sleepers are laid in ballast, the angle beneath.

Mr. Holley, in his report on railways, gives the dimensions and intervals of sleepers on nine New York railroads as —

Average number of sleepers per mile.........	2,242
Length in feet (4 feet $8\frac{1}{2}$ inches gage).........	8.07
Width of bearing surface in inches...........	7.02

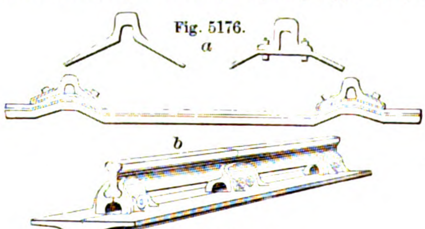
Wooden blocks have been substituted for cross sleepers, and with some success. The object has been to prevent the rocking motion induced by the bearing of the middle of the sleeper on the tightly packed ballast when the support below the rail had been pressed out. The same object was attained in France by cutting the sleepers across at midlength, leaving every twelfth sleeper uncut, to act as a *tie*.

The *sandwich system* of W. B. Adams (England) is a longitudinal support by a timber on each side of the rail, and gripping it beneath the head. The *web* of the rail, which is clasped by the side timbers, is made $\frac{1}{4}$ to $\frac{3}{8}$ inch in thickness, the rail weighing 70 pounds per yard, and being 8 inches deep. It has no appreciable vertical flexure under the passing train, and the longitudinal sleepers are made available for several sets of rails. The rail, being supported by a sleeper beneath the head, does not depend upon the stiffness of the web, which is relieved of lateral strain, being *sandwiched* between the sleepers. The sleepers are secured by bolts and nuts, which pass through holes in the webs of the rails. The rail is double-headed.

By Dimpfel's longitudinal system, the rail is supported beneath its head and foot by continuous longitudinal sleepers.

Seaton's system is also longitudinal, and to insure the perfection he aimed at, requires a heavy rail, being supported by foot

Fig. 5176.



Barlow's Sleepers.

flanges on sleepers with 17 inches breadth of bearing. It is stated that rails of 90 pounds, laid on his system on the London and Northwestern Railway, after the passage of 100 trains daily for two years, showed no signs of abrasion at the joints or elsewhere. See Railway-rail.

Barlow's iron railway-sleeper (English) (*a*, Fig. 5176) is adapted for a saddle-shaped rail, and rests upon iron *ties* or *sleepers*, which have seats for the rails, which are bolted thereto. Like some of the other iron devices, it was intended to preserve the permanent way against the attacks of insects in hot climates.

Fig. 5177.

English Chairs and Sleepers.

Barlow's longitudinal cast-iron sleeper (*b*) has a central line of division and junction; to each cheek the halves of chairs are cast, and these embrace the rail when the halves of the sleepers are bolted together.

Brunton's combined cast-iron chair and sleeper (*c*, Fig. 5177) consists of a base-plate whose flanges prevent horizontal displacement, and whose broad surface rests upon the ballasting of the way. The chair is cast with the sleeper. The sleepers of the respective rails are tied together by bolt-rods.

Greave's chair and sleeper (*d*) consists of a hollow cast-iron frustum, whose upper surface supports the chair. The sleepers are tied across the track by iron rods. This has been used on some railways in England and on the continent of Europe.

Sir Macdonald Stephenson's chair and sleeper is made of punched and bent boiler-iron. The punchings form the slots in which the rails are slipped, and the displayed flanges of the plate form the foot which rests on the ballasting.

Parkins' continuous sleeper for railway-rails, patented in England in 1835, was made of earthen blocks, molded and baked, laid in continuity, tongues and recesses on adjacent blocks serving to lock them together. Samuel's cast-iron, wooden-cushioned sleeper is 42×16 inches, and requires from 100 to 133 tons (of 2,240 pounds) per mile, according to the width of the intervals.

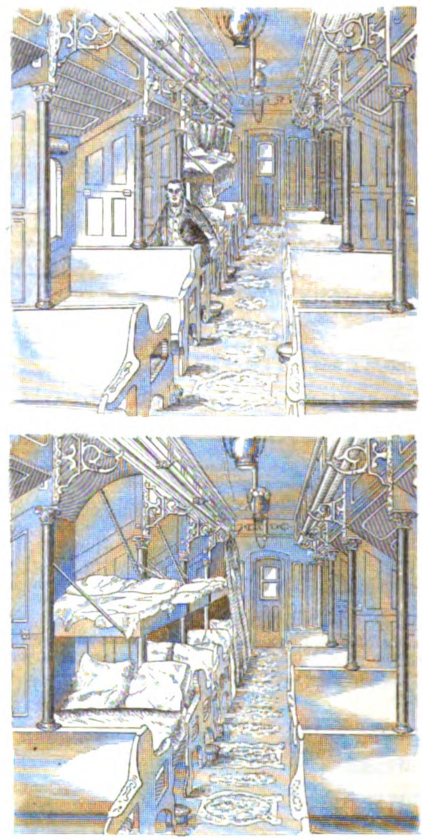
De Bergue's cast-iron sleeper is 20×14 inches, weighs 46 to 56 pounds; each gives nearly two square feet of bearing, requiring 100 tons (of 2,240 pounds) per mile, to give a bearing of $1\frac{3}{4}$ square feet per foot of track. With 20-feet rails, and blocks spaced 30 inches, center to center, this plan requires 22,124 pieces per mile. It was tried in England on several lines.

5. (*Weaving.*) The upper part of the heddle of a draw-loom through which the threads pass.

6. (*Railway.*) Short for Sleeping-car (which see).

Sleep'ing-car. (*Railway.*) A car arranged with berths for passengers during night travel. The seats

Fig. 5178.



Sleeping-Car.

are usually convertible into a lower berth, while an upper berth is let down from the roof.

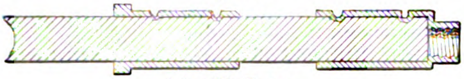
Sleep'ing-ta'ble. (*Metallurgy.*) An apparatus (*tables dormantes* or *jumelles*) consisting of an inclined plane (two such are generally arranged alongside each other), upon which finely pounded ore is washed to concentrate it.

The ore is stirred into a thin mud in a cistern at the head of the incline, and is then allowed to flow in a thin stream, which spreads to a width equal to that of the table: the heavier particles settle first, and the lighter matters pass farther down. The operation is facilitated by brushing the slimes from the lower toward the higher end, which allows the water to wash out light matters which have become entangled in heavier portions of the ore. It is called a *sleeping-table*, because, unlike the *percussion-table*, the *rack*, *frame*, *jigger*, etc., it has no motion.

Sleeve. A tube into which a rod or another tube is inserted. If small, it is often called a thimble; when fixed, and serving merely to strengthen the object which it incloses, it is a reinforce. In the majority of its applications, however, the two parts have more or less relative circular or longitudinal motion.

The example (Fig. 5179) is an axle fitted with sleeves or bushings of brass, which are slipped on

Fig. 5179.



Axle with Sleeves.

the spindle and confined by punching down the brass into countersinks in the spindle. The inner bushing carries a butting collar.

Sleeve-ax′le. A hollow axle running upon an axial shaft.

Sleeve-coup′ling. A tube within which the abutting ends of shafting are coupled together.

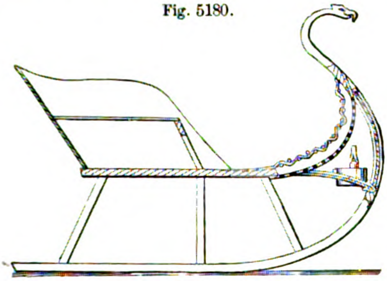
Slee′zy. (*Rope-making.*) Rough from projecting fibers, as yarn or twine made of inferior material.

Sleid. See SLEY.

Sleigh. (*Vehicle.*) A pleasure or passenger vehicle on runners. A somewhat finer vehicle than a *sled.*

Fig. 5180 is a sled with a lamp-stove in front for warming the feet.

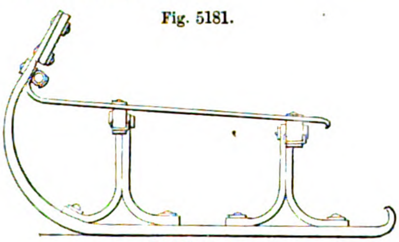
Fig. 5180.



Jumper.

Fig. 5181 is a sleigh-frame, and shows a mode of construction with bent stuff and bolts.

Fig. 5181.



Sleigh-Frame.

Sleigh-bell. A small bell of globular form attached to sleigh harness. The clapper is a ball of iron or bronze.

Fig. 5182.

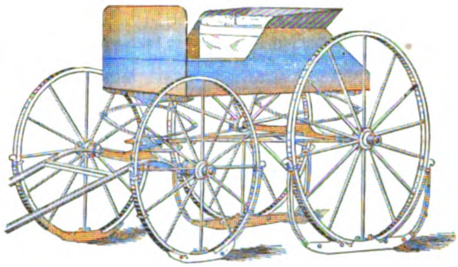
Sleigh-Bells.

Sleigh-brake. See SLED-BRAKE.

Sleigh-run′ner. (*Vehicle.*) One of the curved pieces on which a sleigh slides. See SLEIGH; SLED.

The example shows runners temporarily attached to the wheels of a buggy to make it slide upon snow or ice. The wheels are locked by means of spring straps.

Fig. 5183.



Sleigh-Runner.

Slew′ing. (*Ordnance.*) In serving land artillery, turning the piece on the spot where it stands, equivalent to *training* on shipboard.

Sley. 1. (*Weaving.*) A weaver's *reed.* A frame of parallel vertical slats, between which the warp-threads are passed. The *sley* is mounted in the *batten* or *lathe;* the slats passing between the warp-threads beat the *weft-threads* against the *web* when the batten is swung. See HAND-LOOM.

2. (*Knitting-machine.*) The guide-way of the *slur* or carriage. Any guide-way in a knitting-machine.

Slice. 1. (*Furnace.*) *a.* The instrument used for clearing the air-spaces between the bars of the furnace when they become choked with clinkers.

b. A *peel* or fire-shovel.

2. (*Nautical.*) *a.* A bar with a chisel or spear-shaped end, used for stripping off sheathing or planking.

b. A spade-shaped tool used in flensing whales.

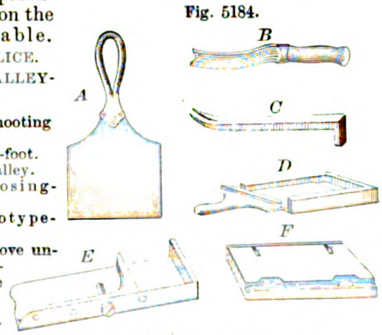
c. A wedge driven between the false keel and the bilgeway, to raise a vessel before launching.

3. (*Printing.*) *a.* A kind of paddle (*A*, Fig. 5184) used for spreading ink upon the inking-table. See INK-SLICE.

b. See GALLEY-SLICE.

B is a shooting stick.
C, sheep's-foot.
D, slice-galley.
E, composing-stick.
F, stereotype-block.
See the above under their respective heads.

Fig. 5184.



Printer's Slices, Sticks, etc.

4. (*Household.*) A broad, thin knife for serving fish at table.

5. (*Pharmacy.*) A round-ended, pliable knife for spreading plasters. A *spatula.*

Slice-bar. (*Furnace.*) A hooked poker for removing slag and cinders from grate-bars of furnaces.

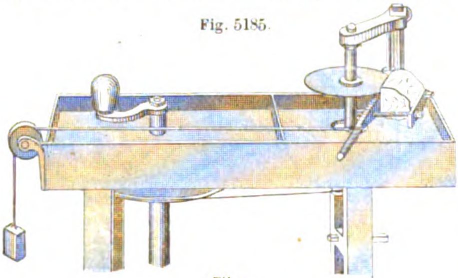
Slice-gal′ley. (*Printing.*) A galley having a movable false bottom or *slice.* *D*, Fig. 5184.

Sli′cer. 1. (*Gem-cutting.*) The circular saw of the lapidary. It is a disk of sheet-iron, revolving in a horizontal plane, and usually about 8 or 9 inches in diameter and $\frac{1}{200}$ inch in thickness. To give it sufficient rigidity, it is hammered into a slightly concave form, about $\frac{1}{8}$ inch in the entire diameter. This does not prevent the cutting of a straight section, as the commencement of a cut is in one plane and the trifling curvature gives way, being flattened

by the kerf it has cut, and in which it is compelled to run.

The slicer is firmly clamped, like a circular saw, between two flanges on its spindle, which is made of such a length that the edge of the slicer may be about three inches above the level of

Fig. 5185.



Slicer

the bench. Diamond-dust moistened with water is employed as an abradant during the cutting process.

In the illustration, the slicer is shown as mounted on the lapidary's bench and the stone mounted on a *crane* which keeps it constantly fed up to the *slicer*. The latter is *seasoned*, and plied with diamond-dust and lubricated with oil of brick.

Slic'ing-ma-chine'. (*Pottery.*) A machine which acts as a substitute for the hand operations called SLAPPING or WEDGING (which see).

It is a kind of pug-mill with an upright axis and cylinder armed with stationary and revolving knives respectively, to cut and masticate the clay. The spiral blades act as a screw, and force the clay out of a lower aperture, where it is sliced into prisms and thrown back into the mixer for a repetition of the process.

In China, the clay is trodden by human feet or by oxen. In various parts of Europe, it is trodden by the feet or worked by mallets or pounders.

Slick. 1. (*Joinery.*) A wide-bitted chisel, used by framers in paring the sides of mortises and tenons.

2. (*Metallurgy.*) A metalliferous slime.

Slick'en-sides. (*Mining.*) *a.* Specula galena, occurring in seams which split asunder when struck by the miner's pick. A Derbyshire term.

b. A seam of clay intersecting a lode and causing a vertical dislocation. Called also *slide*.

Slick'er. 1. (*Leather-working.*) A tool of steel or glass inserted in a wooden stock and used upon leather in process of manufacture.

Fig. 5186.

Slicker.

The steel *slicker* or *stretching-iron* is rounded off at the corners and scraped upon the surface of the leather, under a strong pressure, to remove lumps and inequalities and stretch the leather.

The glass *slicker* is used in rubbing in the coat of size and tallow, in the surface finishing of the leather.

Treating hides with a slicker during the process of currying is shown in the ancient paintings of Kourna, Thebes.

2. (*Founding.*) Or *sleecker*. A small tool, generally of brass, the polished surface of which forms a curve of some kind. Slickers are of various shapes; they are used to slick down the curved surfaces of molds after withdrawal of the pattern, or after blacking, as the trowel adapts itself to the flat parts. The short handle of these tools is a stud at the back, and projects at right angles to the face. The different forms are known as *half-rounds*, *egg-slicker*, *button-slicker*, *angle-slicker*, etc., etc.

Slick'ing. 1. (*Mining.*) A narrow vein of ore.

2. (*Hat-making.*) The attaching of the fur *nap* to the felt body.

Slide. 1. An inclined plane down which logs are driven to a lower level.

The timber slides of the Alpnach in Switzerland are remarkable.

The log chutes of the Ottawa occur occasionally on 200 miles of that river, to avoid stoppage of the logs on the riffles.

2. (*Steam-engine.*) The guide-bars of a box or cross-head.

3. A slip of glass, usually 3×1 inches, on which a microscopic object is mounted. The thin glass for covering the object is made from $\frac{1}{50}$ to $\frac{1}{250}$ of an inch thick. Glass slides are usually of *flatted crown*.

4. A sliding shutter to an aperture, as of a dark-lantern.

5. (*Ordnance.*) The lower part of a ship's carronade or howitzer carriage, on which the top carriage rests and is run in and out. It corresponds to the chassis of a land-fortification carriage.

Slide-box. (*Steam-engine.*) A slide-valve chest.

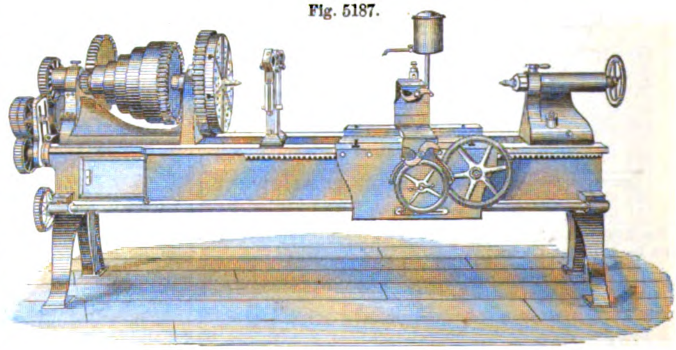
Slide-case. (*Steam-engine.*) The chamber in which the sliding valve operates.

Slide-head. (*Machinery.*) A device for supporting a tool or piece of work in a lathe, etc.

Slide-lathe. The lathe of the metal-worker, in which the tool-rest is caused to traverse the bed from end to end by means of a screw.

That shown (Fig. 5187) has the screw cutting and turning feeds so arranged that one may be changed for the other. The

Fig. 5187.



Slide-Lathe.

larger sizes have a compound slide-rest and automatic cross-feed. The bottom rest has a quick hand traverse, and the screw is supported throughout its length. See SCREW-CUTTING LATHE, etc. See lists under LATHE; METAL-WORKING TOOLS. See also SLIDE-REST.

Slid'er. 1. (*Vehicle.*) A bar which unites the hind ends of the fore hounds and slides under the coupling-pole.

A double slider has a bar above and below the coupling-pole. Called also *sway-bar*.

2. (*Locksmithing.*) A horizontally moving tumbler.

Slide-rail. (*Railway Engineering.*) *a.* A contrivance used in England for shunting cars. A *railway-slide*. It consists of a platform on wheels running transversely across the tracks, and carrying a car from one line of rails to another without *switching*.

b. A switch-rail.

Slide-rest. (*Machinery.*) A tool-rest employed

for lathes, planing-machines, etc., in which the tool is securely clamped to a plate capable of motion in one or several directions by means of screws.

In 1648, engravings published at Rome by Maignan show lathes for turning the surfaces of mirrors, in which the tool was guided by frames so adjustable as to form plane, spherical, or hyperbolical surfaces.

The wheel-cutting engine and fusee-cutting engine of Dr. Hooke, invented about 1655, had mechanical devices for guiding the tools. These, as well as the screw-cutting lathe of Hindley, 1741, and other machines having similar contrivances, were particularly constructed for the use of clockmakers, who were the first to employ special machines in their business.

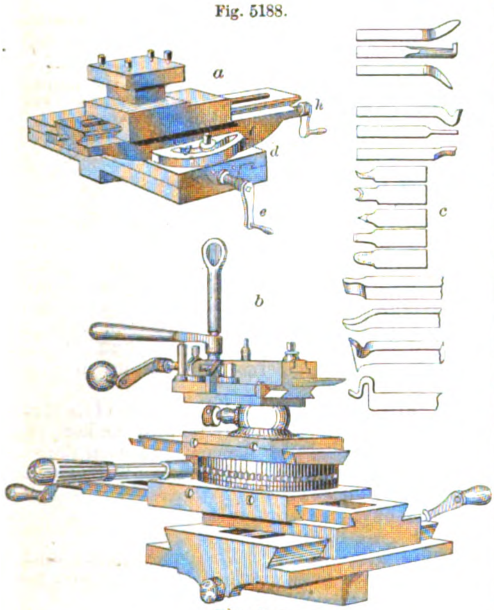
The first instance of the true slide-rest is shown in the French Encyclopédie. This very nearly corresponds with that usually employed in lathes for amateurs by London makers. It was adapted to the purposes of machinery by General Sir Samuel Bentham, who attached it to lathes built for the British Admiralty previous to 1800. The slide-rest is the origin of the planing-machine for metal. Bentham was also the inventor of the first planing-machine for wood, patented in England in 1791, but invented by him in Russia some years previous. The slide-rest is described in his patent of 1793.

Nasmyth ascribes the invention of the automatic slide-rest to Henry Maudslay, who certainly greatly improved the lathe. Maudslay was the pupil and workman of Bramah, and the instructor of Nasmyth and Clements.

Before the invention of the slide-lathe, the turning-lathe depended for its accuracy upon the steadiness of the muscles of the workman. By fixing the turning tool in a rest which is movable accurately in one or another direction, or a line compounded of the two, mathematical accuracy of workmanship is obtained. Bramah himself patented a slide-rest in 1794.

In Fig. 5188, *a* is a slide-rest for the foot-lathe. It has a feather fitting between the two cheeks of the lathe-bed, to which it may

Fig. 5188.



Slide-Rest.

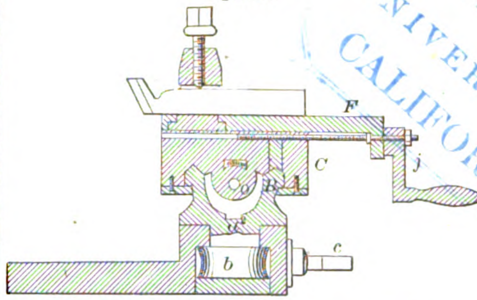
be firmly secured by a bolt. The sliding-plate *d* may be moved laterally by the handle *e*, which turns a screw; the slide *f* may be adjusted angularly by means of the slotted arc and nut *g*, and carries the rest, which is moved longitudinally by a screw and handle *h*. The tool, being clamped in the holder, may be moved in a longitudinal, transverse, or circular direction, as required by the character of the work.

b is the *spherical slide-rest*. This is provided with two additional slides for greater facility of adjusting the tool-holder to varying changes of position required in operating on curved and irregular forms.

c are tools used with the side-rest in hand and power lathes.

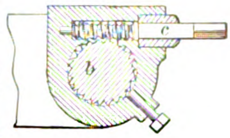
In Fig. 5189, the point of the tool is set at any desired angle with the axis of the lathe by a worm *c* engaging a worm-wheel *b* on the spindle a^2 projecting from the lower part of the bed *B*. The bed *B* and head *C* turn together, carrying with them the tool-holder *F*, which is advanced toward the work by a screw operated by the crank *j*.

Fig. 5189.



Slide-rod. (*Steam-engine.*) The rod which operates a slide-valve.

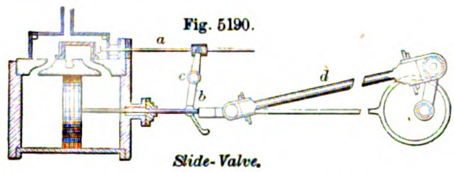
Slid'er-pump. A form of Rotary Pump (which see).



Slide-Rest.

Slide-valve. A valve which opens or closes by sliding over the port or ports. The valve-rod *a* is operated from the crank-shaft of the eccentric by an intermediate lever *b* pivoted at *c*; as the pitman *d* advances by the down stroke of the piston, the valve is drawn back, open-

Fig. 5190.



Slide-Valve.

ing the lower port, which then becomes the eduction-port, and *vice versa*.

The *long slide*, of large condensing-engines, is a slide-valve of such length as to govern the ports at the ends of the cylinder, and thereby bring them alternately in connection with the middle or bridge part at which the steam is inducted, and with the open part of the valve-chamber, which has a connection, through the hollow back of the valve, with the eduction passage to the condenser. The long slide was invented by Murdoch, of the firm of Boulton and Watt.

The slide-valve was substituted for the steam-cock by Murray, of Leeds, England, in 1810.

The slide-valve is placed in the steam-chest to work over the steam-ports by which live steam from the boiler is admitted to the cylinder, and exhaust steam from the latter is allowed to pass to the condenser or to atmosphere, as the case may be. Its form is arched, and it has a flat face all round, which works steam-tight on the valve-seat.

The arched cavity in the valve is constantly in connection with the steam-induction pipe *s*, and the live steam from this cavity is alternately admitted at the ports *a* and *b* as the valve shifts. Fig 5191.

In the three figures the valve is shown *in situ* at the respective ends of its stroke and detached.

At *A*, the steam admitted at *s* passes by the port *b* below, and elevates the piston, the latter driving before it the exhaust steam, which is educted at the port *a*, and passing through or around the valve, departs by way of the escape-pipe *e*, which is secured by flanges and bolts *o p* to the end of the steam-chest.

The valve-rod *t* is secured by a collar and nut *d* to the valve, and passed through a stuffing-box in the cap *m* of the steam-chest.

While the faces *h* of the valve slip upon the seat, the back of the valve has depressions *k k*, which contain a packing, so as to bear against the top plate of the chest.

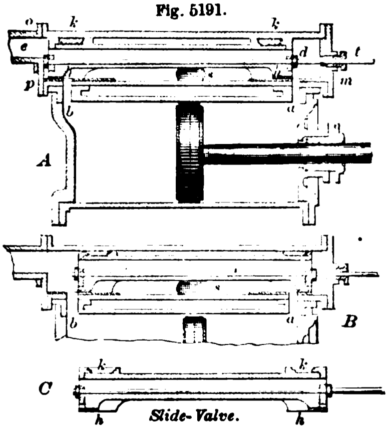
B shows the valve at the other end of its stroke, the port *b* being the eduction, and the port *a* the induction.

C shows the valve detached and destitute of packing in the recesses *k*.

The *balanced* slide-valve, so called, is one in which the steam pressure which keeps the valve on its seat is partially relieved by an upward pressure of steam on the under side, or by a plate, which prevents access of steam to the larger portion of the upper area of the valve.

The *lead* is the width of opening of the steam-port when the

Fig. 5191.



piston is at the end of its stroke. It may be effected by turning the eccentric on the axle a little in front of the crank.

The *lap* is *inside* or *outside*. The former is the difference between the width of the shell part of the valve and the distance between the inside edges of the adjacent ports. The *outside lap* is the excessive breadth of the valve over the width over all the ports.

The *travel* is the length of stroke of the valve.

The *setting* is the arrangement of the eccentric to give the requisite *lead*.

Slide-valve Cal'cu-lat'or. Caldwell's slide-valve calculator is a table with vertical, radial, and circular lines, and a revolving templet, giving all calculations relating to the action of the slide-valve. The following points may be deduced by its use, being read off at sight: —

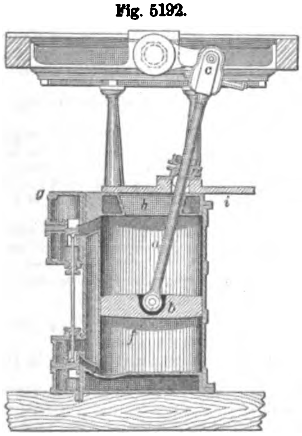
1. The proper travel of valve to produce certain results.
2. The proper lap to cut off at given part of stroke.
3. The proper lap to exhaust at given part of stroke.
4. The proper lap to cushion at given part of stroke.
5. The proper lap to cut off equal on each side of piston.
6. The proper lap to exhaust equal on each side of piston.
7. The proper lap to cushion equal on each side of piston.
8. The proper width of exhaust port to prevent back pressure.
9. The proper lead to give the valve.
10. The proper amount of opening for admission of steam.
11. The position of eccentric on shaft.
12. The relation of valve to piston at every part of stroke.

These points are ascertained at sight.

Slid'ing-cov'er Steam-en'gine. Parkyn's sliding-cover steam-engine (English) has an oscillating piston-rod connected directly to the crank-pin.

a is the piston-rod, which also serves as a connecting-rod, being attached at the lower end to the piston *b*, and at its upper end to the crank-pin *c*. *d* is a recess in the piston *b* for the reception of the lower end of the rod *a*, which is united to the piston by a cross-pin *f*.

Fig. 5192.



Sliding-Cover Engine.

As the rod *a* oscillates in a vertical plane according to the motions of the crank, an elongated slit *h* is made in the cylinder-head *g* in a line parallel with the crank. Over this is a supplementary, steam-tight cover *i*, which slips back and forth on the head *g*, in accordance with the varying positions of the crank and connecting-rod. The upper portion of the stuffing-box has two arms, which turn in suitable bearings in the sliding-cover as the latter moves to and fro.

This is one form of *direct-action steam-engine*, and was invented to avoid the use of the beam in marine engines.

Slid'ing-gage. An instrument used by mathematical-instrument makers for measuring and setting off distances.

The gages used by carpenters and artificers generally are on the sliding principle, though some instruments to which the term "gage" is applied turn on a joint, and others are rigid and immovable in their parts.

Slid'ing-gun'ter. (*Nautical.*) A mast with means for mounting on the after side, used with royals, skysails, etc.

Slid'ing-keel. (*Nautical.*) A movable keel capable of being extended below the usual one, to allow the vessel to carry more sail and to diminish the leeway, and to give to a flat-bottomed vessel or one of small draft the steadiness under sail of a vessel of considerable depth of hull.

The *lee-board* has for many years been used by the Dutch navigators, being launched over the lee side of a vessel to prevent drifting when sailing on a wind.

At what period the lee-board was transferred from the lee side to the center, being lowered in a fore-and-aft well amidships, is not known to the writer. It was introduced into England by Admiral Schank, probably from Holland, and was first applied to a government exploring-vessel destined for New Holland. The wide and strong board which formed the sliding-keel was connected to three vertical planks, which slipped up and down in wells, and were raised and lowered by racks and pinions.

Willoughby made a massive iron keel suspended by iron bars, which slipped in vertical wells amidships. The bars were worked by racks and pinions, as before. The heavy keel acted as ballast.

Shuldham's metallic sliding-keel (English) is of a somewhat triangular shape, and is pivoted at its apex forward. When lowered, the after end is deepest in the water, and resembles the ventral fin of a fish. It moves in a longitudinal well amidships, passing through the true keel. See CENTER-BOARD.

Slid'ing-pul'ley. (*Machinery.*) A kind of coupling in which the band-pulley is slipped into or out of engagement with an arm firmly attached to the shaft and rotating therewith.

Slid'ing-rule. A scale having two graduated parts, one of which slips upon the other. The numbers are so arranged that when a given number on one scale is made to coincide with a given number on the other, the product or some other function of the two numbers is obtained by inspection. It is used for gaging and mensuration. See GUNTER'S SCALE.

Slid'ing-scale. A rule with a sliding member. A *sliding-rule.*

Slid'ing-way. (*Shipbuilding.*) One of the structures on each side of and parallel with the keel, supporting the bilgeways of the cradle whereon the vessel rests in launching. The sliding-ways are the inclined planes down which the vessel slides, and are made of planks 3 or 4 inches wide, laid on blocks of wood. See LAUNCH.

Slime. (*Metallurgy.*) The common name among miners for the mud obtained by wet grinding or stamping the ores of the precious metals.

Slime-pit. (*Metallurgy.*) A reservoir in which water passes slowly to its exit, depositing metalliferous slime. A *labyrinth.* A *buddle-hole.*

Slime-sep'a-rat'or. (*Metallurgy.*) A machine for operating upon slime or metalliferous mud from the stamping-mill. The slime is disseminated in an ascending current of water which floats upward the lighter portions, while the metalliferous matters sink to the bottom. See SEPARATOR.

Sling. 1. (*Weapon.*) A short leathern strap having a string secured to each end, by which a stone is hurled.

The stone lying in the strap, which has a central aperture to receive it, the sling is rapidly whirled, the ends of the two strings being held in the hand, and when one string is released, the stone flies off

at a tangent. The velocity is computed from the length of the radius and rate of revolution.

The sling is a weapon of great antiquity, and is still used among some barbarous nations. About 1406 B. C., when the first great dissension occurred among the Israelites, we read that among the 26,000 Benjaminites were "700 chosen men, left-handed; every one could sling stones at an hair-breadth and not miss." Young David was a skillful slinger.

The sling was used by the Phœnicians, Egyptians, and Persians. By the early Greeks it appears to have been but little known, but the light troops of the later Greeks and Romans consisted largely of slingers. The missiles were usually stones, but cast plummets were also used by the Greeks. Such are found on the plain of Marathon.

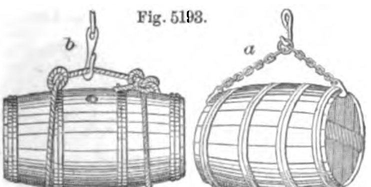
Stones hurled by hand without slings were often used. The Libyans carried three spears and a bag full of stones.

The inhabitants of the Balearic Isles were famous slingers in the time of Strabo.

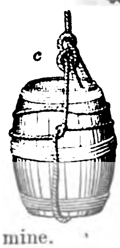
The Huguenots used slings at the siege of Sancerre, 1672, to economize powder.

2. (*Hoisting.*) A device for holding articles securely while being hoisted or lowered. It is usually

Fig. 5193.



Slings.



of rope, but frequently a chain having hooks at its ends and a ring, through which to pass the hook of the hoisting-rope, is employed, as *b*, Fig. 5193.

a c severally represent rope arrangements for slinging a cask on its side and in an upright position.

Fig. 5194 represents a sling for lowering or raising horses in the shaft of a mine.

Fig. 5194.

Horse-Sling.

For embarking or disembarking horses or cattle, the slings have a canvas band which forms a cradle for the animal.

3. (*Nautical.*) The chain, clamp, or rope which supports a mast. To sling the yards for action is to secure them at the slings by iron chains fitted for the purpose.

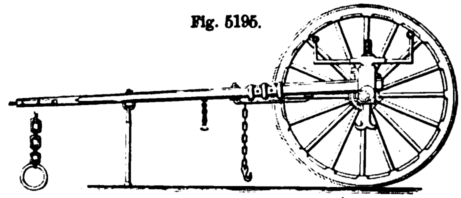
4. The strap by which a rifle is supported on the shoulder.

5. (*Surgical.*) A looped bandage or handkerchief placed around the neck to support a wounded arm.

Sling-cart. (*Ordnance.*) A two-wheeled vehicle used for transporting cannon, etc., short distances.

It has a strong, upwardly curved iron axle, through which passes a perpendicular elevating-screw. The

Fig. 5195.



Sling-Cart.

breech of the gun is slung beneath the axle and the muzzle beneath the pole, and it is raised from the ground by turning the screw.

A four-wheeled vehicle of substantially similar construction, called a *sling-wagon*, is used for transporting heavy blocks of stone, timbers, castings, shafts, and steam-boilers. The coupling-bar of the hind part of the wagon being elevated, the sling-chain is placed around the boiler; the coupling-bar being now pulled down, the chain winds on the hind axle and lifts the load. The bar is then secured to the fore carriage.

Sling-dog. An iron hook with a fang at one end and an eye at the other for a rope. Used in pairs for hoisting, hauling, rafting, etc.

Slip. 1. (*Hydraulic Engineering.*) An inclined plane on which a vessel in its cradle is supported while on the stocks building, or upon which it is hauled for repair. It may be considered that the inclined planes upon which the galleys and triremes of the ancients were hauled were *slips*. Also the planes on which they were hauled or launched at the *diolcos* or drawing-place on the Isthmus of Corinth, in their passage from the Corinthian to the Cenchræan Sea, avoiding the stormy and dangerous passage around the Peloponnesus.

Until the introduction of the heavy vessels of modern times, slips consisted of inclined planes about 220 feet in length, the bottom projecting into the sea and terminating in a timber platform. The inclination or rise was equal to $1/14$ of the length, being about 5 inches in 6 feet. They were adapted for receiving vessels drawing 16 feet of water, which were lightened for the purpose.

Morton's slip (English), patented 1818, has been put down in many of the ports of Britain. Its chief feature is in placing a complete wheel-truck underneath the bottom of the vessel, the truck having a long, straight beam extending beneath the keel of the vessel, with blocks fitted upon it for the keel to rest upon. The support is blocked up to the keel, so that the latter is not strained when out of the water. The truck is borne by three parallel inclined rails by the intervention of numerous wheels. The ship is kept in perpendicular position by a cross-bearer, upon which are blocks adapted to the curvature of the sides of the vessel, forming a cradle. The slip is hauled up the inclined plane by tackle and capstans, pawls falling into a middle rack to sustain the purchase.

Clark's radiating railway for the repairing of vessels, New York, 1827, was of the nature of a turn-table, so that when a vessel was raised on the inclined water-slip and drawn on to the turn-table, it might be partially rotated and then slipped off to one of a circular series of slips, which might each be occupied by a vessel undergoing repair, while but a single slip sufficed for drawing up and launching.

2. A space between wharves or jetties, in which ships or ferry-boats may lie to receive or discharge cargo or passengers.

A ferry slip is usually provided with a landing platform, the landward extremity of which is attached to the edge of the quay by movable hinge-joints, admitting of its free vertical oscillation. The seaward extremity of this platform rests on a floating tank, and has the same elevation above the surface of the water as the deck of the ferry-boat. The outer extremity of the platform, which rests on the floating tank, is thus elevated or depressed with the rise and fall of the tide, but always remains on a level with the steamboat's deck, and affords during high-water a level road, and during low-water an inclined plane, for the passage of carriages and passengers between the vessel and the land.

3. (*Nautical.*) The difference between the speed of the propeller and that of the vessel, being due to the retreat of the resisting body under the impact of the propeller. The speed of the vessel being deducted from the speed of the propeller gives the *slip*.

Negative slip, as it is called, is when the speed of the vessel is apparently greater than that of the propeller. This occurs when, owing to the bad lines of the vessel, a body of dead water is created, which follows in the wake of the ship.

4. (*Porcelain.*) *a.* Fluid material for making porcelain. It consists of finely ground flint or of clay. The flint is calcined, stamped, and ground in water in a GRINDING-VAT (which see), a machine resembling the *arrastra*. Clay is mixed with water and mechanically divided until it makes a creamy fluid.

Slip is strained through silk sieves called *lawns*. A pint of slip weighs from 24 to 32 ounces, according to material. It is evaporated to the required consistence in pans, called *slip-kilns*, and then cut, pressed, and plasticized, by *slapping* or in a pug-mill, and stored in heaps or cellars to age or ripen.

b. The colored clays used to fill up the depressed pattern in the face of a tile, which is to be ornamented by encaustic.

5. (*Printing.*) Matter in column is printed from the *galley* on slips of paper, for revision and amendment, where the corrections are likely to be extensive, requiring additions or removals which would affect the paging.

6. (*Bookbinding.*) The end of the twine to which the sheets are sewed, serving to attach the book to the boards.

7. A leash.

8. A quantity of yarn.

9. The fine mud from a grindstone trough.

10. (*Mining Engineering.*) A dislocation of a seam or lead, destroying continuity. A *shift*. See FAULT.

Slip-dock. (*Shipbuilding.*) A dock whose floor slopes toward the water, so that its lower end is in deep water and its upper end above high-water mark. On the floor of the slip are four parallel rails to support the *cradle*. See SLIP, 1.

Slip-hook. (*Nautical.*) A hook which grasps a chain-cable by one of its links, and may be disengaged or *slipped* by the motion of a trigger, a sliding ring, or otherwise.

Slip-kiln. (*Porcelain.*) An oblong trough of stone or brick, bottomed with fire-tiles, and heated by a furnace beneath. Its length is 20 to 50 feet, breadth 2 to 6 feet, depth 8 to 12 inches. It is used for evaporating *slip* to a workable consistence, after which the clay is *milled;* that is, plasticized by working in a pug-mill.

Slip-knot. (*Nautical.*) A knot which slips around the line or rope around which it is made. A *slip-noose*.

Slip-link. A connecting link which allows a certain freedom of motion.

Slip'per. 1. A covering for the foot; it does not extend so high up as the ankle-joint, and is unprovided with a fastening, so as to be easily drawn on or off.

Slippers were commonly used by the Greeks and Romans (*crepida*). They were made to fit either foot indifferently. Boots were made rights and lefts.

2. A brake-shoe for a wheel in descending a hill.

Slip-rope. (*Nautical.*) A rope by which a cable is secured preparatory to slipping the cable.

Slip-shack'le. (*Nautical.*) One having a lever-bolt which may be let go suddenly when required.

Slip-stop'per. (*Nautical.*) Apparatus for suddenly letting go the anchor out of its lashings when it is required to drop it.

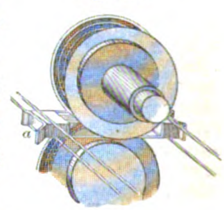
Slip-way. (*Shipbuilding.*) One of the pair of parallel, inclined platforms of timber, firmly founded on the floor of the slip and kept steady in their positions by shores. Their inclination varies from 1 in 12 for small ships to 1 in 24 for the largest. The breadth may be 4 feet and under, according to the size of the vessel. See LAUNCH.

Slit-deal Plane. (*Joinery.*) A tonguing or grooving plane.

Slit-nose Bit. See NOSE-BIT.

Slit'ter. A machine for shearing up sheet-iron into slips for nail-rods, etc. It has a series of steel disks with very sharp edges, with a groove between them of about two inches in depth, into which the disks of another roller fit. A piece of sheet-iron being passed through the guides *a* is divided into a number of strips corresponding to the number of grooves.

Fig. 5196.



Slitter.

Slit'ting-file. A file with two acute and two obtuse edges and parallel sides. Its cross-section is a rhomb, whose longer diagonal has, say, three times the length of the shorter one. A *lozenge*-shaped file.

Slit'ting-gage. (*Saddlery.*) A tool used to cut straps of any given width from the hide. Driving lines, reins, and all the various straps which go to form harness are thus cut from the sides of leather. The stem of the gage is marked in inches and eighths, and the set-screw holds it at the desired adjustment.

Fig. 5197.

Slitting-Gage.

Slit'ting-ma-chine'. 1. (*Metal-working.*) A machine for cutting plate-metal into strips for nail-rods or other purposes. Fig. 5196.

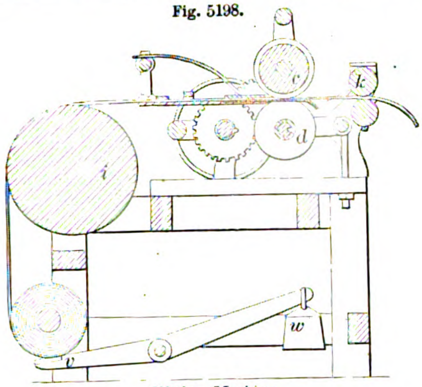
An apparatus of this kind is said to have been introduced by Godfrey Bochs, 1590.

It is related that a man named Foley, a fiddler, living near Stourbridge, first introduced slitting machinery into England from Sweden, where its employment gave great advantages to the Swedish nail-makers over their English brethren. He visited Sweden, and fiddled his way into the iron-works, where he managed to pick up a knowledge of the methods employed. Returning to England, he, with associates, erected a slitting-mill, but when everything was completed the machinery would not work. Nothing discouraged, Foley revisited Sweden in his rôle of fiddler, when he succeeded in obtaining lodgings within the works, where he had an opportunity of making rough drawings of the machinery, with which he returned to England and put his mill in successful operation.

The construction of the machine is essentially similar to that of the iron-rolling machine. Two spindles carry a series of steel-faced disks, which work against each other, dividing thin plates of iron about 6 inches wide into a number of rods, from which the nails are made. Similar rods are also made of larger sizes. They always exhibit two ragged edges, and from the fact of being put up in bundles, they are frequently termed bundle-iron.

2. (*Leather.*) A machine for cutting leather into strips or thongs. That illustrated is designed for dividing wide strips into narrow ones to be used in shoe-binding. The strip is wound upon a roller, passes over a drum *i* on to a table and beneath a flat guide, where it is presented to the action of a series of cutting-disks *c d*, and is divided into ribbons which are drawn through two rollers, shown at *k*.

Fig. 5198.



Slitting-Machine.

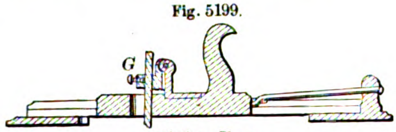
A lever *v* with weight *w* keeps the strip taut while being unwound.

Slit'ting-mill. 1. (*Gem-cutting.*) A very thin sheet-iron disk, the edge of which is charged with diamond-powder and lubricated with brick-oil, mounted on a stand and revolved by a treadle or otherwise. Used by lapidaries in *slicing* or *slitting* gems, stones, porcelaneous shells, porcelain, and other materials, previous to grinding and polishing. See LAPIDARY'S MILL.

2. (*Metal-working.*) A machine in which iron plates are slit into nail-rods. See SLITTING-MACHINE.

Slit'ting-plane. (*Carpentry.*) A tool for cutting boards, etc., into strips. In the example, the board is cut into thin slices by being passed under

Fig. 5199.

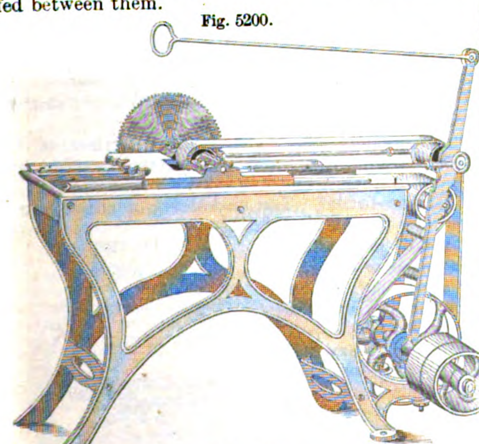


Slitting-Plane.

a cutter *G* arranged vertically to a hinged holder on a sliding stock moving on ways at each end and having a retracting spring.

Slit'ting-roll'er. One of a pair of coäcting rollers, having ribs which enter intervening spaces on the companion rollers, and cut into strips material fed between them.

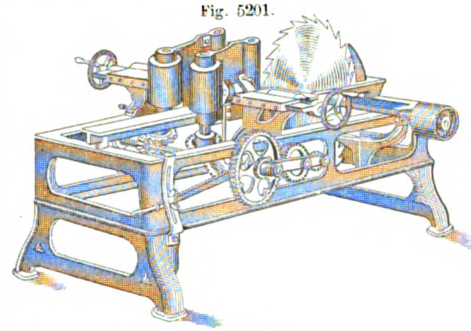
Fig. 5200.



Slitting-Saw

Slit'ting-saw. (*Wood-working.*) A machine for slitting scantling, boards, etc., into thin planks. It is provided with self-acting feed-rollers and adjustable table, and is, in general construction, similar to the RESAWING-MACHINE (which see). It fre-

Fig. 5201.

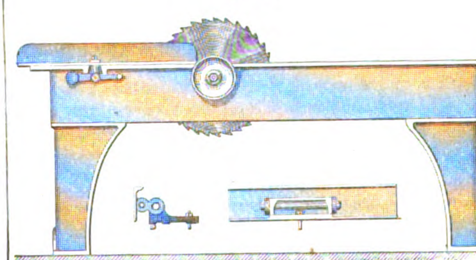


Slitting-Saw.

quently has a gang of saws for sawing the second way, and is applicable to a variety of uses, such as making lath, pickets, blind-slats, etc., from the bolt, effecting a great saving in labor over the ordinary method of doing such work with a single saw.

Fig. 5201 is a geared machine of this class, adapted for heavier work than that illustrated in the preceding cut, and Fig. 5202 a machine having a hand-feed.

Fig. 5202.



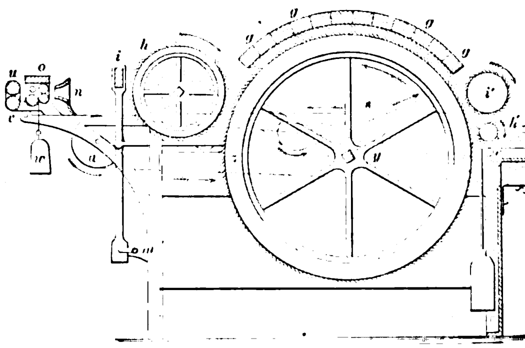
Slitting-Saw with Hand-Feed.

Sliv'er. (*Fiber.*) A continuous strand of cotton or other fiber in a loose, untwisted condition, ready for *slubbing* and *roving*, preparatory to being spun. The process is effected by the *finishing-card.*

The carding-machine (Fig. 5203) receives the roller from the lapping-machine in the grooves *a*, resting at the same time upon the roller *b*, which turns it by friction, so as to unwind the fleece or *lap*. This is conducted over the table *c*, between the two nipping or feed rollers *e*, where it is caught by the card-drum *z*, covered with the card-cloth in strips, parallel with its axis; *h'* is the *small runner*; *i'*, the *large runner*; *g g g g*, the flat *top-cards*; *h*, the *doffer-card*, which takes the fleece off the main drum, and which in turn is cleared by the *doffer-knife i*. This knife receives a very fast up-and-down motion from the crank *m*, by which it peels a gossamer-like fleece from the doffer-card. It is actually a comb, with very fine teeth, which penetrate slightly between the wire of the card as it moves downward. The fleece thus separated from the card is then drawn together through the tin funnel *n*, so as to form a narrow band or *sliver*, and is thus presented to the *drawing-rollers* at *o*. The front pair of these, being driven with a slightly greater velocity than those behind, draw the sliver through faster than it is delivered by the latter, and by this means attenuate the same. This action brings about a still greater parallelism of the fibers, which is repeated in every subsequent machine. The top rollers are pressed down upon the lower ones by the weight *w*. The rollers *u v* deliver the drawn sliver into cans, ready for the drawing and doubling process.

Sliv'er-box. The machine in which slivers of

Fig. 5203.



Finishing-Card.

long-stapled wool are lapped on each other and then elongated. It is like the drawing-frame of the cotton manufacture, except that the slivers of worsted being made by hand-cards, taper toward each end and are not continuous. Each sliver is laid upon the one preceding, so that its end reaches to the middle of the one in advance. The rate of acceleration of the relative speeds of the pairs of rollers is such as to make a uniform sliver eight times the length of the slivers as fed into the first pair of rollers.

Sliv′er-ing-ma-chine′. (*Wood-working.*) A machine for cutting splints, slivers, or shreds of wood for various purposes.

a. Narrow thin slats for making woven window-blinds in which slats form the weft.

Slats or scaleboard of thin wood, capable of being worked up into boxes for millinery, collars, small fruit, and what not.

Splints for making up into baskets.

Free's machine for cutting slats for blinds has a knife set in a reciprocating stock, which moves below the block to be worked; the knife-carriage on its return strikes a lever connected to a pawl that operates gear-wheels to feed down the block of wood for the next cut. See SLAT-MAKING MACHINE.

See also splint-cutting machine patents: —

2,289. Gleason, Oct. 9, 1841.	101,021. Jordan, Mar. 22, 1870.
19,971. Wheeler, April 13, 1858.	115,110. Scow, May 23, 1871.
26,268. Horton, Nov. 9, 1859.	138,378. Clark, April 29, 1873.
28,470. Grant, May 29, 1860.	

b. Finely shredded wood to serve as a substitute for curled hair for upholstery purposes. Known as *excelsior*.

Machines for slivering wood into small shreds, called *excelsior*, usually make two cuts; one to sever a scale, and the other to split the scale into shreds. Taggart's machine, January 23, 1866, has a rotary annular plane with a series of plane-bits and scoring-cutters thereon, and above which is a cylinder having a series of block-holders, so arranged that the blocks will fall on the annular plane after the action of each plane-bit and scorer, so that the whole block will be cut and scored into fine fibers.

Brooks and Clements' excelsior machine, March 25, 1868, is also a rotary shredder. The bolt is pressed downward within its fixed case by a weighted lever, and subjected to the action of the scoring and plane cutters at the upper surface of the horizontal rotating wheel. See Fig. 1897, page 815.

See excelsior machine patents: —

2,654. Baker, May 30, 1842.	93,428. Folsom, Aug. 10, 1869.
10,893. Prescott, May 9, 1854.	111,415. Wolff, Jan. 31, 1871.
12,424. Smith and Cowles, Feb. 20, 1855.	118,289. Smith, Aug. 22, 1871.
26,791. Skinner, Jan. 10, 1860.	120,866. Felber, Nov. 14, 1871.
27,597. Noyes, Mar. 20, 1860.	128,970. Mayo, July 16, 1872.
39,747. Post, Sept. 1, 1863.	131,147. Brackett, Sept. 10, 1872.
75,728. Brooks and Clements, Mar. 24, 1868.	136,529. Mayo, March 4, 1873.
	151,742. Bailey, June 9, 1874.

Sloam. (*Mining.*) A layer of earth between coal-seams.

Sloates. (*Vehicle.*) The cross slats in the frame forming the bottom of a cart or wagon bed.

Sloop. (*Nautical.*) *a.* A fore-and-aft rigged vessel with one mast, like a cutter, but having a jib-stay and standing bowsprit, which the cutter has not.

b. Formerly a ship of war of a size between a *corvette* and a *brig*.

War-vessels of 2,000 tons and upward, as large as line-of-battle ships in the days of Howe and Nelson, carrying 12 to 22 heavy guns, are now termed sloops.

Slop. (*Pottery.*) See SLIP.

Slope. 1. (*Civil Engineering.*) An inclined bank of earth on the sides of a cutting or an embankment. The slope is of varying angle, according to the nature of the soil and the hight of the slope.

The allowance is about as follows: —

Gravel, sand, or common earth, cuts, or banks, of less than 4 feet	1	base to 1 vertical.
Clay, cuts, or banks of less than 4 feet	2	base to 1 vertical.
Earth, of mixed sand and clay, cuts, or banks of 4 to 15 feet	1½	base to 1 vertical.
Pure gravel or sand, cuts, or banks of 4 to 15 feet	2	base to 1 vertical.
Clay, in banks of 4 to 15 feet	2	base to 1 vertical.
Stratified clay and sand, cuttings of 4 to 15 feet	3	base to 1 vertical.
Broken rock, in banks over 15 feet high	1½	base to 1 vertical.
Earth, of mixed sand and clay, cuts, or banks over 15 feet high	2	base to 1 vertical.
Pure gravel or sand, cuts, or banks over 15 feet high	2	base to 1 vertical.
Clay, cuts, or banks over 15 feet high	3	base to 1 vertical.
Stratified clay, in cuttings over 15 feet high	3 to 4	base to 1 vertical.

A *revetment* or retaining wall at the base of the slope saves excavation. The natural, strongest, and ultimate form of a slope is a curve, in which the flattest portion is at the bottom. Cultivation, sodding, and draining are preservatives.

Table representing the ratio of the horizontal to the perpendicular of certain angles of slopes: —

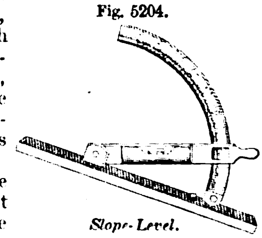
Angle.		
75° 58′ =	¼	horizontal in 1 perpendicular.
63° 28′ =	½	horizontal in 1 perpendicular.
53° 8′ =	¾	horizontal in 1 perpendicular.
45° =	1	horizontal in 1 perpendicular.
38° 40′ =	1¼	horizontal in 1 perpendicular
33° 42′ =	1½	horizontal in 1 perpendicular.
29° 44′ =	1¾	horizontal in 1 perpendicular.
26° 34′ =	2	horizontal in 1 perpendicular.
23° 58′ =	2¼	horizontal in 1 perpendicular
21° 48′ =	2½	horizontal in 1 perpendicular.
19° 59′ =	2¾	horizontal in 1 perpendicular.
18° 26′ =	3	horizontal in 1 perpendicular.
17° 6′ =	3¼	horizontal in 1 perpendicular.
15° 56′ =	3½	horizontal in 1 perpendicular.
14° 55′ =	3¾	horizontal in 1 perpendicular.
14° 2′ =	4	horizontal in 1 perpendicular.
13° 15′ =	4¼	horizontal in 1 perpendicular.
12° 32′ =	4½	horizontal in 1 perpendicular.
11° 53′ =	4¾	horizontal in 1 perpendicular.
11° 19′ =	5	horizontal in 1 perpendicular.
10° 47′ =	5¼	horizontal in 1 perpendicular.
10° 18′ =	5½	horizontal in 1 perpendicular.
9° 52′ =	5¾	horizontal in 1 perpendicular.
9° 27′ =	6	horizontal in 1 perpendicular.

2. (*Mining.*) The dip or inclination of a stratum or vein of ore.

3. (*Fortification.*) The inclined surface of the interior, top, or exterior of a parapet or other portion of a work. See PARAPET.

Slope-lev′el. The slope-level or clinometer is used for determining the angle of embankments, the grade of roads, pitch of roofs, fall of water-courses in some cases, and, by sights on the base-piece, may be adjusted to measure angles of elevation.

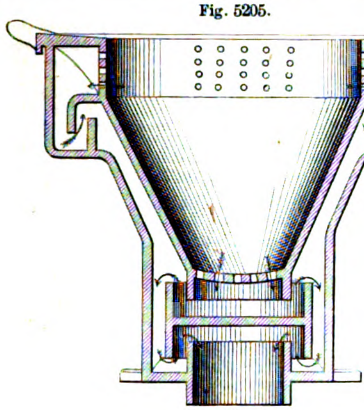
Fig. 5204.



Slope-Level.

Slop-hop′per. The basin of a water-closet or sink. The example

Fig. 5205.



Slop-Hopper.

shows one whose inner hopper has a marginal trap in a trough of the casing and a lower one in the double cup, whose recess beneath forms a trap over the exit-pipe. See WATER-CLOSET.

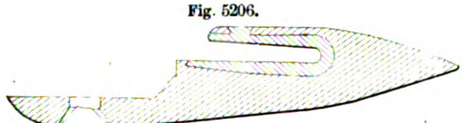
Slop-mold'ing. (*Brickmaking.*) As distinguished from PALLET-MOLDING (which see). In slop-molding, the mold is dipped in water before charging and the mold is usually carried by the off-bearer, who dumps the brick on the drying-ground. This is the English practice. Slop-molding, therefore, requires several molds; pallet-molding only one, as the molder dumps the bricks on to pallets, upon which they are carried off to the drying-ground.

Slop'ping. (*Pottery.*) The process of separating a mass of clay, or throwing the two halves together in a direction different from their former contact. It blends the materials of the mass and makes it homogeneous. It is also called *wedging* or *slapping*.

Slosh-wheel. (*Machinery.*) A wheel having two slots crossing at right angles and forming guides for two slides which traverse in them like the slides in a TRAMMEL (which see). A bar pivoted to the two slides makes two reciprocations in each direction for each revolution of the wheel.

Slot. (*Machinery.*) An elongated, narrow perforation or aperture. The slot in the finger or guard of a harvester is for the knife to play in, and its invention by Hussey marks one of the greatest advances in the invention of the reaper.

Fig. 5206.



Harvester-Finger.

Slot-drill'ing Ma-chine'. A machine for forming elongated holes by drilling instead of punching, as in the slotting-machine. The latter leaves the work in a rough and unfinished condition, while, when the former is used, no after-treatment with the file is required.

Fig. 5207 illustrates the machine employed in drilling the cotter-hole in a steam-engine cross-head.

The drill-spindle *a* is supported on a carriage *b*, to which the requisite traverse is imparted by connecting it to a stud on the face of a revolving disk, the extent of motion being determined by the distance from the center of the disk at which the stud is fixed.

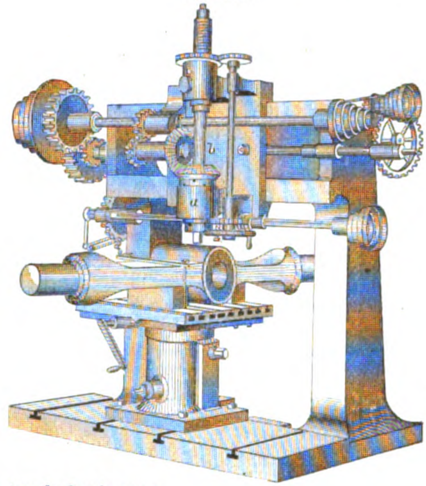
To insure uniformity of motion to the carriage, the pinion driving the disk is eccentric and the disk itself elliptical.

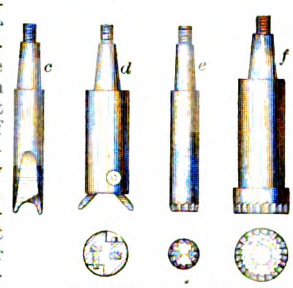
The drills *c d*, the latter having two loose cutters fixed by screws, and the rose-cutters *e f* for finishing, are employed in this machine.

Slot'ting-au'ger. One having side-cutting lips so as to make a slot in work fed laterally against it. See Fig. 459, Vol. I.

Slot'ting-ma-chine'. (*Metal-working.*) A variety of *planing-machine* in which the tool is vertically reciprocated while the work is fed beneath it between cuts. It is an outgrowth of the *key-groove* machine invented by Roberts. It has, however, two horizontal slides at right angles to each other and a circular adjustment or turn-plate, all three used in shifting the position of the work beneath the cutter,

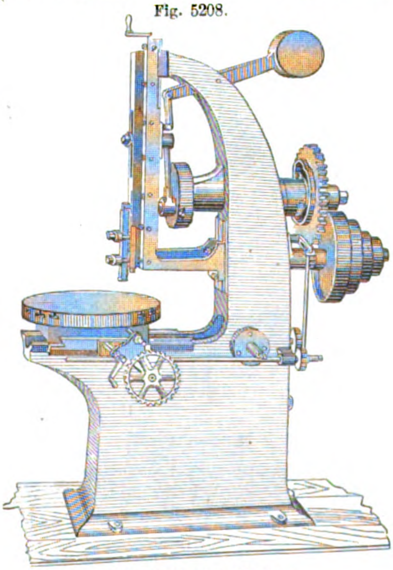
Fig. 5207.





Slot-Drilling Machine.

Fig. 5208.

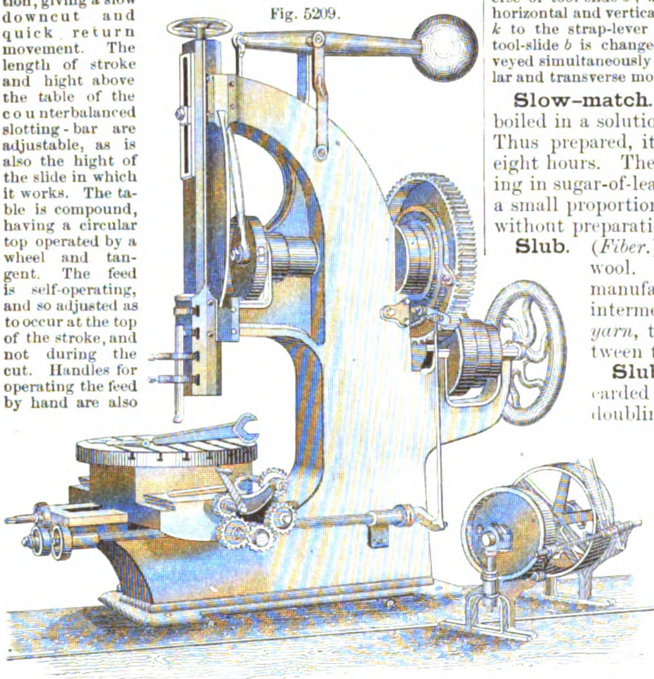


Sellers's Slotting-Machine.

and all three fitted with self-acting devices for feeding between the strokes of the cutter.

The machine (Fig. 5208) is provided with the Whitworth motion, giving a slow downcut and quick return movement. The length of stroke and hight above the table of the counterbalanced slotting-bar are adjustable, as is also the hight of the slide in which it works. The table is compound, having a circular top operated by a wheel and tangent. The feed is self-operating, and so adjusted as to occur at the top of the stroke, and not during the cut. Handles for operating the feed by hand are also attached to the machine.

Fig. 5209.

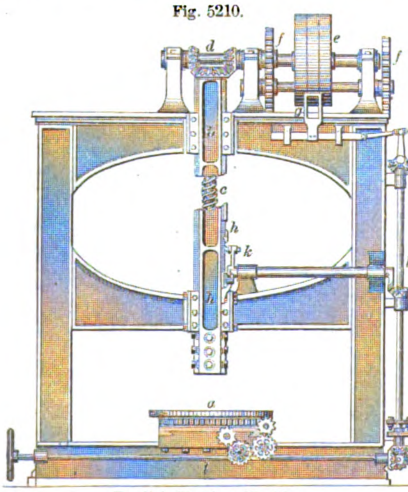


Slotting-Machine (New York Steam-Engine Company).

In the machine (Fig. 5209), the tool-holder has vertical adjustment by means of a hand-wheel and screw; the work-table has a hand as well as automatic feed, and the tool-holder may be reciprocated when desired by throwing the driving-pulley out of gear and turning a hand-wheel at the back of the machine on the pulley-shaft.

In the large English machine (Fig. 5210), *a* represents the work-table; *b*, the tool-slide, which has a slow downward and quick upward return motion; *c*, the guide-screw, taking into a nut on the back of the tool-slide; *d*, bevel-gears, the central one is keyed on the guide-screw *c*, the vertical ones receive motion from the two exterior pulleys at *e*, the central pulley is loose; *f f*, gears transmitting motion from right-hand pulley to right-hand bevel-wheel; *g*, strap-lever apparatus; *h h*, stops, which may be fixed any distance apart, according to the desired traverse of tool-slide *b*; *k*, lever, on which the stops *h h* act; *l l*, horizontal and vertical shafts for conveying motion from lever *k* to the strap-lever apparatus *g*, whereby the motion of the tool-slide *b* is changed; the motion thus derived is also conveyed simultaneously to the table *a*, whereby self-acting circular and transverse motions may be imparted to it.

Fig. 5210.



English Slotting-Machine.

Slow-match. Slightly twisted hempen cord boiled in a solution of distilled water and saltpeter. Thus prepared, it burns at the rate of one yard in eight hours. The rope may also be prepared by boiling in sugar-of-lead water, or by steeping in lye with a small proportion of quicklime added. Cotton rope without preparation may also be employed.

Slub. (*Fiber.*) A slightly twisted roving of wool. Like the *roving* of the cotton-manufacture, which occupies a condition intermediate between the *sliver* and the *yarn*, the *slub* of wool is intermediate between the *carding* and the yarn.

Slub′bing. Reducing the sliver of carded fiber to a uniform thickness by doubling and slightly twisting. The reduction of thickness of the sliver renders it so weak that the twist is required to make it hold together. The twist is given by rapidly revolving the can which receives the *slub* or *roving* from the drawing-rollers.

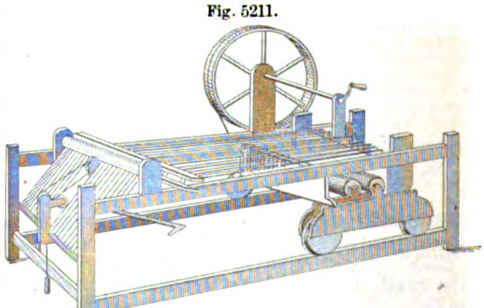
Other modes of giving the twist which makes the distinction between a *roving* or *slub* and the *sliver* from which it is produced are the *jack* and the *bobbin and fly frame* (which see). See also ROVING; DOUBLING.

Slub′bing-bil′ly. The first spinning-machine for drawing and twisting slightly the *cardings* or scribblings of wool. See SLUBBING-MACHINE.

Slub′bing-ma-chine′. A *slubbing-billy*. A machine for giving a light twist to the *cardings* of wool.

The *slubbing-billy* consists of a wooden frame, within which is a carriage called the *billy-gate*, moving upon the lower side-rails, and containing a number of spindles which are made to rotate by a series of cords passing round the pulley of each spindle and connected with a drum extending the whole breadth of the carriage. The drum is turned by a crank-handle on a shaft connected by a band with the drum.

Fig. 5211.



Slubbing-Billy.

The *cardings* are arranged upon an inclined leather apron, and pass from thence under a wooden roller called the *billy-roller*, which compresses them slightly. In advance of the roller is a movable rail, which is lifted to allow the cardings to be drawn out by the carriage, and is shut down when the portions

of the cardings beyond the clasp are to be drawn out into an elongated thread.

The machine was introduced soon after the invention by Hargreaves of the *spinning-jenny*, about 1767. The jenny was the original of the *slubbing-billy* and the *mule*; the traveling carriage carrying spindles, the interrupted paying out of the carding or roving, the elongation of the roving and spinning of the thread during the forward motion of the carriage, and the winding of the *cop* during the return motion, are common to the *slubbing-machine* and the *mule*. The points of difference between the two machines last cited and the *jenny* may be seen by comparing them with the latter. See SPINNING-JENNY.

In operation, the spindle-carriage is wheeled close up to the *billy-roller*, and the clasp is opened by means of a lever to release all the cardings. The carriage, being drawn forward a short distance from the clasp, pulls forward a corresponding length of the cardings; the clasp is then lowered, holding the cardings firmly, while the carriage, continuing to recede, stretches and twists that portion of each carding which is included between the spindles and the clasp. During the motion of the carriage, the attendant rotates the crank-shaft, and the spindles are rapidly revolved, giving the cardings the required degree of twist for this part of the process. The slubbing-machine does not make *yarn* but *slubs*, which have only a partial twist. The inclined position of the spindles prevents the cardings from unwinding upon them during the twisting part of the process, the rovings continually slipping over the points of the spindles as the latter rotate. When the requisite elongation and twist is attained, the attendant drops the *faller-wire*, which bears down the rovings from the points of the spindles and causes the slubbing to wind upon the spindles as the carriage is pushed back toward the *billy-roller*.

The *cardings* are very tender, and will not bear drawing upon the inclined apron, so the latter is caused to move upward with the cardings to an extent and at a time coincident with the paying out of the carding by the *billy-roller* at the early part of each forward motion of the spindle-carriage. New lengths are added to the ends of each carding as they are gradually fed through the roller, the junction being made by a peculiar rolling of the ends together by the fingers of the children in attendance. One carding-machine will keep a slubbing-machine of 60 spindles in work. One boy will manage 30 cardings.

The slubbing-billy is sometimes employed to spin coarse yarn, but usually leaves the *slub* about double the size that the yarn is intended to be. The farther reduction — that is, elongation and twist — is obtained in the *mule*.

Another form of *slubbing-machine* is termed a *condenser*, and requires a different preliminary treatment of the wool. The *scribbling-machine*, or first carding-machine, delivers the *fleece* or *lap* on to a wooden cylinder, round which it winds as it is taken off the *doffer* by the *comb* When the *fleece* has wound round the roller a certain number of times, a bell is rung mechanically, which gives notice for the removal of the fleece, which is done by running the finger lengthwise along the periphery of the roller, dividing the fleece, which is removed in a sheet to the second carding-machine, whose feed-cloth it just covers.

The doffing-cylinder of the second carding-machine has circumferential rings of cards around, each about ¾ inch broad, and divided by spaces of ¼ inch These rings become charged with wool, which is removed by the *comb* or doffing-knife in the form of separate slivers, one from each ring, the slivers being subsequently formed into continuous slubbings by means of the *condenser*.

The *condenser* consists of a pair of rollers supporting a traversing belt of leather, on which the slivers are carried; a third roller of leather lies transversely upon the slivers and the leather belt, having, in addition to its rotary motion, an endwise motion, which rolls the slivers into a somewhat cylindrical form, compacting them and causing the fibers to interlace. By this means the slubbings acquire sufficient strength to enable them to stand the operation of spinning. The effect is similar to rubbing the sliver between the hands.

The slubbings thus formed are wound upon a horizontal reel, as long as the width of the machine. This, when full, is removed and placed on the mule, which draws from it, the same as it would from bobbins on a creel.

Sludge. (*Metallurgy.*) The metalliferous slime from the ore-stamp. See SLIME; AMALGAMATOR; SIZING-CISTERN; SEPARATOR.

Sludge-hole. (*Steam.*) A hole in a steam-boiler at which mud or deposits are raked out.

Sludg'er. A cylinder forming a bucket for removing mud from a bored hole in rock or soil. Known also as a *sand-pump*, or *shell*. See page 2027.

Sludg'ing. (*Hydraulic Engineering.*) Stopping the crevices incident to the contraction of clay piled in embankments, by mud sufficiently fluid to run freely.

Slug. 1. (*Printing.*) A strip of metal less than type high and as long as the width of the column or page. Slugs are used to fill out a short page or between *display lines*.

2. (*Projectile.*) *a.* An extemporized leaden projectile formed by cutting bar or sheet lead into irregular masses; used in case of necessity as a substitute for balls or shot.

b. In breech-loading arms, which carry a bullet slightly larger than the bore of the barrel, the bullet, when forced to assume the sectional shape of the bore in the act of firing, is said to *slug* or to be *slugged*.

3. (*Metallurgy.*) Partially roasted ore.

4. (*Hat-making.*) A hatter's heating-iron.

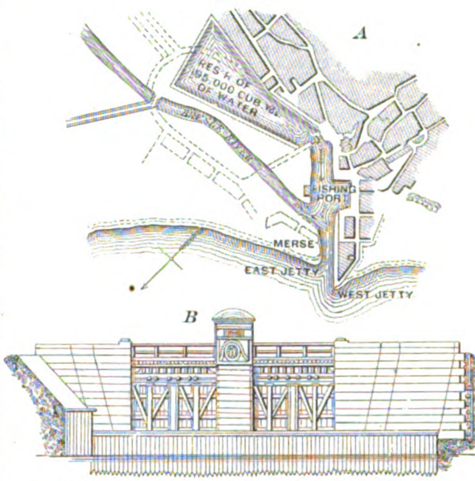
Sluice. 1. (*Hydraulic Engineering.*) A waterway provided with a valve or gate by which the flow of the water is controlled. It is used in regulating the passage of water into and out of canal-locks and in the hydraulic arrangements for sluicing harbors to deepen the channels.

The sluices of the northern French ports of Dieppe, Treport, Havre de Grace, and Cherbourg, are good examples of sluices of the latter description. The fresh water of rivers or canals is reserved by means of a barrier, or the sea-water is allowed to flow through the open sluice into a reservoir while the tide is rising; at low water the sluice is opened, and the rush of water cleans out the silt, sand, and mud which obstruct navigation.

The sluice constructed by De Cessart at Treport, France, may be taken as an example.

De Cessart improved this port in 1778, and constructed the scouring-sluice, by which the port is kept constantly cleansed.

Fig. 5212.



Treport Harbor and Elevation of Scouring-Sluice.

It has two passages for the water, each 21 feet in width, separated by a pier 8 feet thick, terminated at the sides by walls 10 feet in thickness, with wing walls and returns.

The platform fills the space between the walls, both above and below. Below the apron is a row of sheet piling, which keeps the earth of the foundation from washing away. Above these are two rows of sheet piles, which prevent the work from being undermined.

Each of the two passages is closed by two gates, 12 feet in hight; a wooden bridge, 13 feet wide, affords a passage across the sluice. The upper platform is constructed of timber, so that it can be readily repaired, without injury to the walls. The pivots and sockets on which the gates move are of cast-iron, each weighing 193 pounds. The lower rail of the gates is kept 2 inches above the level of the platform; a sill of the same hight fills this space and prevents loss of water. The gates turn in circular indents in the side walls, and the difference in the areas of their sides is about 6 inches, which suffices to open them when the tide rises.

Sluices were used from a very early period to assist in raising or lowering vessels from one level to another in canal or slack-water navigation, or in overcoming shallows or bars of rivers.

The most ancient on record is that of the canal of Pharaoh Necho, which united the Red Sea with the Nile. Diodorus Siculus (60 B. C.) states that this had sluices or gates ingeniously

contrived, which opened to afford ships a passage through and then quickly shut again. He speaks of the canal as constructed by "Necos, the son of Psammeticus," afterward partially restored by "Darius the Persian," and subsequently by "Ptolemy the Second."

Strabo mentions an *eriplus* (a gate) which Ptolemy Philadelphus constructed when he reopened the canal, and which opened an easy passage from the Red Sea to the canal. The French Survey, during their occupation of Egypt, determined that the Red Sea at Suez at high water is 32 feet 6 inches higher than the Mediterranean at Tyneh at low water.

The ancient canal was made by Sesostris, according to Aristotle, Strabo, and Pliny. It commenced about 12 miles northeast of the modern town of Belbays, the *Bubastis Agria* of the Romans, and was about 96 miles long. It appears to have been reopened by Necho, about 605 B. C., and Ptolemy Philadelphus, about 300 B. C. 60,000 men are said to have perished in the latter undertaking. It was neglected by the Cæsars, reopened by the Caliphs, and abandoned when the route by the Cape of Good Hope was discovered.

According to historians, the undertaking was several times abandoned by the fear of flooding Egypt with salt water, the Red Sea having a higher level than the Nile. The sluice or *gate* at the Red Sea end seems to have prevented the steady flow of the salt water to the sacred river. The modern canal, in connecting the salt waters of the Red Sea and the Mediterranean, has not raised the question.

Sluices are used for overcoming the different levels on the great rivers of China, but whether they use locks is not known to the writer. The Great Canal of China is 825 miles long, 200 feet broad, and deep enough for vessels of large cargo. It was commenced in the ninth century, about the time of Charlemagne. The authorities which give it a length of 2,000 miles probably include branches or the rivers which are included in the system of inland navigation. See CANAL.

The canals of the Romans and those of the Italians down to the fourteenth century were furnished with sluices, and no certain mention of canal-locks occurs previous to the time of the brothers Domenico. See CANAL-LOCK.

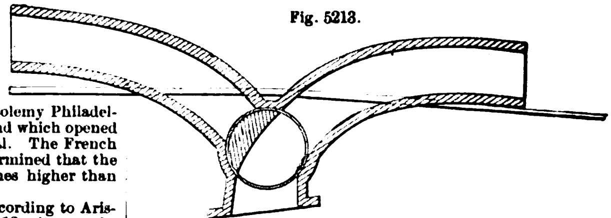
The sluice-gate of Italy is thus described by Cresy: —

"The lower beam of each gate was framed with the head and heel posts, so as to allow a space of six inches between it and the sill. From the middle beam to the top, the gates were planked over in the ordinary way; the lower part was left open or in skeleton framing, and was closed by paddles and sluices, which were moved up and down by rack and pinion. When the paddles were let down, they descended three or four inches lower than the surface of the floor on the lower side, which acted as a rebate, against which they pressed, and effectually closed the lock. They also had a bearing against the lower cross-beam of the gate, and the head and heel posts rested on square stones made fast in the sill.

To make use of these gates, it was necessary, first, to raise the paddle as high as the lower cross-beam, which permitted the water to pass through at the foot of the gate. The paddles were then elevated to the hight of the middle beam, which was placed at the ordinary level of the water, usually four or five deep upon the sill.

The gates were easily opened, as the boarded part was entirely out of the water. A serious objection to this early contrivance in aid of internal navigation is the injury that vessels might sustain at the time of passing through when one end was elevated out of the water. The sides and floor of the sluice were boarded and a foot of length was allowed for every inch of fall."

Fig. 5213.



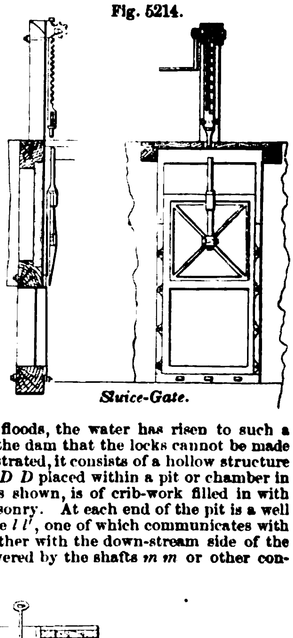
Sluice for Hydraulic Propeller.

2. (*Steam.*) The injection-valve by which the water of condensation is introduced into the condenser from the sea, river, or well.

3. A *tubulure* or pipe through which water is directed at will. In the hydraulic propeller, in which a vessel is driven by an issuing column of water, the sluice-way is controlled by a valve. In the example, a rotating sluice is placed at the point of divarication of the passages of a rotary pump to give direction to the discharge of the water, for going ahead or backing.

Sluice-gate. (*Hydraulic Engineering.*) *a.* Lock-gates of canals are provided with sluice-gates, as are also the sluice-walls in other structures where a flush is obtained by the sudden releasing of the pent-up water. The sluice-gate is a simple plate, which covers the opening, and is raised or lowered by means of a rack-bar and pinion. See FLUSHING.

Fig. 5214.



Sluice-Gate.

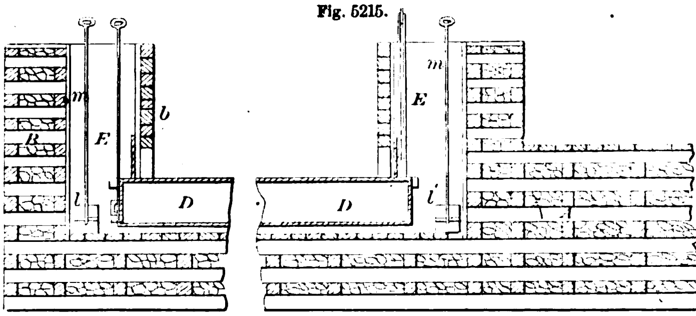
Brunot's (Fig. 5215) is more particularly designed for application to dams erected for purposes of slack-water navigation, and is intended to be available when, in floods, the water has risen to such a hight over the head of the dam that the locks cannot be made use of. In the form illustrated, it consists of a hollow structure of timber or plate-iron D D placed within a pit or chamber in the dam A B, which, as shown, is of crib-work filled in with stone, but may be of masonry. At each end of the pit is a well E E provided with a gate l l', one of which communicates with the up-stream and the other with the down-stream side of the dam, and is raised or lowered by the shafts m m or other contrivances. The gate D D is also provided with valves, which are opened or closed to admit or withdraw water as required. At ordinary stages of water, it is retained at a level with the head of the dam and assists in retaining the water behind it; but when the river has risen to a considerable hight above the dam, one or more of the valves are opened, permitting the water to flow into the gate, which sinks, leaving the sluice open so that it

A *falling-sluice* is one whose gate falls by pressure, to enlarge the waterway during floods.

Sluices are used in all systems of drainage on a large scale, where a periodical fall is obtainable, as in marshes on tide-water, where the fresh water of the drains is allowed to pass off at the lowest state of the tide.

This has been practiced from time immemorial in the low countries bordering on the mouths of the Rhine and neighboring rivers; also in the Italian systems of drainage, though the facilities there are not great, as the tides of the Mediterranean have a much smaller range of elevation.

Fig. 5215.



Sluice-Gate.

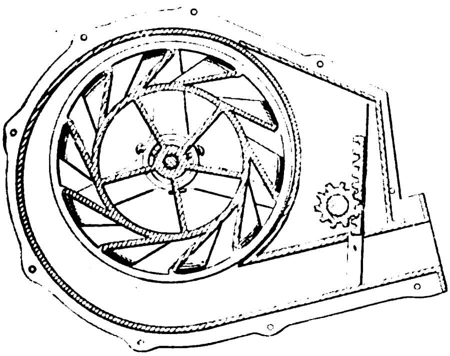
The Romney marsh, Essex, England, was obtained from the sea nearly 2,000 years back, and consists of 24,000 acres. The water is kept back by a levee 6,000 yards long, and the fresh water from the ditches passes out at the lowest state of the tide by three sluices.

For modern data on sluices, barrages, and slack-water dams, see "Report on Hydraulic Gates and Dams in the Ohio River," Ex. Doc., No. 78, 42d Cong., 2d Session.

may afford a passage for boats. When the gate $D\ D$ is to be raised, the gate l' of the down-stream passage of the well E is opened and the other gate l of the up-stream passage is closed, permitting the water to flow wholly or partially out of the pit, and the appropriate valve in the gate DD is also opened, allowing water to escape from and air to enter it, so that it will float. The valve is then closed and the action of the gates $l\ l'$ reversed, again filling the pit with water, upon which the gate $D\ D$ rises and closes the sluice as before.

b. The gate which admits water to the scroll-chute

Fig. 5216.



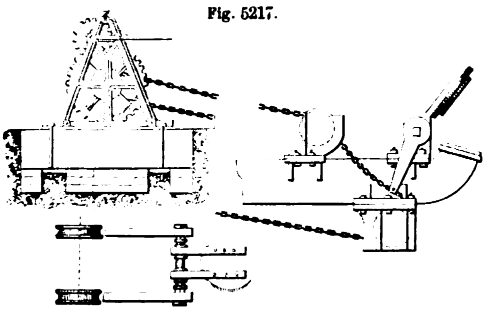
Sluice-Gate for Water-Wheels.

of a water-wheel. In the example, this is worked by rack and pinion.

Sluice-valve. The sliding door which governs the opening through a sluice-gate.

Sluice-valves at the mouth of a discharge pipe or main serve to control the exit of water from a reservoir. They are of several kinds: some are made to slide in ways to and from the seat,

Fig. 5217.

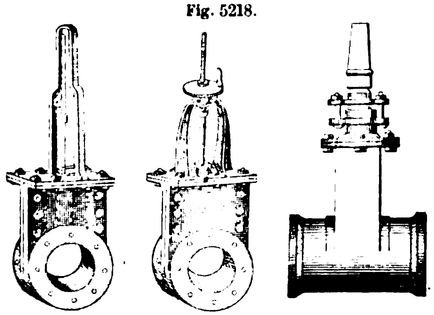


Sluice-Valve.

like those described under STOP-VALVE; and others are more nearly allied to the clack-valve, being opened by machinery against the pressure of water.

In the latter case, the valve which covers the mouth of the discharging pipe has two arms secured to an iron axle, at the extremities of which are two levers. The chain fastened to one pulley passes under a pulley, and that fastened to the other lever passes over another pulley, so that by turning a windlass either chain can be worked for the purpose of opening or closing the valve, respectively.

Fig. 5218.



Sluice-Valve.

Fig. 5218 shows three varieties of valves for gas, water, and steam pipes; the first is raised and lowered by a rack and pinion, the second by a screw, the third by a key or wrench.

Slung-shot. (*Weapon.*) A leaden ball with a strap attached.

Slur. 1. (*Knitting-machine.*) A piece of metal in a stocking-frame which travels on a *slur-bar* beneath the ends of the *jacks*, and thus depresses the *jack-sinkers* in succession, *sinking* one loop of thread between every pair of needles.

2. (*Printing.*) A blurred impression.

Slur-cock. (*Knitting-machine.*) A cam or wiper projecting from the traverse or carriage to lift the *jacks*, and through them the *jack-sinkers*.

Slush. 1. A mixture of grease and other materials used for lubrication.

2. White-lead and lime used in painting bright parts of machinery.

Slushed-up. (*Bricklaying.*) The joints and intervals between the bricks and courses filled with mortar. See GROUT.

Smack. (*Nautical.*) A one-masted vessel, resembling a sloop or a cutter, as the case may be, and used in the coasting-trade. The Leith (Scotland) smacks ran as high as 200 tons.

Small-arm. A term including muskets, rifles, carbines, and pistols. In the English service there were, until lately, seventeen varieties, issued to the cavalry, artillery, engineers, infantry, and navy. Eleven other kinds are issued for service in India. The tendency now is to reduce the variety of pieces and have a greater uniformity of bores and ammunition. See FIRE-ARM; PISTOL; RIFLE; SHOT-GUN; REVOLVER, etc.

Small-chis'el. A burin or graver used by engravers, chasers, etc.

Small Pi'ca. (*Printing.*) A size of type between *Long Primer* and *Pica.*

Long Primer, 89 ems to a foot.

Small Pica, 83 ems to a foot.

Pica, 71 ems to a foot.

Smalt. A blue coloring material prepared from cobalt ore. It is extensively used for tinting glass, painting porcelain and earthenware, fresco-painting, tingeing linen and paper, coloring paper-hangings, and other purposes.

The ore of cobalt was first known in the Saxon mines as an impurity of silver ore, and its property of imparting a blue color to glass was accidentally discovered. In its native state it is mixed with various other metallic compounds, as those of arsenic, bismuth, nickel, etc. It is prepared by stamping, washing, and roasting. The residue is mixed with potash and calcined quartz-rock, and melted in pots in a furnace resembling that of the glass-maker, forming a beautiful blue glass. The smalt thus produced is crushed, sifted, ground, washed, and sorted into fine powders of various tints of blue, constituting the smalt, azure, etc., of the color-shops. An inferior kind is termed *zaffre.*

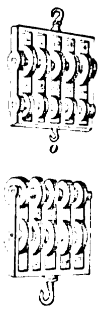
Smash'ing-ma-chine'. (*Bookbinding.*) A press made on the principle of an embossing-press, and used for compressing books.

Smear'ing. (*Pottery.*) An operation in firing pottery whereby an external luster is imparted to pottery without glazing. The saline flux of the saggars is reverberated and condensed upon the ware, or a fusible composition is so placed that the vapor reaches the ware.

Smea'ton's Block. A compound block devised by the celebrated engineer Smeaton and designed to

keep the cords parallel and prevent the displacement by tension incident to systems of blocks combined together.

Fig. 5219.



Smeaton's Block.

The course of the rope may be traced by the numbers on the sheaves.

One end of the rope is attached to the hook *o*, at the bottom of the upper block; from this point the rope is brought under the wheel marked 1, over 2, under 3, over 4, under 5, and so on, according to the order of the figures, until it is finally passed over the wheel marked 20, on which the power immediately acts. In this arrangement the blocks cannot get deranged, because the power acts directly over the weight. The weight being distributed over 20 parts of the rope, which are equally stretched, it follows that the weight is 20 times the power.

Smed'dum. (*Metallurgy.*) The smaller particles which pass through the sieve of the *hotching-tub* or *hutch* in the water treatment of ores by agitation.

Smee Bat'ter-y. (*Electro-magnetism.*) A form of single-fluid galvanic battery, invented by Alfred Smee, F.R.S., surgeon to Bank of England, in which copper mechanically roughened is the + element and silver roughened by a deposit of platinum is the − element. It was found that this roughening prevented the adherence to the plates of the bubbles of hydrogen evolved during action.

Smeir. (*Pottery.*) A semi-glaze on pottery; common salt added to an earthenware glaze.

Smelt. To fuse; as an ore, to extract the metal from extraneous substances.

Smelt'er's Fume. (*Metallurgy.*) The metallic fume resulting from the smelting of lead, the sublimation of zinc from ore, mercury from cinnabar, etc.

The fumes of some lead-smelting furnaces are 3 feet in width, 6 feet in hight, and are sometimes several thousand yards in length.

The gallery of the Allen lead-mill, Northumberland, England, has a length of 8,789 yards (nearly 5 miles), a hight of 8 feet, and a width of 6. The lead thus collected in Mr. Beaumont's mines, in the district mentioned, amounts to $50,000 annually.

Quicksilver furnaces are elaborate examples of this form of condenser. See MERCURY; ALUDEL.

Blende or black-jack is sublimed, and the fumes filtered through bags. See ZINC.

The fumes of the copper-smelting furnace are led to great distances to avoid injury to animal and vegetable life in the vicinity. Sulphur and arsenic fumes are an incident to many metallurgical operations.

Condensers, of much smaller proportions, in which the assistance of water is invoked, are in common use. See CONDENSER.

The *arsenic* and lampblack chambers are merely large buildings, with one or more apartments, in which the fumes cool and deposit

Smelt'ing. The process of obtaining metal from ore by the combined action of heat, air, and fluxes.

Smelt'ing-fur'nace. A furnace for disengaging the metal from its gangue or the non-metalliferous portions of the ore. The furnaces differ much for treating different metals. See list under METALLURGY; FURNACE.

The smelting-furnace for iron is in the form of a truncated quadrilateral pyramid about 50 or 55 feet high. The outer part is of brick or squared stone, with contrivances to obviate the danger of its cracking by the expansion that takes place when it is heated, and it is lined with two courses of fire-bricks having a layer of pounded coke between them to prevent the escape of the heat. The interior or cavity may be divided into the following parts from below upward. First, the hearth, about two feet high; its base and sides are formed of massive blocks of coarse, pebbly gritstone, as being the most infusible of all common building-stones. Upon this is erected the crucible, a four-sided cavity between 6 and 7 feet high, slightly enlarging upward, so as to be at top about 2½ feet wide. The part above, called the *boshes*, is in the shape of a funnel or inverted cone, about 8 feet high and 12 feet wide at top. On this is placed the great cavity of the furnace, of an irregular conical form, about 30 feet high, and gradually narrowing so as to be only about 3 feet in diameter at the top. From this part it enlarges into a funnel-shaped chimney, about 8 feet high, in which is cut a large square aperture, through which the charge is thrown from time to time into the furnace. About two feet above the hearth is an aperture through which the blast-pipe or tuyere is introduced. Sometimes there are two opposite tuyeres, and occasionally even three.

The character of the iron is affected by the nature of the fuel, and, by the choice of the latter, metal may be rendered more suitable for the purpose for which it is intended.

The effect in the smelting-furnace is due to the high temperature, and this is produced by the action of the oxygen of the atmosphere, which enters at the tuyere-hole, excites intense heat by combination with the carbonaceous particles of the fuel, the other constituents of the air passing out, in company with certain gases evolved, at the top of the furnace.

The air may be hot or cold, but is driven by a machine of some description. Varieties of the original forms of blowers may be found under *bellows*, but the larger kinds of blast apparatus are associated under the caption BLOWERS (which see). In a furnace working under high pressure and delivering 6,292 cubic feet per minute (estimated at atmospheric pressure), the weight of the air thrown in is calculated at 693,504 pounds, while the charge of coke, ore, and limestone in the same time amounts to 74,648 pounds.

The heat is developed, as has been said, by the combination of the oxygen of the air with the carbon of the fuel; but part of the carbon is required to reduce the magnetic oxide to the metallic state, and some carbon is also required to unite with the iron to form cast-iron, which is a compound of iron and carbon. The amount of air required will therefore be the quantity necessary to combine with the remainder of the carbon of the fuel, after deducting the amount of carbon required to reduce the oxide, and to unite with the metal.

The charge, placed on top of the furnace, descends gradually, the iron becoming gradually carbonized. As the carbon penetrates the fragments of ore, the limestone parts with its carbonic acid, which passes off The fuel loses some of its combustible ingredients. As the charge comes under the direct action of the blast, the reactions are more energetic, the fuel burns rapidly, its carbon uniting with the oxygen and with the metal, which becomes melted, while the lime unites with the earthy particles to form a fusible slag; the fused matters descend from the boshes into the crucible, the metal, by its superior gravity, taking the lower position on the hearth, from whence it is drawn off from time to time, either into ladles to form castings, or into furrows made in sand, where it is run into pigs.

The vitreous scoriæ or *slag* floats on the iron and overflows at an aperture. See SLAG; BLAST-FURNACE.

The appearance of the slag indicates the cooking condition of the furnace. Here the skill of the smelter will watch the healthy working of his furnace, detect the signs of disorder, and determine upon the appropriate remedies.

An authority gives the following indications: If the color of the slag be pale yellow, the sign is favorable. Green color indicates oxide of iron and a deficiency of lime. Streaks of blue indicate protoxide of iron, and show a deficiency of fuel or excess of blast.

Dark-colored, heavy slag shows that iron is going to waste, and suggests that the iron produced will be deficient in carbon. It indicates either a deficiency of fuel or a too rapid working of the furnace, so that the iron was imperfectly carbonized on arriving within the action of the blast.

Great economy of fuel, with a generally admitted deterioration of quality of the metal, is effected by using a blast, heated artificially. The heat attained varies from 200° to 600° Fah. This was invented by Neilson. See HOT-BLAST.

The primitive smelting-furnace by which the "iron is taken out of the earth" (Job xxviii. 2), and which the Hebrews learned to use while in Egypt, was probably like the ancient Indian furnace yet used in Asia, and thus described by Dr. Ure: —

"The furnace or *bloomary* in which the ore is smelted is from 4 to 5 feet high; it is somewhat pear-shaped, being about 5 feet wide at bottom and 1 at top. It is built entirely of clay. There is an opening in front about a foot or more in hight, which is filled with clay at the commencement, and broken down at the end of each smelting operation. The bellows are usually made of goat's skin, and the nozzles are inserted into tubes of clay which pass into the furnace.

"The furnace is filled with charcoal, and a lighted coal being introduced before the nozzles, the mass in the interior is soon kindled. As soon as this is accomplished, a small portion of the ore, previously moistened with water to prevent it from running through the charcoal, but without any flux whatever, is laid on top of the coals, and covered with charcoal to fill up the furnace. In this manner ore and fuel are supplied, and the bellows urged for three or four hours. When the process is stopped, and the temporary wall in front broken down, the bloom is removed with a pair of tongs from the bottom of the furnace."

It was said of the land of Canaan (Deuteronomy viii. 9), "a land whose stones are iron, and out of whose hills thou mayest dig brass" (copper). The hills of Palestine furnished the ore in the time of the Judges, and do to this day. It was used for making the bedstead of Og, king of Bashan (see BEDSTEAD), for the axes and sickles of the Egyptians from time immemorial, and for axes in Palestine in the times of Samson and Elisha; for chains in the time of Jeremiah; harrows in the time of Samuel and David; for mattocks, files, goads, swords, spears, shares, colters, forks, etc., previous to the time of Saul, say about 1100 B. C., and no doubt long before.

The Israelites worked in the iron-furnaces of Egypt during their captivity. The rigidity and strength of iron afford a basis for several metaphors in that most ancient and wonderful poem, the Book of Job.

The iron-smelting furnaces of Africa are thus described by Dr. Livingston: —

"At every third or fourth village (in the regions near Lake Nyssa) we saw a kiln-looking structure, about 6 feet high and 2½ feet in diameter. It is a clay, fire-hardened furnace for smelting iron. No flux is used, whether the specular-iron, the yellow hematite, or magnetic iron ore be used, and yet capital metal is produced. Native manufactured iron is so good that the natives declare English iron 'rotten' in comparison, and specimens of African hoes were pronounced at Birmingham nearly equal to the best Swedish iron."

Dr. Barth makes a similar statement.

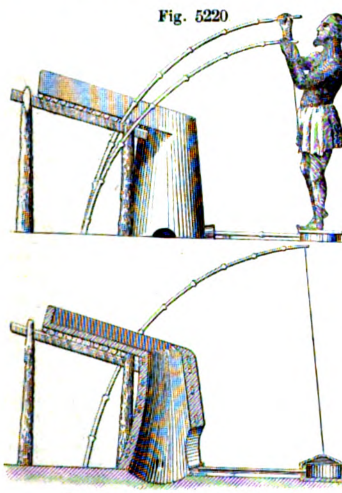
The articles produced by these peoples are hammers, tongs, hoes, adzes, fish-hooks, needles, and spear-heads. The *assagais* of the Caffres are made of iron similarly procured, and of excellent quality. The *wootz* of India is still produced in the manner partially described by Aristotle when speaking of India, and by Diodorus Siculus, referring to the iron ores of the island of Ethalia.

The Hottentots, though so far below the average of what may be classed as savages, have pottery, iron manufactures, sheep, and oxen.

Their iron-furnace is a hole in a raised ground, large enough to contain a good quantity of iron stones, which are plentiful on the surface in some parts of their country. About 18 inches from the upper hole they make a smaller one, connecting with the former by a narrow channel. A hot fire is made in the upper hole, sufficiently long to heat the earth thoroughly, and it is then charged with fuel and iron. Fuel is added, and the fire urged until the metal runs into the receiver. When it is cool it is broken into pieces, heated, and hammered out with stones. It is almost exclusively used for making weapons.

Fig. 5220 represents a blast-furnace of the Kols, a tribe of iron-smelters in Lower Bengal and Orissa. The men are nomads,

Fig. 5220



Kol Smelting-Furnace, Hindostan.

going from place to place, as the abundance of ore and wood may prompt them. The charcoal in the furnace being well ignited, ore is fed in alternately with charcoal, the fuel resting on the inclined tray, so as to be readily raked in. As the metal sinks to the bottom, slag runs off at an aperture above the basin, which is occupied by a viscid mass of iron. The blowers are two boxes with skin covers, which are alternately depressed by the feet and raised by the spring-poles. Each skin cover has a hole in the middle, which is stopped by the heel as the weight of the person is thrown upon it, and is left open by withdrawal of the foot as the cover is raised.

Variously modified in detail and increased in size, these simple furnaces are to be found in several parts of Europe, the Catalan and Swedish furnaces resembling in all probability those of the Chalybes, so famous in the time of Marathon (490 B. C.), and those of the *fabrica* or military forge established in England by Hadrian (A. D. 120) at Bath, in the vicinity of iron ore and wood. The brave islanders met their Roman invaders with scythes, swords, and spears of iron, and the export of that metal from thence shortly afterward is mentioned by Strabo.

During the Roman occupation of England some of the richest beds of iron ore were worked, and the *débris* and cinders yet exist to testify to two facts, — one, that the amount of material treated was immense; the other, that the plans adopted were wasteful, as it has since been found profitable to work the cinders over again.

During the Saxon occupation the furnaces were still in blast, especially in Gloucestershire.

The direct method of obtaining wrought-iron from the ore prevailed until the commencement of the fifteenth century, and then gradually gave way to a less direct process, but one more convenient in the handling of large quantities. Furnaces, operating by the aid of a strong blast, to *melt* the iron and obtain *cast-iron*, which is carbureted in the process, were in use in the neighborhood of the Rhine about 1500. A second process in a *forge* hearth was used to eliminate the carbon and other impurities, and the result was *wrought-iron*.

It took several centuries to accomplish this with wood, and several other centuries to devise means for substituting pit-coal for charcoal.

In the reign of Elizabeth blast-furnaces were of sufficient size to produce from two to three tons of pig-iron per day by the use of charcoal. In the small works the iron was made malleable before being withdrawn from the blast-furnace, and in larger works was treated by the refinery furnace.

Wood becoming scarce, and a number of furnaces having gone out of blast, in 1612 Simon Sturtevant was granted a patent in England for 31 years for the use of pit-coal in smelting iron. Failing in his proposed plans, he rendered up his patent in the following year. Successive persons applied for a patent for the same, the government continuing desirous of encouraging the development of home resources. Dudley, in 1619, succeeded in producing three tons of iron per week in a small blast-furnace by the use of coke from pit-coal. The parties who yet possessed plenty of wood, and with whom the production of iron was fast becoming a monopoly, urged the charcoal-burners to destroy the works of Dudley, which was done. Dudley's patent was granted for 31 years, which would bring it to 1650, the time of the Protectorate, when England had a ruler fit to succeed Queen Bess. The celebrated statute of King James, limiting the duration of patents to 14 years, was passed in 1624. Dudley's petition for an extension was refused.

Iron of poor quality continued to be made in districts where wood was scarce, and of good quality from charcoal in places where forests yet remained. The demand for iron continuing to grow, — a natural effect of advancing civilization, — iron was imported from Sweden and Russia in large quantities and of excellent quality. The forests of these countries gave them a natural advantage over England, whose forests had by this time become thinned out, so that the use of wood for iron smelting had been forbidden by act of Parliament in 1581 within 22 miles of the metropolis, or 14 miles of the Thames, and eventually was prohibited altogether.

The art of making iron with pit-coal and of casting articles of iron was revived by Abraham Darby, of Colebrookdale, about 1713, and was perseveringly followed, although it was but little noised abroad. In the "Philosophical Transactions" for 1747 it is referred to as a curiosity. See CASTING, p. 449.

The extension of the iron manufacture dates from the introduction of the steam-engine, which increased the power of the blast; and the blowing engines, driven by manual, horse, or ox power, were henceforth operated by steam-engines. The dimension of the blast apparatus was increased from time to time, and about 1760 coke was commonly used in smelting. In 1760 Smeaton erected at the Carron Works the first large blowing cylinders, and shortly afterward Boulton and Watt supplied the steam-engines by which the blowers were driven. Neilson, of Glasgow, introduced the hot blast in 1828. Aubulos, in France, in 1811, and Budd, in England, in 1845, heated the blast by the escaping hot gases of the blast-furnace. In the smelting of iron four tons weight of gaseous products are thrown off into the air for each ton of iron produced. See under IRON; MALLEABLE IRON; and other titles, for which see list under METALLURGY.

As a means of estimating by comparison the value of the hot blast, some facts may be mentioned. Mushet states that at the Clyde Iron Works, before the introduction of the hot blast, the quantity of materials necessary for the production of one ton of pig-iron was, —

Calcined ore	1¾ tons
Coke	3 tons
Limestone	½ ton.

In 1831, when the system was coming into use, the blast being *warm*, —

Calcined ore	2 tons
Coke	2 tons
Limestone	½ ton.

In 1839, with a hot blast, —

Calcined ore	1¾ tons
Coke	1¾ tons
Limestone	½ ton

the saving in fuel being nearly one half.

In addition may be mentioned the fact that anthracite coal and black band ore are intractable under the cold blast, but the former yields an intense heat, and the latter a rich percentage of good iron with the hot blast.

The Calder Works, in 1831, demonstrated the needlessness of coking when the hot blast is employed.

Experiments in smelting with anthracite coal were tried at Mauch Chunk in 1820, in France in 1827, and in Wales successfully by the aid of Neilson's hot-blast ovens in 1837. The experiment at Mauch Chunk was repeated, with the addition of the hot blast, in 1838–39, and succeeded in producing about two tons per day. The Pioneer furnace at Pottsville was blown in July, 1839.

The first iron-works in America were established near Jamestown, Virginia, in 1619. In 1622, however, the works were destroyed, and the workmen, with their families, massacred by the Indians. The next attempt was at Lynn, Massachusetts, on the banks of the Saugus, in 1648. The ore used was the bog ore, still plentiful in that locality. At these works Joseph Jenks, a native of Hammersmith, England, in 1652, by order of the Province of Massachusetts Bay, coined silver shillings, sixpences, and threepences, known as the *pine-tree coinage*, from the device of a pine-tree on one side.

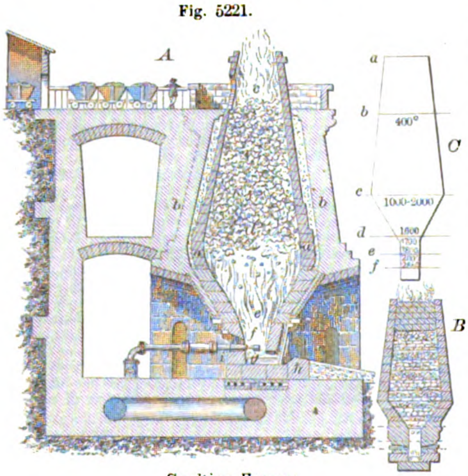
Early in the eighteenth century, a smelting-furnace was erected in Virginia by Sir Alexander Spottswood, governor of Virginia, who lived at the Temple Farm, near Yorktown, Va. He had been wounded at Blenheim, where he served with Marlborough. He was the first to cross the Blue Ridge and see the Shenandoah Valley. He was appointed commander of the expedition to Carthagena, but died at Annapolis, Md., June, 1740, as the troops were about to embark. He was buried in the mausoleum from which the Temple Farm derived its name. In this expedition the elder brother of George Washington served, and on his return named his estate on the Potomac "Mount Vernon," after the English admiral.

The blast-furnace for reducing iron from its ores is shown at Fig. 5221, *A*.

It consists of an interior lining of fire-bricks *a a*, forming a doubly conical chamber, surrounded by a packing of broken scoriæ or refractory sand, and incased within a construction of masonry *b b*, from the upper part of which the charge of fuel and ore is delivered through a suitable opening into the furnace.

The portion from *c* to *d* is termed the *shaft*; *d* to *e*, the *boshes*; the widest part being the *belly* or upper part of the boshes; the narrow part *f* the throat, below which is the crucible or hearth *g*, which receives the molten metal; the lower part of this is prolonged toward the front, forming the breast-pan, which is closed by the dam-stone *h*, between which and the side of the furnace wall is a slit, called the tap-hole, closed by fire-clay, which is removed to withdraw the molten metal. The dam-stone is protected by an iron plate. The top of the open side of the hearth is formed by a large slab of stone, termed the *tymp*, supported by a massive piece of iron, termed the *tymp-iron*. *i* is one of the tuyeres, usually two in number, through which compressed air is forced, to assist combustion and promote fusion of the metal.

Fig. 5221.



Smelting-Furnace.

The furnace is charged first with fuel, and as this burns down alternate layers of fuel and of mixed ore and limestone or other flux, according to the nature of the ore employed, are added (*B*).

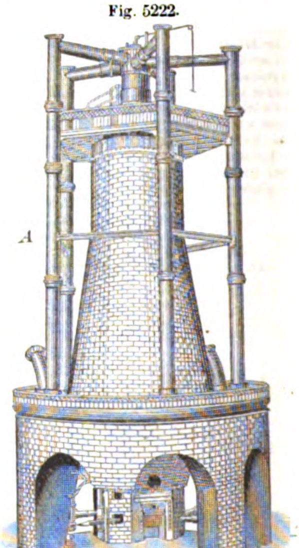
The iron collects on the hearth, while the slag produced by the combination of the flux with the foreign matters in the ore floats on top and is drawn off over the dam-stone. As the hearth becomes filled with metal, usually about twice in 24 hours, the tap-hole is opened and the metal allowed to flow.

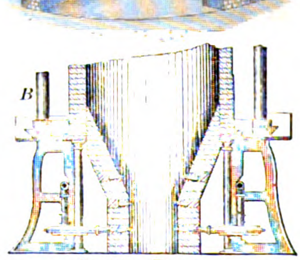
The interior of the furnace may be divided into five zones: the first heating zone *a b* (Fig. 5221, *C*); the reduction zone *b c*; the carburation zone *c d*; the melting zone *d e*; the combustion zone *e f*. In the first, the materials become thoroughly dried and are brought to a low red heat; in the second, the ore is reduced to a protoxide, and finally to metallic iron, by the various gases, carbonic oxide, carbureted hydrogen, and hydrocyanic-acid gas or vapors of cyanide of potassium; in a certain part of this zone the iron is present in a malleable state. In the carburation zone the metal becomes combined with carbon, producing a steely and caky iron, which, on falling into the lower or melting zone *d e*, becomes fully charged with carbon, by which it is brought into the condition of pig-iron.

The figures indicate the temperatures at the respective parts of the furnace.

Büttgenbach's blast-furnace is so arranged that the base is independent of the stack, which is a mere shell of fire-bricks, about equal in thickness to the lining of the ordinary blast-furnace. The base is formed either of brickwork with open arches (*A*) or of cast-iron standards (*B*). In the first case the shaft rests on a crown-ring above the tops of the arches, and in the latter upon a cast-iron ring-plate supported by the standards. The boshes join the stack just above the base-ring, and both are hooped at intervals; they and the tuyeres are protected by water-boxes. The gases are led off by a central tube, and through lateral openings, which communicate with the hollow columns, which serve as downtakes, and also support the gallery.

Fig. 5222.





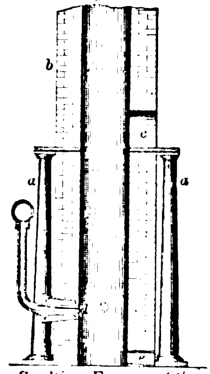
Smelting-Furnace.

Fig. 5223 is a vertical section of the smelting-furnace commonly used in the Pacific States.

Four cast-iron columns, from 8 to 11 feet high, support a square cast-iron plate *d* with a circular hole about 4 feet in diameter. On this plate is built the stack *b* of the furnace, with an opening *c* through which the furnace is charged. Under the plate and inside the columns is built the cylindrical shaft of the furnace, filling the space from the plate to the ground. *d* is a tuyere, and *e* the stirring and discharging hole.

The smelting-furnace of Shropshire, England, is a stone and

Fig. 5223.

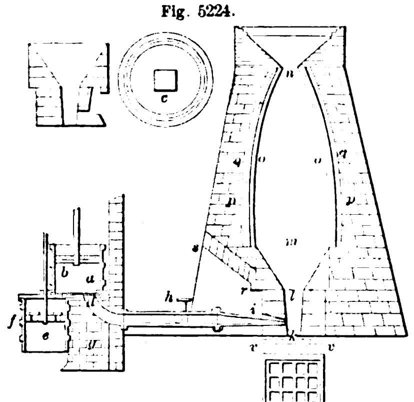


Smelting-Furnace of the Pacific States.

brick structure of a truncated conical form, 55 feet high, and 38 wide at bottom. Its cost, there, is about £1,800; and it requires in its construction 160,000 bricks, 3,900 fire-bricks, and 825 bosh-bricks. Its production is about 60 tons of iron per week. The furnaces are built larger and smaller than the size mentioned Including the coal of calcination, it is estimated that $3\frac{1}{4}$ tons of coal are required to obtain a ton of cast-iron. The proportions of the materials dumped into the furnace are $14\frac{1}{2}$ tons of coke, 16 of roasted ore, $6\frac{3}{4}$ tons of limestone, every 24 hours, producing 7 tons of pig-iron every 12 hours. Advantage is taken of a side-hill to make a convenient access for charging and delivering.

In the illustration, *a* represents the regulating-cylinder, 8 feet in diameter and hight; *b*, the floating piston, loaded with weights, proportionate to the power of the machine; *c*, a valve 26 inches long, 11 inches wide, by which the air is passed from the pumping-cylinder into the regulator; *d*, the aperture at which the blast is forced into the pipe leading to the tuyere. The pipe is 18 inches in diameter; the wider this can be made, the less is the friction and the more powerful the blast; *e* is the blowing or pumping cylinder, 9 feet high, and 6 feet in diameter, the piston within it having a stroke of from 5 to 7 feet; *f*, the blowing piston, with its valve or valves, of which there are sometimes several distributed over the surface of the piston, the area of each being proportioned to the number; *g* is a pier of stone or masonry supporting the regulating-cylinder, to which is attached the flange and blowing-cylinder; *h* is the safety-valve or cock, by the simple turning of which the blast may be admitted to or shut off from the furnace, passing to a collateral tube on the opposite side; *i*, the tuyere, by which the blast enters the furnace; the end of the taper pipe which approaches the tuyere receives small pipes of various diameters, from 2 to 3 inches, called nose-pipes; these are applied at pleasure, as the strength and velocity of the blast

Fig. 5224.



Shropshire Smelting-Furnace.

may require. *k*, the bottom of the hearth, 2 feet square; *l*, the top of the hearth, 2 feet 6 inches square; *k l*, the hight of the hearth, 6 feet 6 inches; *l* is also at the bottom of the boshes, and where they terminate is of the same size as the top of the hearth, only the former is round and the latter square. *m*, the top of the boshes, 12 feet diameter and 8 feet perpendicular hight. *n*, the top of the furnace, at which the materials are charged, commonly 3 feet diameter; *m n*, the internal cavity of the furnace from the top of the boshes upward, 30 feet high; *n k*, total hight of the internal parts of the furnace, $44\frac{1}{2}$ feet. *o o*, the lining; this is done in the nicest manner, with fire-bricks made on purpose, 13 inches long and 3 inches thick. *p p*, a vacancy round the outside of the first lining, 3 inches broad, and filled with coal-dust; this space is allowed for the expansion which might take place in consequence of the swelling of the materials by heat when descending to the bottom of the furnace. *q q*, the second lining, similar to the first. *r*, cast-iron lintel on which the bottom of the arch is supported. *r s*, the rise of the arch; the arch on the outside is 14 feet high and 18 feet wide. *v v* are the extremes of the hearth, 10 feet square; this and the bosh-stones are always made from a coarse gritted freestone, whose fracture presents large rounded grains of quartz, connected by a cement less pure.

The description by an iron-master, as given by J R. Chapin, gives a sensible idea of the process: —

"You must know that there are about 140 tons of material in the furnace, in the proportion of 60 to 75 tons of ore, 60 tons of coal, and 15 to 20 tons of limestone, fed into the furnace at the opening above The furnace is 40 feet square at bottom, and 40 feet high, with a hollow space or "flask" in the center, lined with fire-brick, and about 14 feet in diameter. The material dumped into the furnace becomes melted, and the iron, being the heaviest, sinks to the bottom, while the flux, like oil upon water, floats upon the surface, and, having an affinity for the dross of the coal and iron, it grasps and holds it separately from the metal, until it is drawn off in what is called *slag*. This is done once every hour. The gases evolved pass out at the chimney. The trouble is, the iron also has an affinity for the dross, and does, and will, retain some of it, notwithstanding all we can do.

"The floor of the building is of fine sand, divided into two parts by a track, on either side of which gutters, or *runners*, are formed leading from the mouth of the furnace. At equal distances are 8 branch gutters, or *sows*, as they are technically called, which conduct the molten ore to feed the *pigs* in the *bed*. All these are nicely formed by each set of hands after the previous cast has been cooled and removed." See BLAST-FURNACE.

"You see, there are 26 *pigs* in a *bed*, and 4 *pigs* in the *sow*; that is, they break the *sow* into 4 pieces, each the size of a *pig*. There are 16 beds, and consequently there are 480 *pigs*, or about 11 tons in each cast. At each of the branch gutters, or *sows*, a man is stationed with a spade, with which he prevents the metal flowing into his bed until the bed below him is filled, when he suddenly transplaces it, and, cutting off the flow downward, turns it into his own bed. The next man does the same in succession, and when all the beds on one side of the track are filled, the flow is turned in the same manner into the other *runner*, and the process is repeated until all are filled, when the opening in the flask is closed by clay prepared for that purpose. New supplies of coal, ore, and limestone are dumped in above, and the operation of smelting goes on for the next 12 hours."

The pig-iron is used either for casting, or for conversion into wrought-iron by puddling, etc. See CASTING; PUDDLING.

Howell's furnace for making malleable iron direct from the ore with stone coal, patented in the United States about 1831, was thus described by the inventor: "This furnace combines within itself the advantages of a close furnace and an open fire. In the upper or close portion, being all that above the hearth, with anthracite coal, excited by a proper blast, a degree of heat is generated much greater than can possibly be obtained in the ordinary fire with charcoal; while the lower portion, opening into the hearth and permitting the free action of the blast upon the burthen, performs all the offices of the open or forge fire. The ore, descending to the region of the tuyeres, becomes perfectly fused, and, passing below the influence of the blast, a part is driven out at the open front. The burthen in the furnace being temporarily supported by bars, the masses are gathered into a *loup*, which is removed by tongs and taken to the forge-hammer."

Smetz-glass. This is formed by fusing lengths of colored glass into each other, in layers either level or contorted, so the section shall resemble carnelian, agate, onyx, etc.

Smid'dum-tails. (*Mining.*) The slimy mud deposited in ore-washing.

Smift. (*Mining.*) A match of paper saturated with niter or other combustible substance, for igniting a charge of powder. A *fuse*.

Paper rubbed over with gunpowder and grease is also used by miners. See SLOW-MATCH.

Smit'ing-line. (*Nautical.*) A rope by which a yarn-stoppered sail is loosened without sending the men aloft.

Smock-mill. A form of windmill in which a cap rotates on a vertical axis to present the sails toward the wind. The term is used in contradistinction to *post-mill*, in which the whole mill rotates for a similar purpose.

Smoke-arch. (*Steam-engine.*) The smoke-box of a locomotive.

Smoke-ball. (*Ordnance.*) A paper shell filled with a composition which, when ignited, emits volumes of smoke. It is thrown into military mines to suffocate working parties, or into forts to cover an advance. It has also been used as a signal.

Smoke-bell. A glass bell suspended over a

gas-light, to intercept the smoke and prevent its blackening the ceiling immediately over the jet.

Smoke-black. Lampblack obtained by deposit of smoke from burning resinous material.

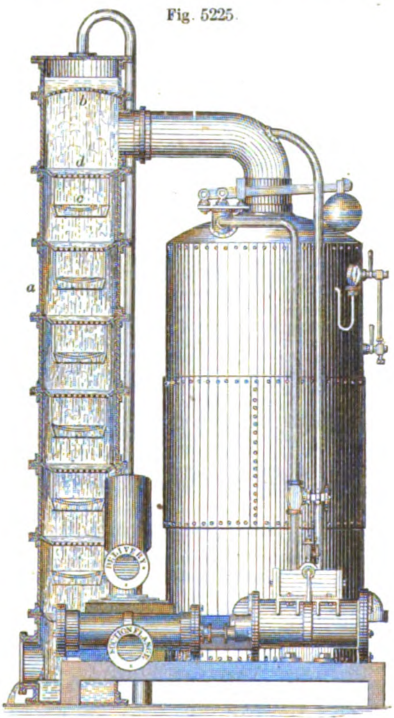
Smoke-board. A board placed against a fire-place to keep smoke from issuing into a room.

Smoke-box. (*Steam.*) *a.* A chamber in which the smoke and heated gases of the flues are collected, and from which they pass to the chimney, funnel, or stack. Some forms of reverting-flue boilers have smoke-boxes at each end.

b. In locomotives, the end of the boiler on which the chimney is placed. It receives the draft from the tubes. Locomotives with *inside cylinders* have them placed in this box, which keeps them and the steam-pipes at a high temperature.

Smoke-con-dens'er. An apparatus for precipitating the soot and smoke emanating from furnaces underground or in other confined situations. The chimney of the furnace is led into the upper part of the precipitator *a*, where it encounters a

Fig. 5225.



Smoke-Condenser.

stream of water delivered by a pump into the head of the apparatus and falling through a perforated diaphragm *b*, termed the *strom* or *strum*. The shower of water falls successively through a series of cups *c* and saucers *d*, and after having eliminated the fine solid particles from the smoke, is discharged through a pipe at the bottom. Where the water supply is large the cups and saucers may be dispensed with.

Smoke-con-sum'ing Fur'nace. Smoke has been defined as the visible effluvium or sensible exhalation of anything burning. So far as our subject is concerned, it may be considered as particles of finely divided carbon or pellicles of carbon containing inflammable gas. The object of the devices to be cited is to so apply the fuel that the escaping combustible matters shall be exposed to incandescent fuel and a due supply of vital air, which conjunction of agents will consume the combustible gases and the particles of carbon suspended therein.

In 1819, the British House of Commons appointed a commission to "enquire how far it might be practicable to compel persons using steam-engines and furnaces to erect them in a manner less prejudicial to public health and comfort, and report their observations thereupon to this House"

A large number of practical and scientific men were examined, and, the commission becoming satisfied that "the reduction of smoke from furnaces might be practically accomplished," a bill was brought forward and passed which made the avoidable production of smoke from furnace-chimneys an indictable and finable offense.

Complaints against the smoke nuisance are of very old date. Great prejudice was felt in former times in England against the burning of coal, known then as sea-coal, because it was brought from the Tyne to the Thames by sea. It was supposed to be injurious to trade, health, the complexion, and a whole catalogue of evils was feared from its use. In 1306, the king of England issued a proclamation against its use, and a commission was issued for the purpose of ascertaining who burned sea-coal within the city and its neighborhood, and to punish them by fine for the first offense and by the demolition of their furnaces if they persisted; but even these severe proceedings failed to put down the nuisance. A law was therefore passed, making the burning of sea-coal within the city a capital offense, and permitting its use only in the forges in the neighborhood. In the reign of the first Edward a man was tried, convicted, and executed for burning sea-coal in London.

"Much has been written on this branch of the subject [consuming smoke]. The principles concerned are extremely simple and easily applied.

"The volume of air supplied must be neither greatly in excess nor greatly deficient of that necessary for perfect combustion. If it be seriously deficient, the fuel, if bituminous, is partly only distilled or sublimed into black smoke and tarry soot, the adherence of which to the boiler surfaces becomes a cause of farther loss of effect.

"If the fuel be carbonaceous only, as coke, anthracite, etc., its gases are only oxidized to the state of carbonic oxide in part; and if the fuel be wood or peat, the last result occurs with the distillation of various tarry and acid products (pyroligneous acid), highly destructive to iron boilers.

"If the volume of air be greatly in excess, the heat of the furnace is reduced, and may be so to an extent to cause even imperfect combustion, and a great volume (or weight) of air is uselessly heated and discharged by the chimney.

"Non-bituminous fuel is more easily burned perfectly than bituminous; with either, but especially with the latter, if combustion is to be practically perfect, there must be a sufficient draft to carry the air-current steadily through the fuel. The layer of this upon the dead-plate and grate should never exceed 10 to 15 inches, and is best not to reach 6 or 7; but thin firing requires very careful stoking, or bare patches of grate are exposed, occasioning much loss. With coke or anthracite, and especially with a blast, a much greater depth of fuel may be practicable.

"The air is best admitted partly beneath and through the fuel, and partly in adjustable volumes, at or just behind the bridge, where it should be so arranged that the air and combustible gases shall mingle as completely as possible. This is the plan so much and so justly insisted on by Mr. C. W. Williams, Mr. Prideaux, and several others. The air admitted should be heated; and this is best of all done by the use of Mr. C. Siemens' regenerator, applied to the flues of the boiler between the latter and the chimney-stack. If the air be cold, the combustible gases are chilled more or less, and below a red heat these cannot burn perfectly or without the production of smoke. The area of air aperture at the bridge is fixed by Mr. Williams at 1 square foot for every 36 square feet of grate, when the latter burns 25 pounds of coal per foot per hour, and in like proportion for larger consumption. The maximum of economy will, in perhaps all boilers, be effected by the regenerative principle; and in this case the air passed into the flues above the fuel or at the bridge may be admitted at even 800° or 900° Fah.

"When the proportioning and arrangements of the furnace-grate and draft are such as to insure the conditions for complete combustion, the next great point to be attended to is, that the rate of passage through the flues, or past the heat-receptive surfaces of the boiler, must be such that the combustion of gases shall have been perfected before they have been robbed of so much heat by the boiler as to fall in temperature below that for complete oxidation; if not, smoke, soot, or tarry products may be still formed in the remoter ends of the flues.

"Where the regenerative system cannot be applied to the air-supply, Mr. Fairbairn's double furnace cylindrical boiler, for alternate firing, is the next best arrangement. It is one that practically works well with the ordinary amount of stoker's attention, which alone can be reckoned on." — ARMSTRONG.

One principal difficulty has arisen from the usual practice of placing the coals on top of the incandescent fuel, so that as the smoke is evolved it has free passage to escape by means of the chimney. This is the simplest way of feeding a fire, but is evidently wasteful, unless secondary means be employed to consume the matters thus escaping.

To obviate this, and cause the smoke to pass over a mass of burning fuel, various contrivances have been invented for introducing the fresh fuel beneath that which is already burning: among these may be mentioned Cutler's; and Dr. Arnott's, which is an improvement upon it. These and others are adapted for open grates. See GRATE, SMOKE-CONSUMING; BASE-BURNING STOVE.

Watt, in his specification of 1785, claims "constructing furnaces so that the smoke or flame of the fresh fuel is caused to pass, together with a current of fresh air, through, over, or among fuel which has already ceased to smoke, or which has already been converted into charcoal, coke, or cinders, and which is intensely hot." Several ways of effecting this are described by him. The introduction of fresh air, to consume the carbonaceous particles which have escaped the action of the air originally admitted to the furnace, is a very important element in producing a successful result, and appears to have been original with Watt. It has been introduced into most, if not all, subsequent devices of value.

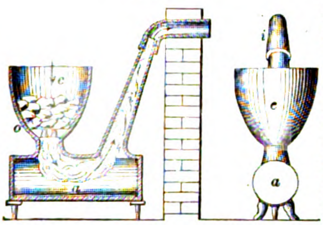
Among the plans suggested and practiced for securing the perfect combustion of the fuel and its resulting valuable gases, may be cited: —

1. Introducing the fuel into the fire in such manner that the smoke and gases evolved pass through a bed of red-hot matter.

To this class belong: —

a. The *Athanor* or constant furnace of the alchemists, used for keeping up a constant heat for many consecutive days, in their patient and laborious attempts to transmute base metals into gold, or produce the elixir of life. Alongside the fireplace was a hollow containing charcoal, and closed above by a tight lid. As the fire consumed the fuel, the charcoal descended and replenished it.

Fig. 5226.



Delasme's Smoke-Consuming Furnace.

b. Delasme's base-burning furnace, exhibited by him at St. Germain's, in 1685. It was in the form of an inverted siphon: the shorter leg *c* contained a grate *o*, and served as the fire-chamber, the longer leg *i* constituting the chimney; the smoke was thus caused to pass through the incandescent fuel, and more or less perfectly burned. The fire was kindled at the top, and the chimney *i* was heated by a lamp to originate the draft.

c. Watt's base-burning furnace, in which a body of coal is supplied in a hopper, the coal gradually falling into the fire as the substance of the lower layer is consumed. The coal-chamber may be covered in by a tight lid, so as to prevent the draft of hot air through it; or the inlet draft of air may be conducted through it. The former is perhaps the preferable mode, and the coal should be discharged through a throat of such capacity as, on the one hand, not to choke, and on the other, not to encourage, the access of fire to the contents of the supply-chamber.

Fig. 5227.

Watt's Base-burning Furnace.

In its character as a smoke-consuming furnace, it will be noticed that the fresh coal is constantly in contact with the incandescent fuel, and that all the gases evolved by the combustion are obliged to pass *through* a body of hot coals, whereby the hydrogen and carbon which constitute the valuable portion of the smoke are consumed.

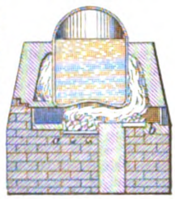
This feature is to be found in some stoves in which a body of coal is brought into contact with the fuel in such a manner that the volatile products of the fresh coal are compelled to pass *through* the incandescent mass of fuel.

d. Stoves of the base-burner class, in which the fuel is introduced beneath the fire. See STOVE, BASE-BURNER; MAGAZINE.

e. A furnace in which the escaping smoke from one fire is burnt at a second fire; also found in Watt's patent, 1785.

This is thus described in the words of the inventor: "I place the fresh fuel on a grate as usual, as at *a*, and beyond that grate, at or near the place where the flame passes into the flues or chimneys, I place another small grate *b*, on which I maintain a fire of charcoal, coke, or coals, which have been previously burned, until they have ceased to smoke, which, by giving intense heat and admitting some fresh air, consumes the smoke of the former fire."

Fig. 5228.



Watt's Double-Fire Furnace.

A modification of the Watt furnace, by a Mr. Thompson, patent 1796, had an extension of the grate bars and arched bridge, about ⅔ the distance from the front end. Beneath this bridge the volatile products of the first part of the furnace were carried, and deflected upon a mass of incandescent fuel, which occupied the rear portion of the furnace, where they were met by a current of air admitted back of the bridge. This backward portion was kept supplied with red-hot coals from the former fire, or by coke or charcoal separately introduced.

Gregson's patent, 1815 (also English), depended upon the exposure of the volatile and inflammable results of combustion, to intense heat at an aperture at the back of the fire and passing through the fire-bridge.

Losh's double-fireplace furnace, 1815, is another example of this class.

This furnace has two fires, which are alternately replenished with fuel. The fireplaces are connected, and either is thrown in connection with the chimney by means of suitable flues and dampers. The fireplace which has just received coal pours its smoke and gases into the mass of red-hot coals of the other fire, from whence the volatile matters, deprived of their inflammable gases and carbon, pass to the chimney. When the time comes to replenish the fire, the one which has acted as the secondary furnace receives the coal and delivers the smoke under the arch of the division wall to the other fire, which is connected to the chimney, by change of dampers.

The City Flour Mills, Upper Thames Street, London, are fitted with boilers consuming their own smoke, generating steam for an engine of 220 nominal horse-power. The boilers are 7 in number, and the engine is on the marine principle. The engine was formerly one of the stationary engines on the Blackwall Railway, when the carriages were drawn by a rope.

The furnaces are arranged in a row, with communicating flues guarded by dampers. When one fire has received fresh coals, its immediate connection with the chimney is closed, and the smoke is discharged into the adjoining furnace, whose fire is burning red.

2. The plan of admitting a second body of air to inflame the unconsumed combustible matters which pass away from the fire.

John and James Robertson, of Glasgow, patented a furnace in 1801, in which, by means of a pipe, air was admitted directly into the body of the fuel while burning, — the first practically successful contrivance of the kind.

In other cases, the air is admitted at or near the fire-bridge or in a chamber behind the fire-bridge.

Evett's reverberatory furnace (English patent, 1812) has a *conductor* which introduces a body of air through the bridge-wall, and ejects it upon the eddying volumes of smoke and gas which occupy the dome of the metal-chamber The size of the aperture in the air-tube was regulated by a valve. This is, perhaps, an advance upon Watt's patent of 1785, in which the accessory body of air passes through the grate-bars of a supplementary fire, which assists in the combustion of the smoke.

Chapman's furnace (1824) had hollow grate-bars, forming a series of parallel tubes opening into two boxes, one in front and the other behind the grate. The rear one connected with a hollow fire-bridge, which discharged heated air in jets into the volume of smoke passing over the bridge, thereby causing the heated gases to ignite.

C. Wye Williams' furnace depends for its action on the thorough intermingling of the gas evolved by fuel with atmospheric air before the temperature of the carbon contained in the gas, then in the state of flame, be reduced below that necessary for its ignition, — about 800°, according to Sir Humphry Davy. This is effected by admitting the proper proportion of air through several hundred half-inch orifices in and above the door-box. According to Mr. Williams, it is immaterial in what part of the furnace the air is introduced, provided that the above condition be attended to. In the experimental furnace at the Newcastle trial, the area of the openings for the admission of air was equal to four inches square for each square foot of grate-bars.

This received the prize of £500 offered by the Colliers' Association of Newcastle for the best furnace of the kind.

3. The *dead-plate* system. Also described in the specification of Watt's smoke-consuming furnace, 1785.

It had a grate with a slight descent to the rear, to enable the fuel to be pushed back from time to time, to give room for fresh coal. The fresh supply is laid on a plate called the *dead-plate*, at the front part of the grate. The fuel being *coked* by the heat, the gases and particles of carbon which form smoke are caused to pass over the incandescent fuel, and are thereby consumed.

The plan, to be successful, requires frequent feeding of the

furnace, and necessitates the opening of the furnace doors. To avoid this, self-feeders have been used, being hoppers by which the coal is introduced from time to time or continuously in small quantity.

Stanley's feed-apparatus for furnaces consists of a hopper at the front upper part of the furnace, containing a supply of small coals equal to a couple of hours' consumption. Through an aperture at the lower end of the hopper the coal drops between two grooved rollers, which crush it and allow it to fall upon the *dead-plate*, whence it is blown by air from a revolving fanner, which wafts it upon the burning fuel on the grate.

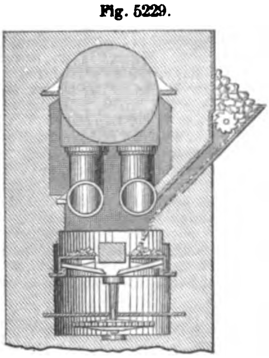
Other feed-apparatus consists in a hopper similarly situated, and having a counterpoised valve at bottom, which opens to allow the coal to fall upon the fire. Another feed will be described in connection with the *revolving grate.*

A feed-apparatus adapted to furnaces in which the fuel is burnt under pressure is illustrated in AIR-ENGINES, Bennett's patent, 1838.

4. The *revolving-grate furnace* was introduced in England by Steel, about 1818, and afterward improved by Brunton and Murray.

The fireplace is of circular form, and the grate is made to revolve on an upright axis by means of a cog-wheel on its lower extremity. The coal is placed in a hopper on the upper front end of the furnace, and is delivered in regular and graduated quantities by a roller so situated as to command the throat of the hopper. This roller rotates, so as to crush the coal to a proper size. The comminuted fuel traverses the inclined chute and falls upon the surface of the incandescent fuel on the grate, which revolves beneath. The illustration shows a tubular high-pressure boiler set in masonry. The rim of the rotary grate revolves in a trough with sand to prevent the passage of air around the edge of the grate.

Fig. 5229.



Steel's Revolving-Grate Furnace.

Brunton added a revolving scraper, which gathered up the ashes as they fell upon the ash-plate, and devices by which the rotation of the feed-wheel may be regulated to give a greater or less amount of coal, according to the requirements. It is not understood that a thermostatic arrangement was attached to graduate the amount of coal according to the heat of the furnace or the tension of the steam, or a device from the governor, which might also control the air-induction opening at the ash-pit.

In Juckes' furnace the fire-bars form an endless grate, which advances so that the fuel is gradually carried from the front to the back of the fireplace. Coal in regulated quantities is dropped from a hopper upon the front of the grate, and the air for burning the fuel passes between the bars. The whole area of the grate is covered with fuel, but, as the portion last laid on is always nearest the front, the smoke from that portion is compelled to pass over the more thoroughly ignited portion behind, where it undergoes thorough combustion, very little finding its way into the chimney.

5. Yet another method for attaining the perfect combustion of the smoke consists in injecting jets of steam into the furnace. Evans, in England, 1824, patented a method in which the steam was to be decomposed by passing through the hot fuel.

In 1844, Christian Burckhardt, of Cincinnati, consumed the smoke of a steamboat furnace by projecting fine jets of steam into its upper part.

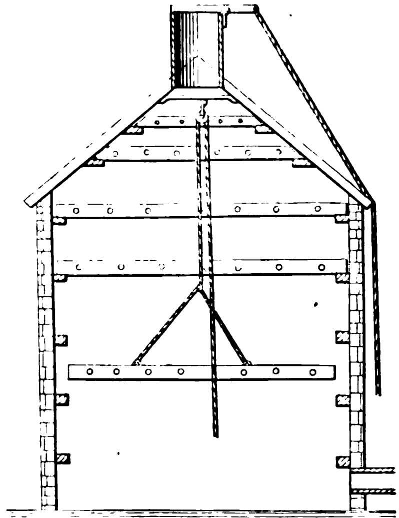
Economy of fuel being a secondary consideration on the Western waters, contrivances of this kind have met with but little attention.

Smoke-house. A building employed for the purpose of curing flesh by smoking. It is provided with hooks for suspending the pieces of meat, which are hung over a smudge or smoldering fire kindled at the bottom of the apartment.

"The Kerretani are a people of the Iberians. The hams they cure are excellent, fully equal to those of the Cantabrians." — STRABO.

In smoking on a large scale, the hams, shoulders, and sides are sometimes hung in an attic, and the smoke is conducted by pipes from the cellar, where it is made. This makes it cool on arrival, which is a great advantage. Green hickory wood is used.

Fig. 5230.

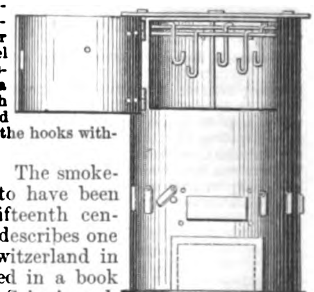


Smoke-House.

Fig. 5230 shows a smoke-house in which the beams from which the meat is suspended are held by cleats on the walls. A beam, being suspended by tackle within easy reach, is filled with meat and is then raised to its place in the house. A damper on top of the chimney regulates the draft.

Fig. 5231 is a sheet-iron portable smoke-house. It has a drawer for fire, a mica panel for observation, register air-holes, and a door above by which the meat is introduced to be suspended from the hooks within.

Fig. 5231.



Portable Smoke-House.

Smoke-jack. The smoke-jack is supposed to have been invented in the fifteenth century. Montaigne describes one he met with in Switzerland in 1580. It is noticed in a book on "Cookery," by Scippi, cook to Pius V. in 1570.

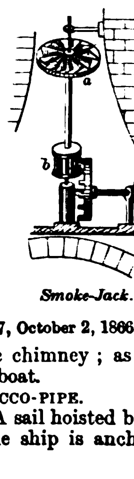
"My own jacke do carry it [a chine of beef] well." — PEPYS' *Diary*, 1663.

It was superseded by other roasting-jacks driven by animal or mechanical power, and all the jacks have, unfortunately for the meat and the consumers, been superseded by the oven, which bakes but roasts not.

The spit, so common in English kitchens in the last century, was frequently turned by a dog. The ordinary roasting-jack is called the *bottle-jack*, and has a clock-movement by which the suspended meat is turned at a moderate pace, so many revolutions in one direction and then in the opposite.

In the smoke-jack (Fig. 5232), the horizontal wheel *a* has a series of vanes or sails which cause it to be rotated by the current of smoke and heated air ascending the chimney, turning the wallower *b*, into which gears a crown-wheel that turns a pulley connected by a cord with a pulley on the axis of the spit. See also ROASTING-JACK.

Fig. 5232.



Smoke-Jack.

The principle has been applied to an engine. See Ensign's patent, No. 58,397, October 2, 1866.

Smoke-pipe. 1. A metallic chimney; as that of a locomotive, a stove, a steamboat.

2. A *smoking-pipe*. See TOBACCO-PIPE.

Smoke-sail. (*Nautical.*) A sail hoisted before the funnel of the galley when the ship is anchored

head to wind, to screen the quarter-deck from the smoke.

Smoke-stack. (*A chimney.*) The term *stack* is properly applied to a brick or stone chimney, but is not properly applicable to the funnel or furnace chimney rising above the deck of a vessel. With war-vessels the *funnel* is made telescopic, so as to be lowered during action.

The term *smoke-stack* is also applied to the chimney of a locomotive.

Smok′ing-pipe. See TOBACCO-PIPE.

Smooth-file. 1. A finishing-file, whose teeth are of a grade of coarseness between the *second-cut* and the *dead-smooth*. See ROUGH-FILE.

The number of teeth to the inch is according to the length of the file in inches.

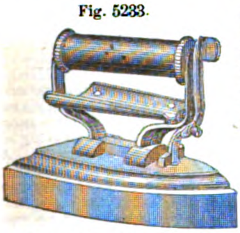
Inches..........	4	6	8	12	16	20
Cuts	112	83	72	72	64	56

The angle of the chisel in cutting is about 5° from the perpendicular.

2. The rubbing-tool used by the needle-maker in pressing and rolling a pack of wires, cut for needles, to take out of them the bend they have acquired by the coiling of the wire. See NEEDLE.

Smooth′ing-ir′on. A domestic implement, used in the laundry to smooth (iron) linen. It is heated by placing on a stove, by a gas jet, by a hot iron or charcoal fire placed within it. The various modes of heating, of attaching the handle, and devices for shielding the hand from excessive heat, give rise to many patents. See SAD-IRON.

Fig. 5233.



Smoothing-Iron with Shield.

Fig. 5234.

Egyptian Smoothing-Tool.

The shape and purpose, but not the material usually employed by us, are shown in a wooden tool found in Thebes. It was used in smoothing and pressing cloth, though Mr. Wilkinson thinks that the finish attained evidences the use of metal. Those found were about 6 inches in length, and made of hard wood.

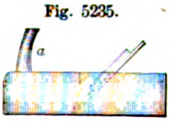
Smooth′ing-ir′on Heat′er. A heater for smoothing iron. See SAD-IRON HEATER.

Smooth′ing-mill. The polishing-mill of the lapidary. It is of tin, or wood covered with leather, revolves on a vertical axis, and is touched with rotten-stone, or other material adapted to the subject.

Smooth′ing-plane. A short plane, finely set, for finishing. It is $7\frac{1}{2}$ inches long.

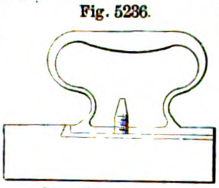
Fig. 5235 is a plane commonly used for roughing out, as the jack-plane is in England and this country. The horn *a* is held by the left hand, while the right is placed on the back of the stock. The horn is known as a *toat.*

Fig. 5235.



Smoothing-Plane.

Fig. 5236.



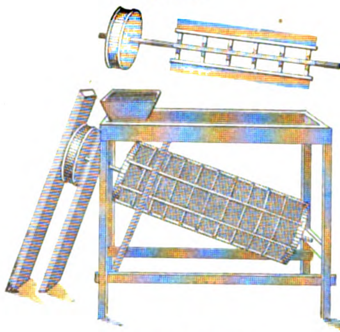
Smoothing-Stone.

Smooth′ing-stone. A substitute for a smoothing-iron, made of steatite, attached to a plate and handle of metal.

Smooth-plane. A smoothing or finishing-plane; the last used of the series of *bench-planes,* known respectively as *jack, trying,* and *smooth planes.*

Smut-ma-chine′. The smut-machine is said to have been invented by Hall, of Surry, England, and as contrived by him consists of a reticulated cylinder, inside of which are a number of brushes attached to the arms of a reel and revolved rapidly. The wheat passes in a continuous stream from the hopper above, and gradually finds its way down the inclined screen, at the foot of which it is discharged. By the action of the brushes and the current of air generated, the smut is driven through the meshes or perforations of the screen.

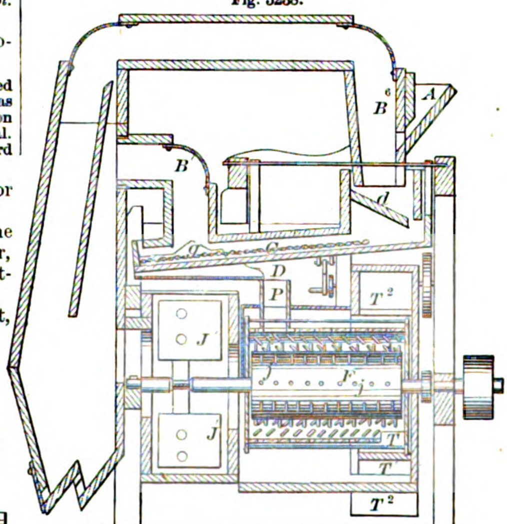
Fig. 5237.



Hall's Smut-Machine.

In the machine (Fig. 5238), the grain from the hopper *A* falls upon an inclined table *d*, and thence drops on to a vibrating trough *C*, having a roughened bottom and a transverse ridge-piece *g* to partially arrest the grain during its passage, and permit the blast from the fan *J′ J′* to act more efficiently in removing impurities, which are carried off by the

Fig. 5238.

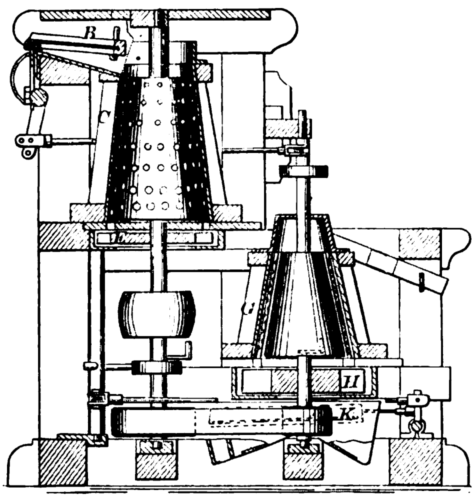


Smut-Mill.

spouts B' B^6. The grain drops on to the incline D, and is conveyed through the hopper P into an inclined receiver, where it is subjected to the action of a revolving beater F, studded with pins j j. The receiver has a series of spirally arranged slots, along which the grain is conducted to an opening T, passing into an inclined spout T', by which it is delivered into the vertical discharge-spout T^2.

In Fig. 5239, the grain is fed to the upper screen B, to remove the straw and coarse material; thence

Fig. 5239.



Smut-Machine.

it is delivered within the outer shell of the conical smutting-device C, which has at its base a fan E; thence the grain is passed to the conical brushing-apparatus G, which also has a fan H at its base; and finally it passes over a vibrating screen K to the hopper for grinding.

In another machine, a series of hopper-shaped revolving disks, with ribs on their upper sides, throw the grain centrifugally upon concentric rings, which drop it upon the next disk, until it reaches the outermost, where it is collected by a hopper, and passed to a similar arrangement on a lower level.

Snaf′fle. (*Harness.*) A bridle-bit with a joint in the middle, rings at the ends for the attachment of the reins, without *branches*, but in some cases having *cheeks* (side-bars) to keep the rings from getting inside the mouth of the horse. They are designated as *jointed*, *twisted*, or *double-mouth* snaffles, according to the construction.

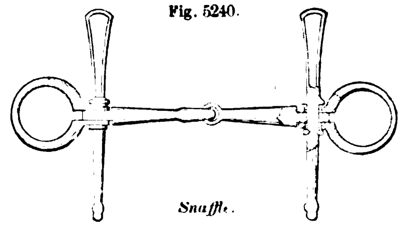
Snaffles are made heavy or light, gentle or severe. The action of pulling causes the sections to close against the gums of the lower jaw. When the pieces which form the bit are large, they are not so severe upon the mouth as when small, because the latter imbeds itself more deeply in the gums of the mouth.

The *snaffle* usually consists of 4 pieces, which are secured together by ring joints, so as to be movable on each other. The portions of the bit which meet in the middle mouth form ring-loops which engage each other. The rein-rings pass through holes in the other ends of the bit-pieces.

In Fig. 5240, the rein-rings, cheek-pieces, and jointed bars are made in separate parts, and are connected by passing the cheek-pieces through eyes, which are formed on the mouth-pieces and rings, and securing the whole together by bands or collars applied to the cheek-pieces.

The snaffle may be made more severe by coiling wire around it, or more gentle by wrapping it with leather or a band of india-rubber.

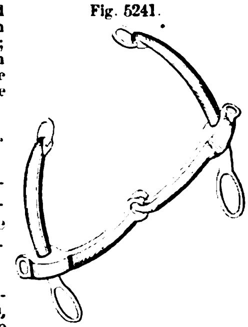
Fig. 5240.



Snaffle.

Price's bridle-bit, March 26, 1867, combines the snaffle-bit with a lever-bar, to confer power upon the bit. The headstall and reins are attached to the opposite ends of movable and sliding levers, which run through the eyes of the bit; these, as they are drawn through by the reins, increase the leverage on the jaw of the horse.

Fig. 5241.



Price's Bridle-Bit.

Snaf′fle-bit. See SNAFFLE.

Snag-boat. A steamboat with hoisting apparatus, employed on the Western rivers for removing snags.

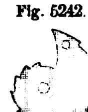
These obstructions to navigation are caused by large trees, which, being precipitated into the water, by the river undermining its banks, are borne away on the current, and occasionally get entangled, and even become firmly fixed, in the bed of the stream. Sometimes a branch of the tree is seen projecting from the water, but often no part of it is visible, the only indication of its existence being a slight ripple on the surface of the water. They have received from the boatmen of the Mississippi the names of *snags*, *planters*, and *sawyers*, bearing one or other of these designations, according to their positions and the manner in which they are fixed in the river. The term *snag* is applied to a tree firmly imbedded in the bottom, and lying at a considerable angle, with its top inclined down the stream. A *planter* is a tree firmly fixed in a nearly perpendicular position; and a *sawyer* is the name applied to a tree whose roots or branches have become entangled in the bed of the river, and whose trunk, being loose, is kept constantly swinging up and down by the current, alternately showing its head and plunging it under the surface. Sometimes several of these trees collect together in the same place, and form a small islet, which, after maintaining its position for some time, and gradually increasing its dimensions, at length attains an enormous magnitude, and often becomes an impassable barrier, extending along the river's course for many miles. This is what the boatmen call a *raft*. It generally occurs in the tributaries of the Mississippi, and not in the river itself. One instance of this is afforded by the Red River, and another by the Atchafalaya, a river flowing *out* of the Mississippi, at a point about 250 miles from the sea. The Atchafalaya raft extends over a space of 20 miles; but the river's bed, for the whole of this distance, is not filled up with drift-timber, — the actual length of the raft itself being only about 10 miles.

The *snag-boat* consists of two hulls, firmly secured to each other, at a distance of a few feet apart; and over the intervening space a deck is thrown, having an aperture left in the center. A powerful crab is placed over this aperture, from which strong chains and grapplings are suspended in the space between the two vessels. The snag-boat is propelled by paddle-wells, which, with the gearing for raising the snags, are worked by a steam-engine placed on its deck. In using the apparatus, the vessel is brought to an anchor over the snag or obstacle to be removed, and the grapplings are made fast to the pieces which are to be raised. The paddle-wheels being thrown out of gear, the engine is applied to work the crab, by which the snag is torn from its hold in the bottom of the river, and after being cut in short pieces is allowed to float down the stream.

Snail. 1. (*Machinery.*) A spiral cam.

2. (*Horology.*) A flat piece of metal of spirally curved outline, used for lifting a movable part, as the hammer-tail of a striking clock.

Fig. 5242.



Snail-Wheel.

Snail-wheel. (*Horology.*) A wheel having an edge formed in 12 steps, arranged spirally, the positions of which determine the number of strokes of the

hammer on the bell. The *snail* is placed on the arbor of the 12-hour wheel.

Snake-line. (*Nautical.*) Line used in worming a rope.

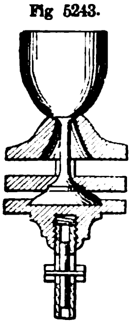
Snak'ing. (*Nautical.*) *a.* Passing a line spirally around a rope, so as to lie in the indentations between the strands. See WORMING.

b. Stoppers passed alternately from one stay or rope to another throughout their length in a parallel direction, so that if one is shot away its functions may be performed by the other.

Snap. 1. (*Harness.*) A mousing-hook for harness. See SNAP-HOOK.

2. (*Glass-making.*) An implement used in making glassware. In Fig. 5243, the central disk is movable and connected to the spring rod, by which it is drawn down upon the base of the goblet, which enters the cylindrical recess in the bed-plate.

Fig 5243.

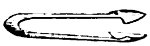


Snap for Glassware.

3. A tool used by boiler-makers for giving the head of the rivet a round and symmetrical form before it cools but after it has been closed.

4. The spring-catch of a bracelet, book-clasp, purse, reticule, etc.

Fig. 5244.



Snap-Dragon.

Snap-drag'-on. (*Glass.*) A kind of tongs used by glass-blowers to hold their hot hollow ware.

Snape. (*Shipbuilding.*) To bevel the end of a piece of timber, so as to make it fit against a surface which it meets obliquely. This angular fitting is also termed *flinching, snying, faying*, etc., in different trades.

Snaped Tim'ber. (*Shipbuilding.*) Timber cut beveling, so that one face is narrower than the other.

Snap-flask. (*Founding.*) A two-part flask having its halves joined together by a butt-hinge at one corner and a latch at the diagonally opposite corner.

Snap'hance. The name formerly applied to the spring-lock of a fire-arm. The word and the object were derived from Continental Europe. It superseded the wheel-lock. The *snaphance* fell upon a movable piece of steel, called a *frizel*, which was placed vertically above the *pan*.

Fig. 5245.

Snap-Head.

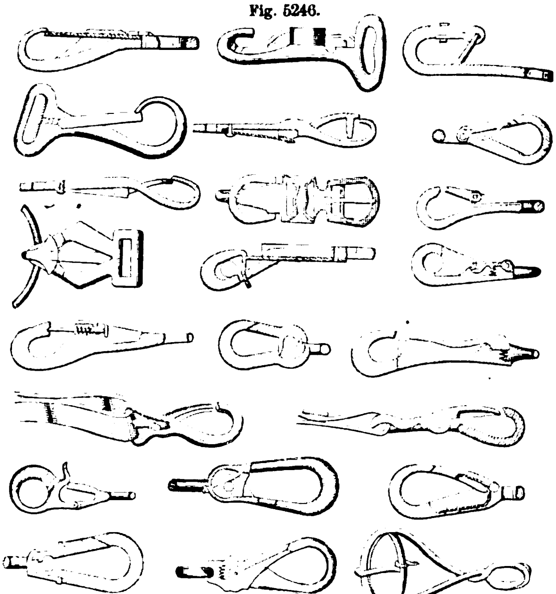
Snap-head. (*Machinery.*) *a.* A round head to a pin, bolt, or rivet.

b. A swaging tool with a hollow corresponding to the form required of a rivet. It is held over the end of the hot rivet and struck by a hammer.

Snap-hook. A hook with a spring mousing by which it is prevented from accidental disengagement with the object to which it is attached, as the bit-ring, hame-ring, or breeching-ring. The mousing formerly consisted of a spring, but a spring latch-piece is now the common form.

Fig. 5246 shows a number of forms of snap-hooks which require no particular description. In some the spring forms the latch; in others the spring actuates the latch.

Fig. 5246.

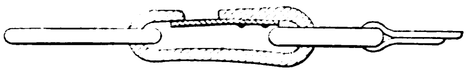


Snap-Hooks.

In Foster's machine for forming snap-hooks, February 2, 1875, a sliding frame and pawl feeds the wire into radial notches in an intermittingly revolving roulette, which, after the wire is cut off, carries it between guides to center it, and then under a griper, that holds it while the milling mechanism rounds the points. At the next movement of the roulette a plunger carries the wire out, and presses it against a former, where it is bent into U shape. Four side-dies are advanced to cross and form the sides, and two vertical plungers give a semicircular bend to the ends in reverse directions. Upon the withdrawal of these plungers, a mandrel is inserted into the loop, and a rear plunger advances and bends down the ends, so that they overlap and form a circle. The dies are withdrawn, and a pusher removes the finished article.

Snap-link. An open link with a spring, for the purpose of connecting parts of harness, chains, etc.

Fig. 5247.



Snap-Link.

Snap-lock. (*Hardware.*) A lock with a spring latch which snaps shut.

Snap'ping-tool. (*Metal-working.*) A stamping-tool used to force a plate into holes in a die.

Snare. 1. A gin; noose; trap. See TRAP.

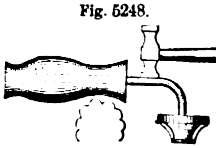
2. The gut stretched across the head of a drum.

Snare-drum. (*Music.*) A small military drum, having a catgut string stretched across its lower head, to impart a certain quality to the tone. The larger drum is called the *bass*-drum.

Snarl'ing. (*Metal-working.*) A method of raising hollow works in metal by percussion.

Snarl'ing-ir'on. 1. (*Metal-working.*) A tool used for fluting or embossing works in sheet-metal, when, from their shape, swages cannot be applied. Its two ends are oppositely curved, one being held by the jaws of a vise, and the other inserted through the mouth of the vessel and applied to the part to be raised. The iron is struck with a hammer, and the reaction gives a blow within the vessel, throwing the metal out in form corresponding to that of the tool, whether angular, cylindrical, or globular. One individual is

Fig. 5248.



Snarling-Iron.

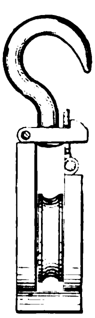
generally required to hold the work while another strikes.

2. (*Nautical.*) A tool used in the operation of snarling.

Snatch. (From *notch.*) An open lead for a rope. (See SNATCH-BLOCK.) If it be without a sheave, it is known as a *dumb-snatch*, such as are provided on the bows and quarters for hawsers.

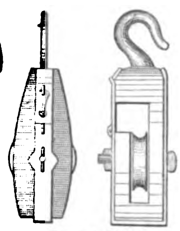
Snatch-block. (*Nautical.*) A single block which has an opening (*notch*) in one cheek to receive the bight of a rope. The block is iron-bound, with a swivel hook. The portion of the strap which crosses the opening or *snatch* in the shell is hinged, so as to be laid back when the bight of the rope is to be inserted, when warping the ship. This saves the trouble of reeving the end through.

Fig. 5249.



Snatch-Block.

Fig. 5250.



Snatch-Block.

Large blocks of this kind are called *viol-blocks* or *rouse-about blocks.*

Fig. 5249 is another form of snatch-block.

Snath. (*Husbandry.*) The helve of a scythe. The handles are *nibs.* Also known as a *sneath* or *snid.*

Snell. A short line of horsehair or gut by which a fish-hook is attached to a line. A *snood.*

Snick. 1. (*Fiber.*) A knot or irregularity on yarn, removed by passing it through a slotted plate.

2. (*Fur.*) A small snip or cut, as in the hair of a beast.

Snif'fle-valve. See SNIFTING-VALVE.

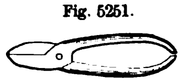
Snift'ing-valve. (*Steam-engine.*) A valve commanding the valve-way through which the air and water are expelled from a condensing steam-engine, when steam is *blown through* the engine.

This is the first operation in starting a condensing engine.

Snigg. (*Nautical.*) A kind of sailing-vessel.

Snip. A small hand-shears for cutting metal.

Fig. 5251.



Snip.

Snipe-bill. 1. (*Joinery.*) A narrow, deep-working molding-plane, used for forming quirks.

2. (*Vehicle.*) A rod by which the body of a cart is bolted to the axle.

Snoff. (*Mining.*) The slow-match for igniting the train in blasting.

Snood. A hair-line, gut, or silk cord by which a fish-hook is fastened to the line. A *snell.*

Snore-hole. (*Mining.*) The hole in the *wind-bore* or lower stock of a mining-pump, to admit the water.

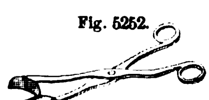
Snot'ter. (*Nautical.*) *a.* A becket on a boat's mast, to hold the lower end of the *sprit* which elevates the peak of the sail.

b. A rope going over a yard-arm, used to bend a tripping line to in sending down the topgallant and royal yards.

Snout. (*Hydraulics.*) The nozzle of a hose.

Snout'er. A cutting shears with one curved blade approximating to the shape of a hog's snout, and used for removing at one cut the cartilage wherewith he roots.

Fig. 5252.



Snouter.

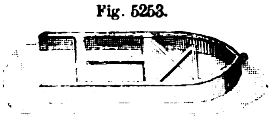
Snout-ring. A ring or staple placed in the nose of a hog to deter him from rooting.

Snow. (*Nautical.*) A brig-rigged vessel, whose *driver* is bent to rings on a supplementary mast just abaft the mainmast.

Snow-plow. This implement is used to clear a track of snow, and is of two kinds; one is adapted to be hauled by horses or oxen on a common highway, and the other to be placed in front of a locomotive. A variety of the latter is adapted for street railways.

The snow-plow for ordinary country roads has long been in use in Northern countries, and the Norwegian plow affords a good example of its general construction. The front is shaped like the bow of a boat, and the sides are braced by an internal framework. The bottom, top, and rear are open. The team is hitched to the ring on the upper edge of the bow, and the snow is divided to right and left as the implement is drawn along, being compacted on either side. A more rude implement is shaped like the letter A, and is drawn along by its apex.

Fig. 5253.

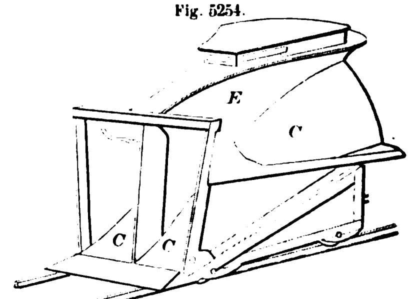


Norwegian Snow-Plow.

For railway purposes the snow-plow is adapted to the character of the country, the amount of snow-fall, tendency to drift, etc. On the Sierra portion of the Pacific Railway and on the Grand Trunk Railway of Canada, great preparations are made in advance of the winter season, and their snow-plows assume gigantic proportions. The depth of the snow is frequently so great that it cannot be compacted to right and left by a prow-shaped implement, but it becomes necessary to give the plow a double action; the upper portion of the snow is lifted and thrown to the right and left upon the snow on each side of the track, while the lower portion of the snow-plow is prow-shaped, and divides the lower stratum of snow, compacting it on each side against that adjacent.

In Fig. 5254, the plow is supported upon an inclined plane on a truck, and its angle is adjustable; it has two nearly vertical cutters, which cut the sides of the track, and a central one *E* for dividing the mass of snow which is carried up the two inclined spiral plates *C C* and discharged on top of the snow-bank at each side.

Fig. 5254.



Two-Story Snow-Plow.

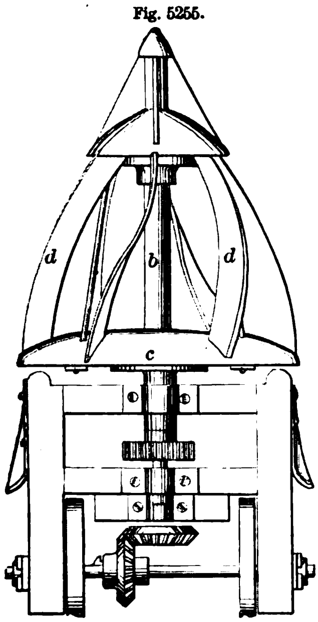
A snow-plow for the Union Pacific Railway, built at the shops in Omaha, is probably the largest and most powerful in the world. The platform on the trucks is 22 feet long, 10 feet 6 inches wide, and is composed of solid oak timbers, held together by iron bolts $1\frac{1}{4}$ inches in diameter, which run crosswise. This solid bed is bolted to the transom beams. The inclined side, placed on the platform, is 22 feet long, slopes at an angle of 30°, and is bolted to the bed and supported from behind by inclined posts. The entire length, from the rear of the platform end of the slide, is 32 feet. The slide is ironed, and an immense plow of the ordinary shape, 18 feet long, 11 feet wide, 5 feet high, and covered with iron $^3/_{16}$ of an inch thick, is placed upon it. On the point of this plow there is an iron plate, steel-pointed, 11 feet long and 4 feet wide. This plate, of course, runs across the track, and only 1 inch above it. The rear of the platform is boxed in, making a room 12 feet high, 11 feet wide, and 10 feet long, for the purpose of keeping the snow out. It is furnished with a door, so that it can be loaded if necessary.

The plow weighs 50 tons, and is operated by three of the heaviest engines on the road. The cost was over $5,000.

In another plow the snow lifted by the plowshare is raised and carried rearward by an endless apron.

The plow (Fig. 5255) consists of a series of spiral

Fig. 5255.

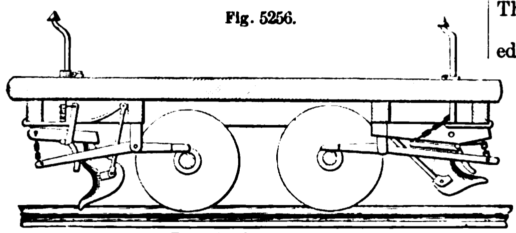


Revolving-Blade Snow-Plow.

blades *d d* connected to a back plate *c* and a pointed front plate, carried on the shaft *b* rotated by gearing from the front axle of the truck; curved side-wings and bottom-scrapers may also be attached to the truck for completely clearing the track.

Fig. 5256 is a snow-plow adapted for street-railways, one or the other being lowered into action according to the direction of motion of the car. The position of the plow, when down, is maintained by a spring, which allows it to yield to solid obstructions.

Fig. 5256.

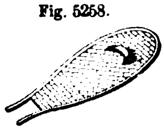


Snow-Plow for Street-Railways.

Snow-shed. A protection for a railway-track in exposed situations where snow-drifts are liable to accumulate on the track and prevent travel.

Snow-shoe. A light frame made of bent wood and interlacing thongs, used to give the wearer a broader base of support when walking on snow. The *tread* of the shoe is formed of strips of raw hide, hard-twisted twine, or, among the Indians, of deer-sinews. In use, the toe is placed beneath the strap and the foot rests on the thongs; as the heel rises in walking, the snow-shoe is not raised, but as the foot is lifted, the toe elevates the forward end of the snow-shoe, which is then dragged along on the snow as the leg is advanced.

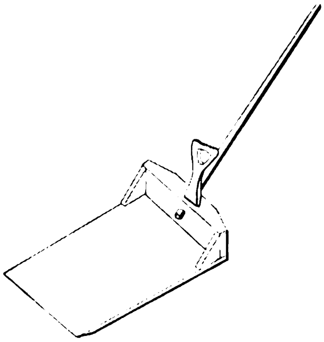
Fig. 5258.



Snow-Shoe.

Snow-shov'el. A wooden or metallic shovel for cleaning off pavements, garden-walks, etc. In the example, the hold for the left hand is secured to the stock of the blade by the stale, which affords a hold for the right hand. The parts are detachable for convenience in stowage.

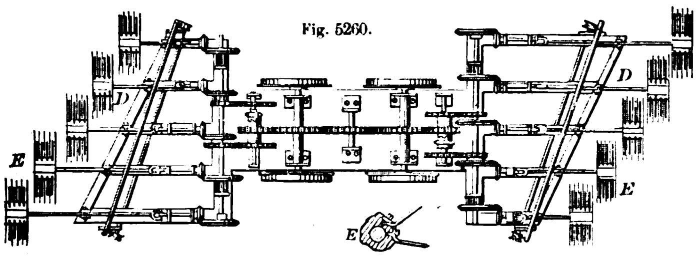
Fig. 5259.

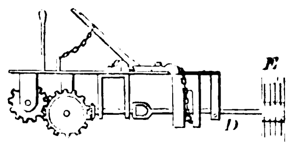


Snow-Shovel.

Snow-sweep'er. A vehicle or apparatus adapted for removing snow from paved streets. The machine (Fig. 5260) consists of a truck carrying a sweeping apparatus at each end, comprising a series of wire brushes *E E* on rods *D D* of unequal length, so that each is slightly in advance of its neighbor, and the whole completely covers the space to be swept. The rods are rotated by clutch connection with the truck-wheels, and have universal joints, so that they, with their frame, may be lifted from the ground when not in use.

Fig. 5260.





Snow-Sweeper.

Fig. 5257

Snow-Shed in the Sierra Nevada.

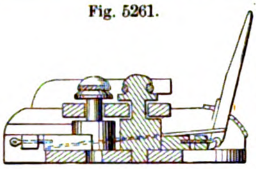
Snub. (*Nautical.*) To check a cable or other rope suddenly when running out.

Snub'ber. (*Nautical.*) A cable-stopper. A device for *snubbing*, that is, stopping the cable from running out.

Snub'bing-line. (*Nautical.*) The line on the bow of a canal-boat, which is taken one or two turns around a post or bollard on the land to check the forward movement of the boat in entering a lock.

Snub-post. (*Nautical.*) A form of bitt or mooring-post on a raft or canal-boat or flat-boat, used for winding the hawser around whereby the raft or boat is brought to a mooring. The same is

Fig. 5261.



Snub-Post for Rafts.

done on steamboats by making a figure-of-eight of the cable around the horns of a becket or kevel on the gunwale in checking the course of a vessel and bringing it up against the dock, easing away the cable when the strain is too severe. In the example, the hawser is wound in serpentine order round several posts standing in two rows, and a hand lever and rod bring a brake into action to check the running of the rope by friction applied to the snubbers. A *head-fast.*

Snuff'er. A shears for cutting the wicks of candles.

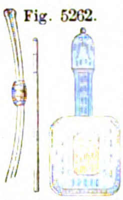
"A new-fashioned case for a pair of snuffers, which is very pretty" — PEPYS' *Diary*, 1668.

Snuff-mill. A machine consisting of a circular arrangement of mortars around a central axis, which is occupied by a master wheel giving motion to the rolling pestle in each mortar.

The snuff-mills of Holland are on a very large scale, and are impelled by wind.

Although Columbus found smokers in the Antilles, and Pizarro first beheld chewers in Peru, yet Brazilians were the first and best fabricators of snuff. Fig. 5262 illustrates their milling and sniffing apparatus. The figure represents a slab of rosewood with a depression for holding the dried leaves while being triturated with a stick of the same material. The friction of the two pieces of odoriferous wood develops a pleasant aroma, which impregnates the powder. While yet warm with the friction, the snuff is inhaled by a double pipe, also shown in the figure. It consists of a double tube formed of two light bones obtained from the wings of a young crane, united by a thread and terminating at their upper ends in small wooden bulbs. The plain ends of the tubes being inserted in the powder, and the others inserted into the nostrils, a smart inhalation distributes the scented dust over the membrane of the nose.

Fig. 5262.



Brazilian Snuff-Mill and Sniffers.

"Take out your box of right Brazil." — POPE.

The taking of snuff — as a habit — is said to have been first adopted in Europe by Catherine de Medici. It was called *herbe de la reine*, 1560

Snug. 1. (*Machinery.*) A small rib, lug, or marginal ridge, cast on to a plate and acting as a lateral support to keep an attached object in place; as, on the edge of a bracket-sole. See BRACKET.

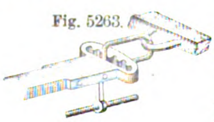
2. (*Steam-engine.*) One of the catches on the eccentric pulley and intermediate shaft, for the purpose of communicating the motion of the shaft through the eccentric to the slide-valves.

Snug'ging. The operation of rubbing down the fuzzy fibers of rope to improve its finish. Known also as *slicking* or *finishing.*

Sny. (*Shipbuilding.*) *a.* A gentle bend in timber curving upward. If it tend downward, it is said to *hang.*

b. The trend of the lines of a ship upward from amidship toward the bow and the stern.

Fig. 5263.



Soam.

Sny'ing. (*Shipbuilding.*) A curved plank worked edgeways into the bow of a vessel.

Soam. A chain by which the leading horses are hitched to a plow. To preserve the line of draft and not draw down the nose of the plow-beam, the *soam* is supported by a hanger below the clevis.

Soap A compound of fatty substances with soda or potash. The processes of making soap are chemical rather than mechanical, and we refer the reader to Ure and Muspratt. A historical account of soap may be found in Beckmann's "History of Inventions."

The Hebrew word rendered *soap* and the fuller's soap both refer to an alkali, and the first distinct mention of soap, now extant, is probably the reference to it by Pliny, in his "Natural History." He speaks of it as the invention of the Gauls, who also discovered the useful properties of brewer's yeast in bread; they were the first to invent a reaping-machine, which was in use from the time of Pliny to that of Palladius, about 400 years. Pretty well for the Gauls. Their record is superb.

The Gallic soap, 18 centuries back, was made from tallow and wood ashes, beechwood ashes being preferred. Beech is a very common wood in France, as well as in England and the United States. A soap-manufactory has been exhumed in Pompeii, the apparatus and manufactured soap in tolerable preservation.

Soap is occasionally mentioned by writers from the second century down (Athene, A. D. 193; Ætius, fourth century); but the more cleanly Saracens, who invented the shirt, seem to have been among the first to popularize the use of soap as a detergent for clothes, and as an external cleansing application.

Soaps are divided into *hard* and *soft;* in the former, soda, and in the latter, potash, is used as the base. A hard soap may be made with potash if a solid fat be employed, but soda soaps are always harder than potash soaps with the same fatty substance. The proportions of alkali required to effect saponification, when dry and pure material is employed, vary from 10 to 14 of soda, or from 15 to 20 of potash, to each 100 parts of the fatty substance employed. Tallow and soda are generally employed for white soaps in Northern climates, but where, as in the South of France, the olive-tree abounds, inferior olive-oil is used. The celebrated brown Windsor soap contains about 10 per cent of this oil, mixed with the tallow.

Marine or *salt-water* soap is made from cocoanut or palm oil, and has the property of being soluble in salt water, which renders it valuable on board ship. It solidifies with a much larger quantity of water than other soaps, samples having been found containing 75 per cent of water.

White soap is, in general, too hard for domestic use, but forms a basis for many toilet and fancy soaps.

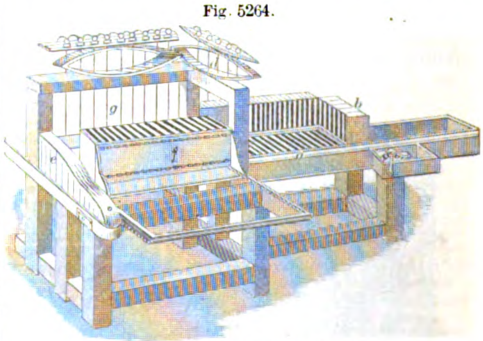
Transparent soap is made by evaporating a soda or potash soap after dissolving it in alcohol; marbled soap, by adding a little sulphide of iron. Silicated soap is made by adding a small quantity of silicate of soda or of alumina to ordinary hard soap.

Colored soaps are produced by mixing mineral colors with the fluid mass; marbled soaps, by rubbing up the coloring ingredient with a little olive-oil or soap, which is then stirred in with a palette-knife, so as to impart a wavy appearance.

There are many other names, geographical, chemical, etc., as Castile, carbolic, etc.

Soap Bar'ring and Cak'ing Ma-chine'. The machine (Fig. 5264) has two followers operated by

Fig. 5264.



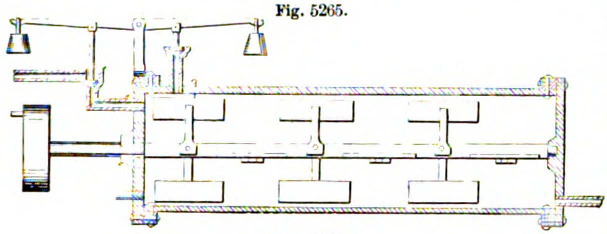
Soap Barring and Caking Machine.

rack and pinion motion and traversing on frames at right angles to each other; a slab of soap is placed on the rollers *a* and carried by the follower *b* against a series of vertical wires *d*, which divide it into bars; by a farther movement of the crank, these are deposited upon the second frame *e*, where the follower

f operates to press them sideways against the vertical wires *g*, dividing the bars into cakes.

Soap-boil'er. A pan for boiling the materials for soap. The example (Fig. 5265) is a closed vat

Fig. 5265.

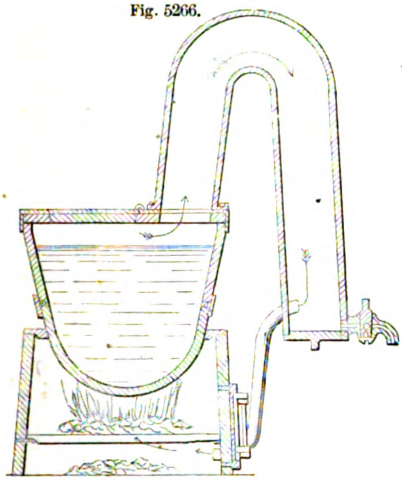


Soap-Boiler.

with rotary stirrers for agitating and commingling the materials under heat and pressure.

Fig. 5266 is a soap-boiler having a large pipe which receives the vapors rising from the kettle, condenses

Fig. 5266.

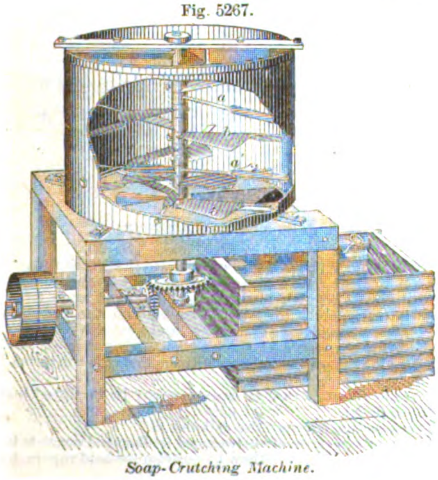


Soap-Kettle.

the watery matters, and passes the inflammable vapors under the grate-bars.

Soap-crutch'ing Ma-chine'. An apparatus

Fig. 5267.

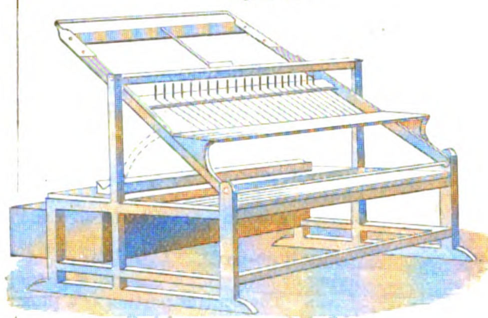


Soap-Crutching Machine.

for *crutching* (mixing) soap. That illustrated consists of an upright cylinder containing a number of radial fixed arms *a a'* and spiral wings *b b'* on a vertical shaft rotated by gearing. The soap is let into the top of the tank, and the spiral arms, being set in motion, act as screws, lifting the heavier materials from the bottom toward the top, and thoroughly intermingling the mass without forming air-bubbles. Any clippings and trimmings are also cut to pieces and incorporated.

Soap-cut'ting Ma-chine'. Fig. 5268 is a machine commonly used in England for dividing soap into bars. A slab of soap is placed in an inclined position and subjected to the cutting action of a series of wires fixed in a pivoted frame; by depressing one end of this frame, the wires cut the soap into bars, which remain on a shelf attached thereto when the frame is again lifted.

Fig. 5268.



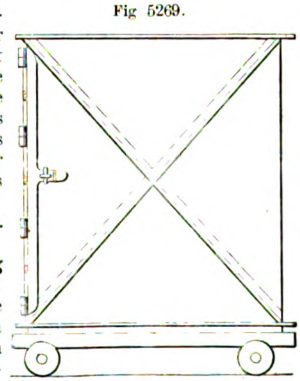
Soap-Cutting Machine.

Soap-frame. A box to hold soap and retain it till it acquires a certain degree of solidity.

It consists of a series of rectangular frames, which are built upon each other to the required hight, and clamped together by screw-rods, so as to make water-tight joints; or of a box whose sides are locked together and to the bottom. In either case the sides or sections are removable from the body of hardened soap, so as to leave it standing, in order to be cut into bars by a wire. See SOAP-CUTTING MACHINE.

In Fig. 5269, the base is mounted on wheels, and has a rabbet around its upper edge containing a rubber packing, against which the sides are clamped. The frame is formed of plates bent at right angles and joined together at diagonal corners by hinged clamps.

Fig 5269.

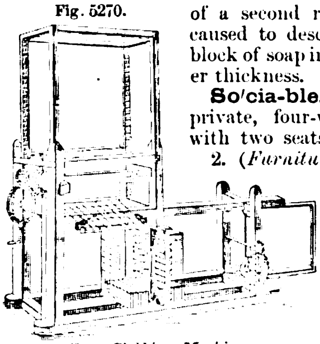


Soap-Frame.

Soap-ket'tle. See SOAP-BOILER.

Soap-slab'bing Ma-chine'. Fig. 5270 has a carriage reciprocated by a rack and a pinion operated by a hand-crank; the soap is placed on the carriage and run beneath a horizontal frame provided with wires, which are adjustable as to distance apart; on turning a crank, the frame is, by means

Fig. 5270.



Soap-Slabbing Machine.

of a second rack and pinion, caused to descend, cutting the block of soap into slabs of proper thickness.

So'cia-ble. 1. (*Vehicle.*) A private, four-wheeled carriage with two seats facing.

2. (*Furniture.*) A kind of couch with a curved S-shaped back, for two persons who sit partially facing each other.

Sock. 1. (*Husbandry.*) The movable share of a plow, so called from its being slipped on to the point of the *sole*.

2. (*Wear.*) A short hose for the foot.

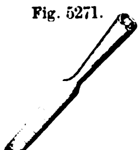
Sock-dol'a-ger. A fish-hook having a supplementary spring hook to catch the fish which touches the bait. See *f*, *i*, *l*, Fig. 2000, page 872.

Sock'et. A tubular recess in which an object is fitted.

The acetabulum of a ball in that form of universal joint.

Sock'et-bolt. (*Machinery.*) One passing through a thimble or sleeve between the parts bolted together.

Fig. 5271.



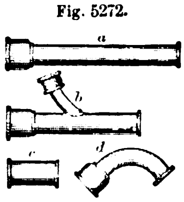
Socket-Chisel.

Sock'et-chis'el. A stout chisel employed for heavy mortising and having a hollow tang to receive the handle.

Sock'et-drill. A drill for chamfering or enlarging a hole to a given depth. The central portion is a plug which occupies a hole previously made.

Sock'et-pipe. A pipe with an enlarged end or branch to receive the end of a connecting pipe, and hold the clay, lead, or other packing which unites the two, to make a water or gas tight joint.

Fig. 5272.



Socket-Pipes.
a, Length of Socket-Pipe.
b, Branch Piece.
c, Connecting Piece.
d, Elbow.

Sock'et-pole. (*Nautical.*) An iron-shod pole used in propelling boats.

So'cle. (*Architecture.*) A plain block or plinth, forming a low pedestal to a statue or column; or a plain face or plinth at the lower part of a wall.

So'da-ap'pa-ra'tus. In the ordinary process of preparing carbonate of soda, the sulphate of soda derived from common salt, treated with sulphuric acid, is heated with chalk and slaked lime or coal. This is known as the Leblanc process.

For a century past efforts have been made to accomplish the direct conversion of the salt into soda by means of various reagents, as oxide of lead, bicarbonate of magnesia, caustic lime, alumina, silica, sesquioxide of chromium, or hydrofluo-silicic acid; but without success on an extended scale.

The "ammonia process," which is now being adopted to a considerable extent in Germany, France, England, and elsewhere, is based upon the action of bicarbonate of ammonia upon a concentrated solution of chloride of sodium, by which the greater part of the solution is precipitated as bicarbonate of soda, chloride of ammonium remaining in the solution: this is treated with caustic lime, reconverting the chloride into ammonia, which is bicarbonated and employed to decompose another portion of the salt solution.

In 1837 Bell, and in 1838 Dyer and Hemming, in England, patented processes in which ammonia was employed.

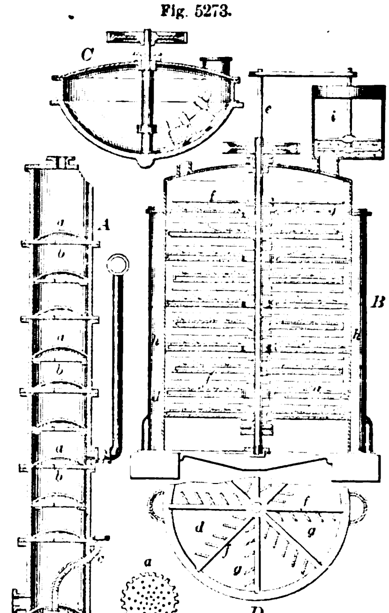
In 1854 Tuerck, and subsequently Schloesing, obtained French and English patents for similar processes, under which attempts were made to manufacture on a large scale, but proved unprofitable.

Improvements were afterward made by Margueritte and De Sourdeval of Paris, and Young of Limehouse, Great Britain, and in 1867 soda produced on the large scale was exhibited at the Paris Exposition by Solvay & Co. of Belgium. The process employed by them is as follows: —

A strong brine is prepared in a reservoir divided by upright partitions into six or more compartments, so connected that a stream of water flows in at the bottom of the first, out at the top of the second, into the bottom of the third, and so on until it becomes saturated with salt; on passing into the last compartment, which is larger, it is diluted by a stream of fresh water to the density of 23° or 24° B., and filtered. It thence flows to the bottom of a second vessel, higher than it is wide, made of tinned iron, or lead lined with wood, and having a perforated bottom, through which the gaseous ammonia enters and is absorbed as it rises through the brine. The liquid increases in volume, its density decreasing to 16° or 13° B. On reaching a certain hight it is known to be saturated, and is allowed to flow through a cooler into the absorber *A* at a point near midway of its hight. This is a cylinder from 35 to 50 feet high, and is divided by a number of perforated segmental plates *a*, beneath which are other flat plates *b* having fewer perforations, the object being to permit the carbonic-acid gas, forced in at a pressure of $1\frac{1}{2}$ to 2 atmospheres through the pipe *c*, and also the non-saturated liquid to ascend, but prevent it from descending to mix with the saturated portion at the bottom. The expansion of the gas prevents the heating which would otherwise ensue. The liquid, saturated with carbonic acid, is drawn off at intervals of half an hour, and the bicarbonate of soda separated by means of a vacuum filter. The remaining liquid, a chloride of ammonium, is then heated with caustic lime, chloride of calcium being formed while the ammonia is expelled and re-collected, or magnesia is employed for this purpose; the resulting chloride of magnesium is heated with water; when hydrochloric acid is given off, leaving caustic magnesia, which may be again employed.

The bicarbonate thus formed is reduced to the ordinary carbonate of commerce by means of the cylinder *B*, having a number of horizontal plates *d* with openings at the center and periphery. A vertical axis *e* passes through the cylinder, and has arms *f f* provided with blades *g g*, so arranged as to force the material alternately toward the center and the periphery of the plates. The plates *d* are hollow, and heated by steam or hot gas entering through *h h*; the bicarbonate is put in at *i*, and by the time it reaches the bottom of the cylinder is converted into the dry protocarbonate.

Fig. 5273.



Ammonia-Soda Apparatus.

A kettle *C* heated over an open fire may be employed instead of the cylinder.

D is a section through the cylinder *B*.

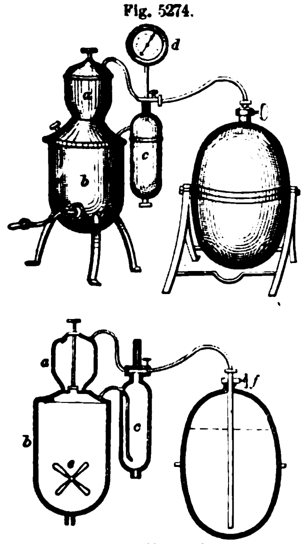
A new process recently introduced in England consists in decomposing chloride of sodium by sulphurous-acid vapors drawn

directly from the pyrite burners. This does away with the lead chambers usually employed, which are costly to build and keep in order. The sulphate of soda produced is reported to be very pure.

Another method of preparing soda and soda salts is that used at Natrona, Pa., and consists in treating the mineral cryolite, which is a double fluoride of sodium and aluminium. This is treated in a reverberatory furnace with quicklime, producing calcium fluoride and aluminate of soda, which is lixiviated out. The alumina is precipitated by carbonic acid, and used for preparing alum and sulphate of alumina. The carbonate of soda is crystallized to form sal-soda, which is then bicarbonated in the usual way. The soda from this source is very pure, and is largely used for making glass. The calcium fluoride is used as a flux for metals. In this cryolite process all the products are utilized. See also SODA-FURNACE; SODA-FOUNTAIN; AËRATOR; FOUNTAIN.

So'da-foun'tain. A vessel for containing soda-water or water charged with carbonic-acid gas under high pressure, and provided with pipes and valves for drawing it off as required. Soda-fountains are usually made of copper, and should be lined with silver to prevent corrosion. Steel is also employed.

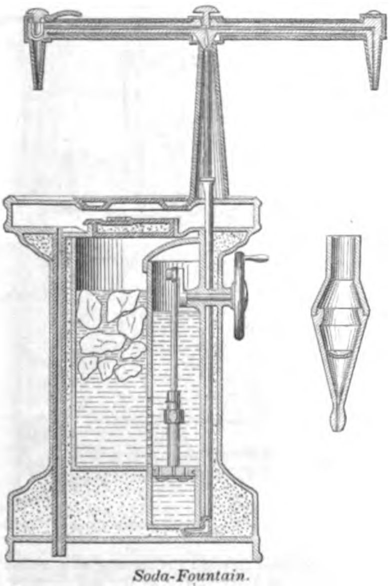
Fig. 5274.



Soda-Fountain.

Fig. 5274 illustrates a simple apparatus for generating the gas and charging the fountain. The generator *a b* consists of two parts communicating by a valved opening. The lower part is partially filled with chalk or other nearly pure carbonate of lime, the upper with sulphuric acid. On opening the valve by turning a small hand-wheel, the acid is brought in contact with the chalk, which it decomposes with the evolution of carbonic-acid gas; this is passed through a purifier *c* containing some material which will remove any deleterious matters from the gas, and provided with a gage *d*, which indicates the degree of pressure in the vessels. The carbonate is kept in motion by a rotary stirrer *e*, and when the desired pressure is attained, the cock *f* is opened, permitting the gas to flow into the fountain *g*, which has been previously partially filled with water, in which a small quantity of soda is, in some cases, dissolved. Pure water is, however, usually employed, and a flavoring sirup added when the fluid is drawn. See FOUNTAIN, Fig. 2086, page 911.

Fig. 5275.

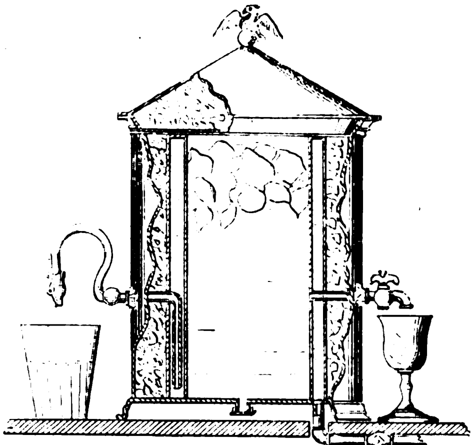


Soda-Fountain.

Fig. 5275 is a portable arrangement for village or picnic use, in which the aëration of the water is produced by the action of acid on an alkali in a chamber near the nozzle. The pump-cylinder is guarded by a perforated partition from the ice-chamber. The water is forced by a piston to the main pipe, the delivery ends of which are respectively a nozzle for plain ice-water, and a nozzle in which an effervescent powder lies upon a perforated diaphragm in the discharge-cup.

In Fig. 5276, the soda-water passes through the annular space between an ice-chamber and an outer case containing some non-conductor of heat. Discharge-faucets communicate with the soda-water reservoir and the ice-chamber. See SODA-WATER APPARATUS.

Fig. 5276.

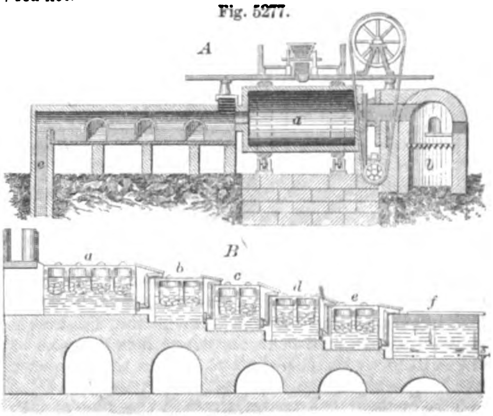


Soda-Fountain.

So'da-fur'nace. A furnace for converting sulphate of soda, obtained by treating common salt with sulphuric acid, into the carbonate. This is effected by fusing the sulphate in combination with chalk and slaked lime or small coal, — according to Leblanc, 100 parts sulphate, 100 chalk, and 50 slaked lime, — but the proportions are varied.

_A_ (Fig. 5277) represents the rotary furnace used for the purpose. It consists of an iron cylinder _a_ lined with fire-clay and having an opening at one side into which the charge is dumped from a wagon above, the cylinder having been previously heated red-hot.

Fig. 5277.



Soda-Furnace.

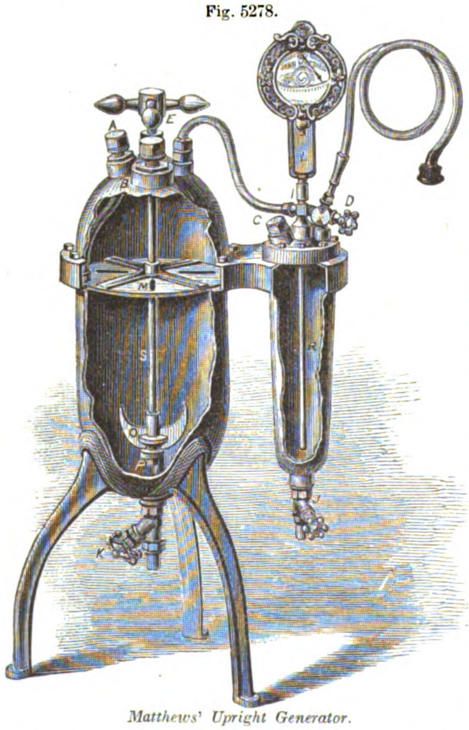
The opening is then closed, and the cylinder, which is provided with exterior ribs resting on friction-wheels beneath, is caused to make a few semi-rotations until the mass inside fuses, when a slow rotatory motion is maintained until the operation is completed. The rotation is effected by suitable belting and gearing, and during the process the heat is maintained by the products of combustion from the furnace *b*, which pass through the cylinder from end to end, and are carried off by the flue *c*. The charge in England is usually about 14 cwt. On the Continent, where the reverberatory furnace is in general use, much larger quantities are employed.

The crude soda is refined by lixiviation. *B* represents Desorme's apparatus for this purpose. It consists of a number of tanks *a b c d e* (usually 12 or 14 are employed) connected by a series of bent pipes ascending from the bottom of each vat to the top of that next below it in the series. The tanks are filled with warm water, and in *e* are placed two perforated vessels filled with pulverized soda; at the expiration of 25 minutes these are removed to *d* and replaced by others; the vessels are thus transferred consecutively from the lower to the higher vats until all are filled, when the first are removed, drained, and emptied. Each time that fresh soda is placed in the vat *e* an equal quantity of water is added to the upper vat, causing a transference of the same amount of lye from each vat to the one below it, until finally received in the clearing-tank *f*, where any impurities are deposited.

So′da-pa′per. A paper made by saturating filtering paper with carbonate of soda. Used for inclosing powders which are to be ignited under the blowpipe, so that they may not be blown away. Also used as a test paper.

So′da-wa′ter ap′pa-ra′tus. Fig. 5278 shows an upright carbonic-acid-gas generator. The acid and water are charged through the bung *A*, and are conducted by a pipe to below the diaphragm *M*, on

Fig. 5278.



Matthews' Upright Generator.

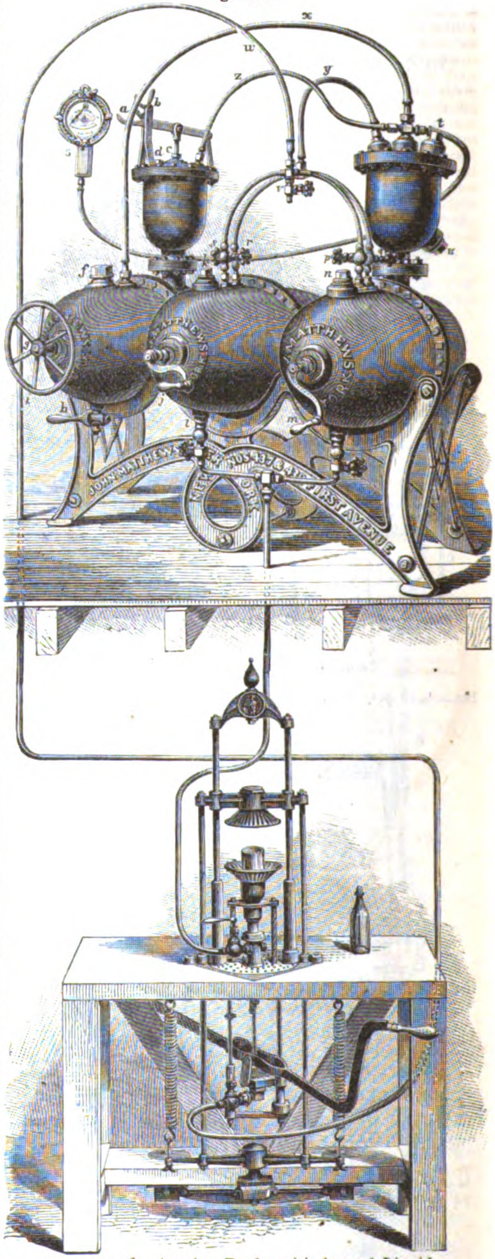
which the marble poured through the bung *B* rests. On turning the handle *E*, a four-winged valve causes this marble to drop through slits in the diaphragm into the dilute acid beneath, where it is diffused by the agitator *O* on the shaft *S*. *K* is the generator discharge-valve.

The evolved gas passes through the pipe *C* into the washer *R*, which is charged through the bung *C*, and, after passing downward through the purifying liquid, is conducted to the fountain by a pipe, to which it may be admitted by the valve *D*.

Fig. 5279 illustrates a Matthews apparatus for aërating beverages, having a horizontal generator and two stationary fountains in connection with an apparatus for charging bottles fitted with gravitating stoppers.

Each fountain is about two thirds filled with pure cold water through the apertures closed by the plugs *k n*, which are then inserted and screwed home. The gas-washer is, in like manner,

Fig. 5279.



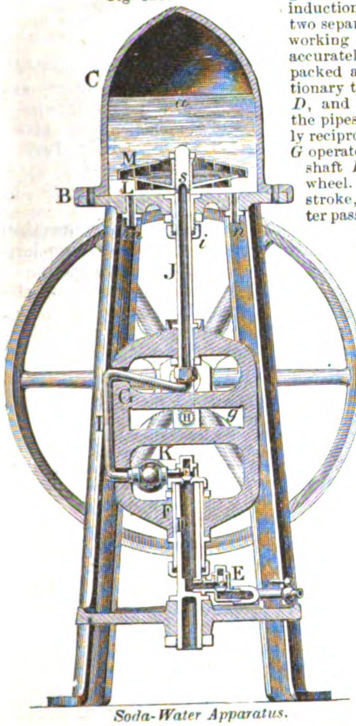
Apparatus for charging Bottles with Aërated Liquid.

about two thirds filled through the opening at *t*, which is then also closed. The discharge-valve *e* of the acid chamber is then

closed by depressing the lever *a*, which is locked by a cam *b*, and sulphuric acid is poured in through a bung *d*. Water is poured into the generator through the bung *f*, and afterward marble, and the two are mingled together by turning the hand-wheel *i* on the agitator. The lever *a* is raised to open the valve *c*, which admits acid into the generator, and the agitator turned until the required pressure is indicated by the gage. The gas passes by the pipe *a* through the washer, and by turning the valve *s* is admitted to the middle fountain, where the agitator is set in operation by turning the handle *j*, thoroughly intermingling the gas and water. Then, through the medium of the stop-cock *r*, connection is made with the bottling-machine. This should be located at least six feet lower than the generating apparatus. The bottle is placed neck downward in the socket of the machine, and is secured by depressing a treadle. Elevating the hand-lever inserts a tube within the neck of the bottle, and, by opening a gas-valve beneath the machine, charges the bottle with gas from the top of the fountain above. The lever is then depressed, and a cock on a pipe leading from the lower part of the fountain is opened, by which the bottle is filled with aërated water. When the middle fountain is emptied, the cock *s* is closed and *q* opened, thus utilizing the remaining gas in that fountain to charge in part the end one; *r* and *q* are then closed and *p* opened to complete the charge directly from the generator. When the proper pressure is thus attained, the cock *q* is opened, permitting the gas and water to flow to the bottling apparatus as before. The bottling-machine is thus alternately put in connection with each of the fountains of the apparatus.

In Matthews' improvement on the "Bramah" apparatus (Fig. 5280), water and gas are admitted to the induction-tube through two separate pipes. The working cylinder *F* is accurately fitted and packed around the stationary tubular plunger *D*, and together with the pipes *I J* is vertically reciprocated by a yoke *G* operated by the crank-shaft *H* of the hand-wheel. At each upward stroke, the gas and water pass through an upwardly opening valve *c*, into the plunger *D*, and at the down stroke a valve at top of the plunger lifting, they are conveyed upward through *I J* and discharged through a series of holes near the top of the latter, which passes through a stuffing-box in the base-plate *B*, and carries two disks *L M*, having scroll-shaped passages beneath, with their spirals arranged in reverse directions; the gas and water circulate around the lower one of these, and are conducted to the other, where, after circulating in the opposite direction, they escape through a central discharge orifice into the condenser *C*. This circulatory movement, together with the churning reciprocatory motion of the disks, tends to insure the complete aëration of the water. The condenser is provided with suitable outlets through the bed-plate for the attachment of a pipe leading to the bottling-apparatus and a pressure-gage or safety-valve. The pressure of gas in the condenser assists the down stroke of the pump, and there are no joints above the water-line *a* to be made gas-tight.

Fig. 5280.

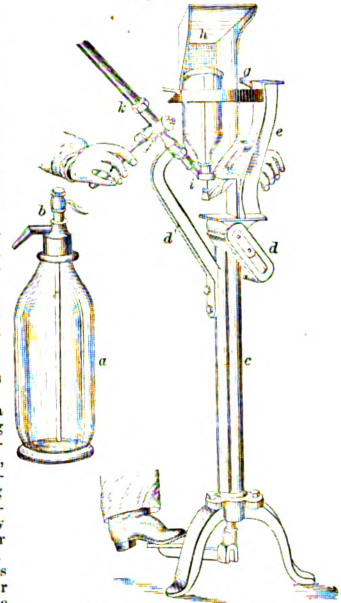


Soda-Water Apparatus.

Matthews' method of making vessels for containing gases and liquids under pressure consists in forming the cylindrical body of several thicknesses of tough sheet-metal, as steel, coated with tin and united by sweating them together. This may be done by inserting several cylinders of slightly varying diameters, one within the other, or rolling a single sheet of metal into volute form, the mode of effecting the junction of the layers being in either case the same; the segmental ends are formed in like manner, and similarly united to the cylindrical body.

Vessels constructed on this principle are used for holding the compressed carbonic-acid gas which serves as a motor for the fish or self-propelling torpedo used in United States naval service.

Fig. 5281.

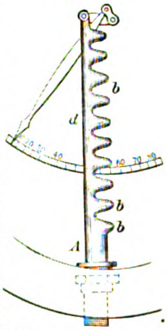


Bottle-Filling Apparatus.

Fig. 5281 is a filling-apparatus.

The bottle *a* has a nozzle *b* communicating with a tube descending nearly to the bottom of the bottle, and has a vertically moving valve, which is depressed either by a thumb-lever or by a knob at top. The apparatus has a tubular standard *c*, at the top of which is an inclined guide *d*, carrying a sliding plate supporting the frame *e*, and raised by depressing a treadle. At the lower part of the frame is a shelf, having an orifice of sufficient size to receive the neck of the bottle. The upper part of the frame has two semicircular arms *g*, one of which is pivoted so as to swing open; the two embrace the bottle, and are secured by a catch; this arm is also provided with a shield to prevent the operator being injured by fragments, should the bottle burst. The bar *d'* holds the socket of the charging-pipe *k*, through which the aërated liquid flows. In charging, the bottle is placed in position in the frame, which is raised by depressing the treadle, bringing the nozzle *b* into a socket on the end of the charging-pipe; by a movement of a lever near *e*, the valve of the bottle is raised, and with the other hand the cock of the pipe *k* is opened, permitting the fluid to flow; when filled, the cock is closed, the interior pressure closing the bottle-valve. See SIPHON-FILLING APPARATUS.

Fig. 5282.



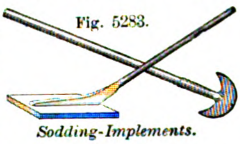
Matthews' Pressure-Gage for Soda-Water Apparatus.

Fig. 5282 is Matthews' pressure-gage for soda-water apparatus (No. 13,468, of 1855). The tube *A* has offsets at one side in the form of hollow plates *b*. By forcing steam or other fluids into the tube, the effect will be to expand or press apart the horizontal portions of the offsets *b*; and thus that side of the tube becomes elongated, producing a deflection of the tube, which (by connection of the upper end of the tube with an indicator) will indicate the pressure. The tube is made by electrotyping upon a core of easily fusible material, such as stearine, which is to be melted when the electrotyping has been finished. This is one of the earliest applications of metal formed by electro-deposition to a strictly mechanical purpose.

Sod-cut'ter. An implement for cutting sods or turfs from the ground. A *paring-plow* or sod-spade.

Sod'ding-im'ple-ments. Tools for cutting sods and laying them down. A sharp bent-handle spade is used for cutting the sods; or, on a large scale, a paring-plow is used.

Fig. 5283.



Sodding-Implements.

In laying down the sods, a curved knife is used, and a flattening mallet for pounding the sods flat.

So'di-um. Equivalent, 23; symbol, *Na* (natrum); specific gravity, 0.972; fusing-point, 190° Fah. This metal was discovered by Sir Humphry Davy in 1807. Sodium is a white metal, oxidizes readily in the air, and rapidly on contact with water. If the water be previously heated, it is decomposed so rapidly and with so much heat as to inflame the hydrogen.

The salts of sodium are widely diffused.

Common salt (chloride of sodium), caustic soda, sulphate of soda (Glauber salts), carbonate of soda, etc., etc., are highly useful in the arts, in glazes, fluxes, medicines, gunpowder, soap, and in preserving meat, as a condiment, etc., etc. See SODA-APPARATUS.

So'di-um A-mal'gam. See AMALGAM, pages 72, 73.

Sod-plow. A plow long in the share and moldboard, adapted to cut and overturn sod.

Sof. A plain cloth made of the hair of the Angora goat.

So'fa. A long, stuffed couch, with seat, back, and ends upholstered.

The couches of the Egyptians, Persians, and Greeks were expensive and handsome. The latter obtained them from their Eastern connections, as indicated by the statement of Athenæus that "Artaxerxes gave Temagoras the Cretan a tent of extraordinary size and beauty, and a couch with silver feet; and he sent him also expensive coverlets and a man to arrange them, saying that the Greeks did not know how to arrange a couch. Plato the philosopher says: 'Men now distinguish the couches and coverings with reference to what is put round the couch and what is put under it.' And his namesake, the comic poet, says: —

'There the well-dressed guests recline
On couches rich, with ivory feet,
And on their purple-cushions dine,
Which rich Sardinian carpets meet.'

For the art of weaving embroidered cloths was in great perfection in his time." — ATHENÆUS (A. D. 220).

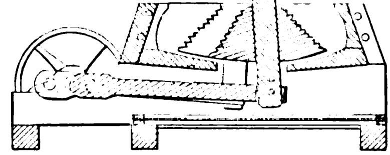
Sof'fit. (*Architecture.*) *a.* The lower surface or *intrados* of an arch.

b. The ceiling of an apartment divided by cross-beams into compartments.

c. The under part of an overhanging cornice or projecting balcony.

Soft'en-ing-ma-chine'. (*Leather.*) A machine of the nature of a fulling-stock, for beating the hides in water to saturate them, as a preliminary to other processes. In that illustrated, the skins, in lieu of simply soaking, are placed in the fulling-mill and water allowed to run into the same. Loose wool is collected by a wire at bottom. The machine is especially employed in the soft or oil treatment of skins of sheep, goats, chamois, deer, etc.

Fig. 5284.



Machine for Softening Sheep-Skins.

Soft Sol'der. An alloy used for soldering.

Tinman's soft solder is usually composed of 2 tin, 1 lead; sometimes, from motives of economy, more lead is used; 1½ tin to 1 lead is the most fusible solder of this kind made without bismuth.

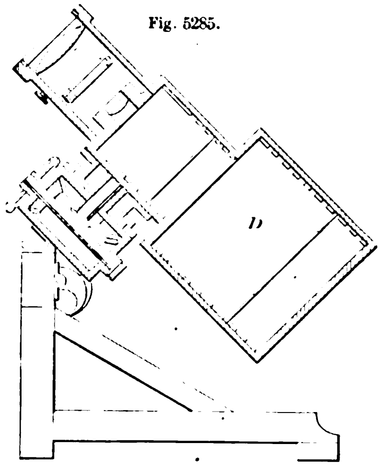
Pewterer's soft solder consists of 2 bismuth, 4 tin, 3 lead; or, 1 bismuth, 1 tin, 1 lead. See pages 62, 63.

Soil-pul'ver-iz'er. (*Husbandry.*) A machine for breaking clods. A form of harrow or flanged roller. See CLOD-CRUSHER, Fig. 1334.

So'lar. (*Architecture.*) A loft or upper chamber of a building. See SOLLAR.

So'lar Cam'e-ra. (*Photography.*) An instrument for enlarging by sunlight. Usually for obtaining an enlarged positive from a negative on glass.

Fig. 5285.



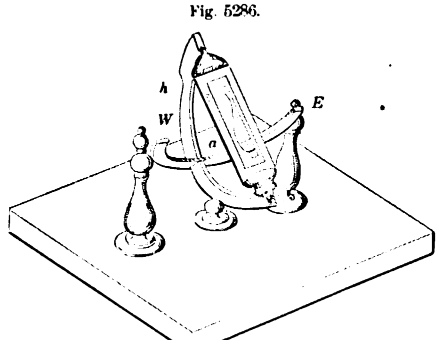
Solar Camera.

The instrument is sometimes used in connection with a heliostat, which keeps the condensing lens directed to the sun. The board to receive the paper for the enlarged picture is placed in such of the grooves in the box *D* as may be adapted to the required enlargement. See also Fig. 3676, page 1681.

So'lar Chro-nom'e-ter. A sun-dial adapted to show mean instead of solar time.

In Fig. 5286, the hour arc *W a E* has the divisions of time engraved upon it, and is set parallel with the equator. To this the arc *h*, which carries the gnomon frame, is centrally fastened, and so that the gnomon is parallel with the earth's axis. The gnomon is a plate perforated by a longitudinal groove, one of whose sides is formed by a curve, the co-ordinates of which are respectively proportional to the sun's declination and to the difference between mean and apparent time for each day, or for successive series of days sufficiently long to render the change in the equation of time graphically appreciable in the scale on which the dial is constructed, so that the shadow cast by the edge of this curve is thrown backward when the sun is fast, and forward when it is slow, to an extent equal to his variation from the mean or clock time, always indicating the mean time upon

Fig. 5286.



Solar Chronometer.

the scale of the equatorial arc. The gnomon must be reversed after each equinox.

So'lar En'gine. An engine in which the heat of the solar rays is concentrated to evaporate water or expand air used as a motor for a steam or air engine.

Archimedes, concentrating the heat rays by mirrors, is said to have set fire to the Roman fleet before Syracuse; however this may be, Buffon, nearly twenty centuries afterward, proved that it was practicable. See BURNING-GLASS.

Professor Mouchat, in France, in 1861, and since, has contrived various apparatus for cooking, distilling, baking, and heating the boilers of engines by solar heat.

Captain John Ericsson has constructed several engines having boilers provided with mechanical devices, contrived by him for effecting the necessary concentration of the solar rays, which he states, when collected from 100 square feet of surface, will effect the evaporation of 489 cubic inches of water per hour,—more than equivalent to one horse-power. This, however, is but a small proportion of the potential energy actually developed by the solar heat hourly received upon this area, which he estimates to be equivalent to that caused by the combustion of 200,000 pounds of coal in the same time.

These experimental engines have cylinders of 2 to 5 inches in diameter, with 6 inches stroke, and have no peculiar constructive novelty; this being confined to the heat-concentrating apparatus.

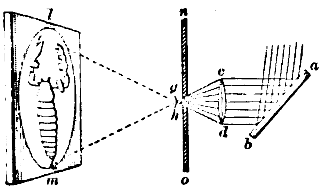
Some are operated by atmospheric air heated to a temperature of 480°, and others by steam of much lower temperature. The speed attained has been in no case less than 100 revolutions per minute, while a regular and continuous rate of 300 revolutions per minute has been reached.

So'lar Eye-piece. Invented by Dawes. An arrangement by which the light and heat are reduced in solar observations by observing only a very minute portion of the solar surface.

So'lar Lamp. Another name for the ARGAND-LAMP (which see). It has a tubular wick and central duct which admit air to the interior of the flame. See page 142.

So'lar Mi'cro-scope. A microscope which throws the magnified image of an object illuminated by the sun's rays upon a wall or screen. A simple form is shown in Fig. 5287. *a b* is a mirror which receives the sun's rays and reflects them through the concentrating lens *c d* upon a transparent object to be magnified. This is placed just within the focus of the magnifying lens *g h*, which throws the image upon the wall or screen *l m*, the size of the magnified figure depending on the distance the instrument is placed from the wall. The room is darkened, usually by a perforated shutter *n o*. This instrument has been now generally superseded by the OXYHYDROGEN MICROSCOPE (which see).

Fig. 5287.



Solar Microscope.

So'lar Tel'e-graph. A telegraph in which the rays of the sun are projected from and upon mirrors. The duration of the rays makes the alphabet, after the system of Morse. It was proposed to apply it to the use of the French army in Algeria, the posts to be established at twenty leagues from each other. See HELIOTROPE.

Sol'der. A metal or alloy used to unite adjacent metallic edges or surfaces. It must be rather more fusible than the metal or metals to be united, and with this object the components and their relative amounts are varied to suit the character of the work.

"Brass is united with brass only by pewter."—LUCRETIUS, Book VI.

Solders are distinguished by specific names, defining quality, composition, or purpose, as *hard, soft, white, spelter, gold, silver, copper, tin, plumber's, pewterer's, button*, etc.

Hard solders are such as require a red heat to fuse them; they are employed for joining brass, iron, and the more refractory metals. Soft solders melt at a comparatively low temperature, and are used with tin and lead, of which metals they are wholly or in part composed. Common tin solder, composed of 1 tin and 2 lead, is perhaps the best-known example of this class. Spelter and silver solders are the most generally used among the hard solders. See ALLOY, page 63.

SOLDERS.

Soft. For lead: tin, 1; lead, 1½. For tin: tin, 1; lead, 2. For pewter: tin, 2; lead, 1.

Hard. For brazing, hardest: copper, 3; zinc, 1. For brazing, hard: tin, 1; copper, 4; zinc, 3. For brazing, softer: tin, 2; antimony, 1.

Gold solder: gold, 1; silver, 2; copper, 3.

Silver solder, hardest: 4 parts fine silver; 1 copper. *Hard:* 3 parts sterling silver; 1 brass wire. *Soft:* 2 parts fine silver; 1 brass wire; ¼ part arsenic is sometimes added at the close of the operation, to make the alloy whiter and more fusible.

Hard brass solder: 8 brass; 1 zinc or tin. *Soft brass solder:* 6 brass; 1 zinc; 1 tin. For iron or steel.

For soldering iron and steel to brass: 3 tin; 39½ copper; 7½ zinc.

White or button solder: 10 parts tin; 6 copper; 4 brass. Also, 10 copper; 8 brass; 12 spelter or zinc.

Fine gold, laminated and cut into shreds, is used for soldering articles, as chemical vessels of platinum, and for gold alloys; silver for soldering German silver; copper in shreds for iron.

The alloy No. 8 in the list, page 62, 2 tin, 1 lead, is used for a variety of metals, as cast-iron and steel, tinware, copper and its alloys, lead and tin pipe, and Britannia ware, an appropriate flux being employed in each case. See list of melting points, ALLOY, page 62.

The fluxes generally employed for soldering, and also for welding, are—

For iron: borax, or sal-ammoniac.
For tinned iron: rosin, or chloride of zinc.
For copper and brass: sal-ammoniac, or chloride of zinc.
For zinc: chloride of zinc.
For lead: tallow, or rosin.
For lead and tin pipe: rosin and sweet-oil.
For pewter: Gallipoli oil (an inferior olive-oil).
For steel: sal-ammoniac, 1 part; borax, 10; pounded together, fused, and pulverized.

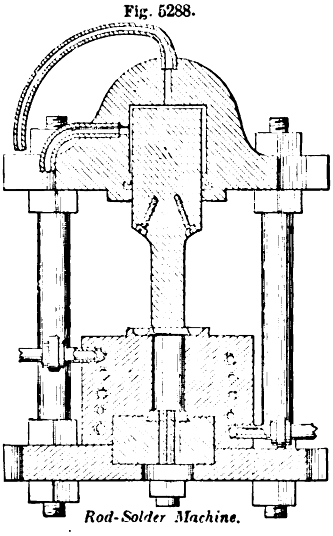
A liquid for use with soft solder is made by dropping small pieces of zinc into 2 fluid ounces of muriatic acid until bubbles cease to rise, and adding ½ teaspoonful of sal-ammoniac and 2 fluid ounces of water to the liquor. See SOLDERING; also page 63, *ante*.

Soft solder is manufactured and sold in the form of ingots, cakes, or rods; the latter are sometimes prepared by forcing the metal in a semi-fluid state through a series of apertures in the bottom of a heated reservoir, in which the metal is poured while fluid, by means of a ram operated by hydraulic power; in other cases the rods are cast in cylindrical radial openings in a wheel, which is caused to rotate beneath the metal reservoir in a manner somewhat analogous to that employed for casting type.

The hard solders are prepared in irregular masses or grains; the finer kinds are drawn into strips or wire.

Sol'der-cast'ing. A mode of making molten solder into sticks or drops for more convenient use.

Fig. 5288.



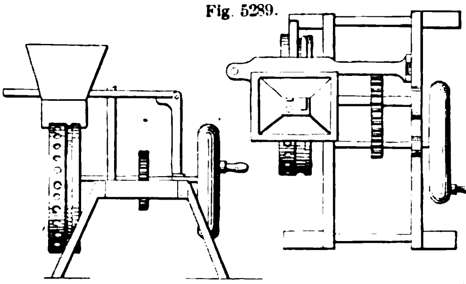
Rod-Solder Machine.

In Fig. 5288, the solder contained within a steam-heated block is expressed therefrom through the perforated bottom by the ram of a hydraulic engine. The die is pierced with numerous holes of the form and size of the rods to be produced.

In Fig. 5289, the reservoir containing the melted metal is hinged by a bar

to a standard on the frame, so as to be elevated when required. The metal passes through an opening in

Fig. 5289.



Drop-Solder Machine.

the floor into the pockets of the periphery of the mold-wheel revolving beneath.

To make spindle-shaped drops, pour the melted solder into cold water at as low a heat as the metal will run. Pour a steady stream ⅛ inch in diameter from a hight of 3 inches above the water.

Sol'der-ing. The process of uniting two pieces of the same or of different metals by the interposition of a metal or alloy, which, by fusion, combines with each. In autogeneous soldering, the two pieces are directly united by the partial fusion of their contacting surfaces, without the intervention of an alloy. See Fig. 738, page 309.

The modes of applying heat are: —
The naked fire.
Hollow furnace or muffle.
Immersion in melted solder.
Melted solder poured on.
Heated iron not tinned.
Heated copper tool tinned.
Blow-pipe flame.
Alcohol flame.
Stream of heated air.

This art was understood and practiced in ancient Egypt. Vases made of imbricated or overlapping plates, and supposed to be soldered together, are represented in tombs of Thothmes III., 1490 B. C. Tin forms an ingredient in soft solder, and was brought from Britain by the Phœnicians 1000 B. C., and probably long before. Malacca also yielded tin in very remote ages.

The pieces which went to form the stand of the silver vase presented to the temple of Delphi by Alyattes, king of Lydia, were of iron inlaid with gold, and were soldered together. This, if it were the second Alyattes, was about 617 B. C. Soldering leaden pipes is mentioned by Vitruvius.

Soldering was apparently unknown in Greece in the time of Homer. Hammered plates, such as armor, were united by mechanical fastenings, — nails, pins, rivets, cramps, and dovetails.

In the ordinary process of soldering small articles, — as, for example, of tinware, — the workman places the two metallic surfaces together, and then, with his *soldering-iron*, which has been previously heated to the proper temperature in a small charcoal furnace beside him, he melts off sufficient solder from the stick or cake, allowing it to flow on, and between the parts to be joined: the hot iron is then applied to the joint, so as to cause the solder to become uniformly fluid, equalize its distribution, and smooth its exposed surface. See also CAN-SOLDERING MACHINE, Fig. 1074, page 452.

Large and heavy pieces of iron and steel are united by interposing sheet copper or brass between the parts to be joined, which have been previously cleansed by filing. They are then fastened together by wire, and the joint is covered with moist clay free from sand; this is allowed to dry, and the pieces are exposed to a blast until they become white-hot and the clay is vitrified; less heat is required for brass than for copper. In soldering iron to iron, the pieces are cooled in water, but in soldering steel to steel they are cooled slowly; brass solder is employed for articles of moderate size, either of iron, steel, or brass. Very fine iron or steel articles are united by pure gold, or hard gold solder, which is also employed for gold. Silver solder is used for silver, and sometimes for German silver. A silver solder, composed of equal parts of silver and malleable brass, is also employed with small iron and steel articles.

For *brazing* or hard soldering, the blacksmith's forge is frequently used, but, in general, a special hearth similar to the forge, but more conveniently arranged for receiving large objects, is used. For large and long works, a flat iron plate standing on four legs having a central aperture for the fuel and provided with tuyeres fed by a fan blower, and having a counterpoised hood suspended from the ceiling, is used. For small works, as articles of jewelry, the blow-pipe is employed, by which the flame of a lamp with a large wick is directed upon the object held upon a charcoal support. The Birmingham cheap jewelry makers employ a gas-jet, and support the object upon a disk of iron covered with a kind of mat composed of fragments of wire and provided with a handle; the blast from a pair of bellows is directed upon the work by a tube.

Great care is taken that the surfaces to be joined shall be perfectly cleaned by filing or scraping: this having been done, they are placed in contact and held, if necessary, by binding wires; the granulated spelter and powdered borax or other proper flux are mixed in a small cup with a very little water and spread upon the joint by a slip of sheet-metal or a spoon. The article is now exposed to the heat, causing first the borax and afterward the solder to fuse and run into the joint, the operation being sometimes assisted by tapping.

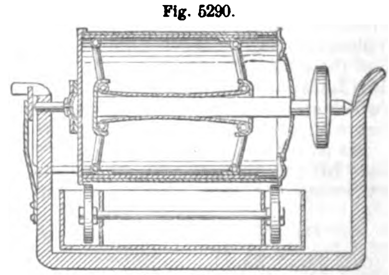
Silver soldering is effected in a very similar way. From its superior fusibility and on account of its not eating or gnawing away the edges of the joints, and, being more sparingly used, requiring less after filing and finishing, it is frequently employed in lieu of the cheaper kinds.

Sol'der-ing-ap'pa-ra'tus. The soldering-apparatus for ordinary work with tin-plate and thin sheet-metals in general comprises soldering-irons (so called) of various sizes, a small portable furnace for heating them, and a box with a spout for holding and applying the rosin or other flux.

The great demand for cans for containing oysters, fruits, and prepared meats has led to the invention of special machines through whose agency the work is greatly expedited.

One of these (Fig. 5290) has collapsible arms which keep the

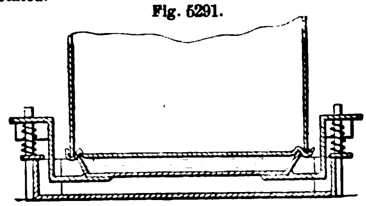
Fig. 5290.



Can-Soldering Apparatus.

body of the can expanded, and hold it while the flux and solder is being applied, automatically or otherwise, when the apparatus is rotated.

Fig. 5291.

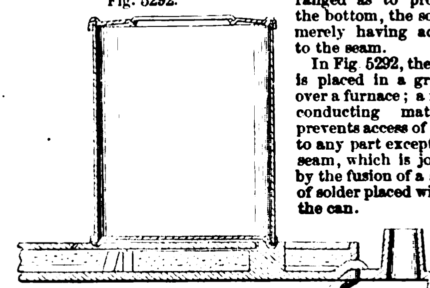


Solder-Pan for Cans.

In another (Fig. 5291), the ends of the can are successively dipped into a bath of molten solder, the support on which the can rests being so arranged as to protect the bottom, the solder merely having access to the seam.

In Fig. 5292, the can is placed in a groove over a furnace; a non-conducting material prevents access of heat to any part except the seam, which is joined by the fusion of a strip of solder placed within the can.

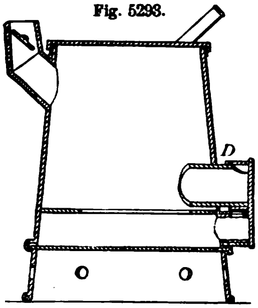
Fig. 5292.



Can-Soldering Apparatus.

Sol'der-ing-fur'nace. A furnace, usually burning charcoal but sometimes having gas-jets, used for heating the soldering-tools used by tinmen, plumbers, etc.

Fig. 5293.

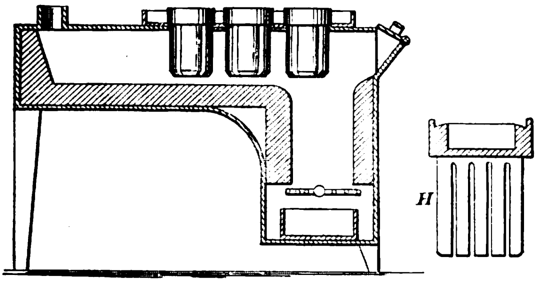


Tinman's Furnace.

Fig. 5293 has a cover *D* inclosing the tube through which the iron is presented to the fire, and which extends sufficiently far inward to prevent the fire acting directly upon the front casing of the furnace. Another furnace (patent No. 49,517) has a soldering-tool passing through the fire and projecting on each side, in order that the work may be held up to it and moved along against the iron.

Fig. 5294 is a furnace having pans on top for heating the ends of cans for soldering. The pans have a slight rim, which is of metal, and a central depression which is filled with gypsum or some other non-conducting substance, in order that the heat may

Fig. 5294.

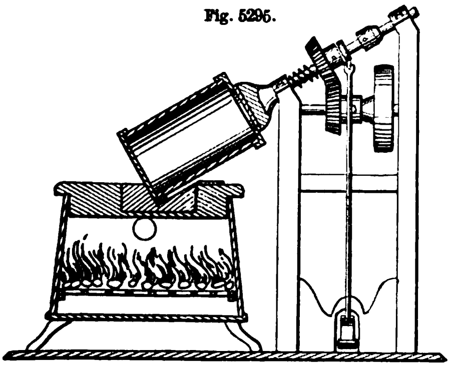


Soldering-Furnace.

affect no part but the rim. The pans have plates *H* (see small figure) extending down into the fire to conduct the heat to the pans.

In Fig. 5295, the can is attached to the end of a shaft, which

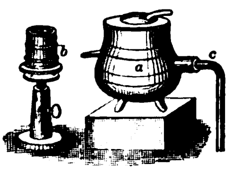
Fig. 5295.



Soldering Tin Cans.

during its rotation causes each part of the seam to dip successively into the solder-bath.

Fig. 5296.



Pewterer's Hot-Blast.

A peculiar modification of the blow-pipe is employed by pewterers. It consists of a common iron pot *a* having a close-fitting cover and apertures on each side through which the blast-pipe *c* passes; this is technically called the *hod;* it is partially filled with ignited charcoal, so as to heat the blast of air which passes through the pipe *c*. The work is supported on a revolving pedestal *b*, termed the *gentleman*, which may be adjusted by a side-screw to any desired hight; a strip of solder is dipped in oil and applied to the joint with the right hand while the work is slowly revolved by the left.

It has been proposed to apply the term *galvanic soldering* to the uniting of two pieces of metal by the deposit formed between them when submitted to electro-magnetic influence in the sulphate bath. This method would seem too tedious and expensive to be of very general application.

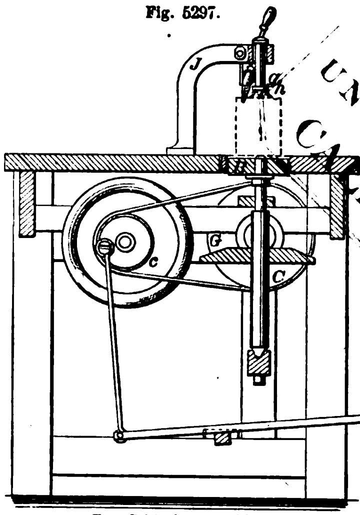
Sol'der-ing-ir'on. The tool whereby solder is melted and applied in the ordinary method of working. It is, however, a block of copper, called a *copper-bit*, on the end of an iron rod provided with a wooden handle. See SOLDERING-TOOL.

Sol'der-ing-lamp. An alcohol or oil lamp with a thick wick, adapted for the dentist and jeweler. The peculiar burner known as the *Bunsen burner* is much used. The gas is mixed with atmospheric air before inflaming, and the result is a hot, blue, smokeless flame. See STOVE-BURNER.

Sol'der-ing-ma-chine'. One for holding cans while being soldered or applying the soldering-tool to them while rotating.

In Fig. 5297, the can rests on a rotating table *B* turned by a treadle *H* operating the band-wheels *C c* and bevel gears *G*, and is held by a spring plunger *g* with spurs *h*; the soldering-iron

Fig. 5297.

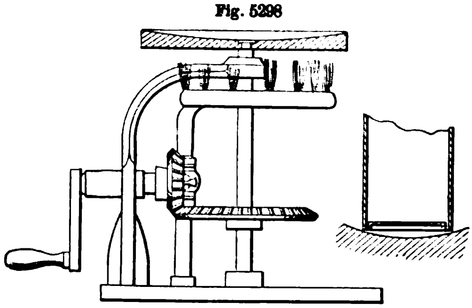


Can-Soldering Machine.

is supported in a rest on the arm *J* and is applied to each part of the seam as the can rotates.

Fig. 5298 has a gas-heated shallow metallic solder-pan. The boxes are placed, one at a time, upon the pan, with their lower

Fig. 5298



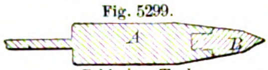
Soldering-Stand.

edges immersed in the solder thereon; the operation is completed by holding them there an instant and then removing them. See CAN-SOLDERING MACHINE, Fig. 1074, page 452.

Sol'der-ing-tool. The soldering-tool, generally termed a *soldering-iron*, used by tinmen and other workers in thin sheet-metals, consists of a copper *bit* or *bolt* having a pointed or wedge-shaped end, fastened to an iron rod with a wooden handle. It is *tinned* previous to being used by heating to a dull red, hastily filing off the scale, so as to produce a clean metallic surface, and then rubbing, first upon a lump of sal-ammoniac and next upon a copper or tin plate on which a few drops of solder have been placed, and afterward wiped clean with tow. Various improved forms have been contrived.

In Fig. 5299, the body *A* is made of cast-iron and has a dovetail mortise at the end, into which a tenon on the copper point *B* is expanded by driving. Another has a copper point cast on to the iron body.

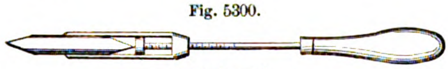
Fig. 5299.



Soldering-Tool.

In another (Fig. 5300), the bit is reversible, and may be protruded any desired distance beyond the socket in which it is held, the rod to which the handle is attached being screw-threaded and working through the socket.

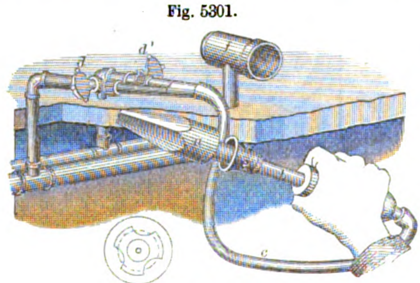
Fig. 5300.



Soldering-Bit.

In Sears' (Fig. 5301), the copper tip *a* is hollow at the base and receives the hollow handle *b*, which is screwed therein, and is connected by a flexible pipe *c* with a nozzle through which two pipes provided with cocks *d d'* project respectively air and gas. The gas is first let on, and as it escapes at the base of *a* is lighted, and the air-supply cock being then opened, a flame is maintained at the aperture in the handle *b*, near the end of the tip *a*, at the point where the greatest heat is required, its intensity being regulated by means of the cocks *d d'*. A shield *e* on the handle serves to deflect the heat back on the tip *a* and protect the hand of the operator. When not in use, the tip is inserted in the hollow rest *f*.

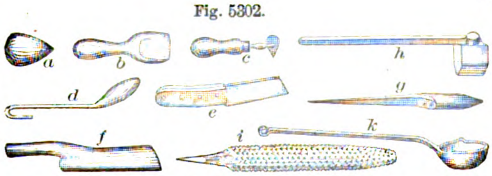
Fig. 5301.



Soldering-Tool.

Fig. 5302 shows the tools commonly used by plumbers for soldering and fitting pipes and joints.

Fig. 5302.



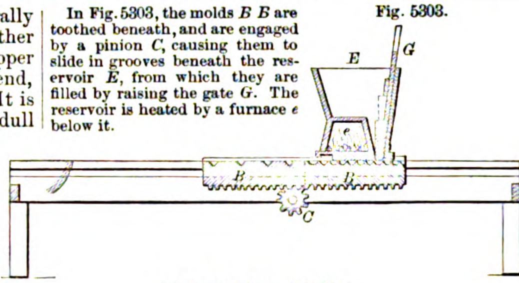
Plumbing and Soldering Tools.

a, turn-pin.	*f*, dresser.
b, side edge.	*g*, copper bolt.
c, shave-hook.	*h*, copper hatchet.
d, round iron.	*i*, rasp.
e, chipping-knife.	*k*, ladle.

Sol'der-mold. A device for casting solder into rods or pellets of convenient form for use.

In Fig. 5303, the molds *B B* are toothed beneath, and are engaged by a pinion *C*, causing them to slide in grooves beneath the reservoir *E*, from which they are filled by raising the gate *G*. The reservoir is heated by a furnace *e* below it.

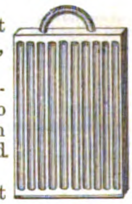
Fig. 5303.



Molding Tinners' Solder.

A mold in which solder is cast into bars. Fig. 5304 is simply a plate having a series of grooves and provided with a loop or handle at one end for lifting and turning out the bars when cool enough. See also SOLDER-CASTING.

Fig. 5304.



Solder-Mold.

Sole. The bottom or bearing part of an object, as a crane, wheel-felly, gun-carriage, plane, rudder, etc.

Sole and *sill* occupy, generally speaking, the same relation to any object to which they are attached or to which they refer, and the words are derived from the same verbal root.

1. (*Shoemaking.*) The bottom part of a boot or shoe.

2. (*Agriculture.*) *a.* The lower part of the plow which runs in contact with the bottom of the furrow. It is generally only the lower surfaces of the *share* and *landside*.

b. The bottom of the furrow.

3. (*Vehicle.*) A strip of metal or wood fastened beneath the runner of a sled or sleigh to take the wear.

It is made of hard wood for farm-sleds, dry sugar-tree or red beech being excellent.

Bob-sleds are shod with an amalgam cast-iron (so called).

Sleighs are soled with band iron or steel.

4. (*Machinery.*) *a.* The top or floor of a bracket on which a plummer-block rests. See BRACKET.

b. The plate which constitutes the foundation of a marine steam-engine, and which is bolted to the keelsons.

5. (*Hydraulics.*) The lower edge of the barrel of a turbine or water-wheel.

6. (*Mining.*) *a.* The seat or bottom of a passage in a mine. The floor of a gallery.

b. The bottom frame of a wagon.

7. (*Fortification.*) The bottom of an embrasure. The *sill* is the inside edge of the *sole*.

8. (*Metallurgy.*) The floor or hearth of the metal-chamber in a *reverberatory*, *puddling*, or *boiling* furnace.

9. (*Shipbuilding.*) *a.* The bottom plank of the cradle, resting on the bilgeways, and sustaining the lower ends of the poppets, which are mortised into the sole and support the vessel.

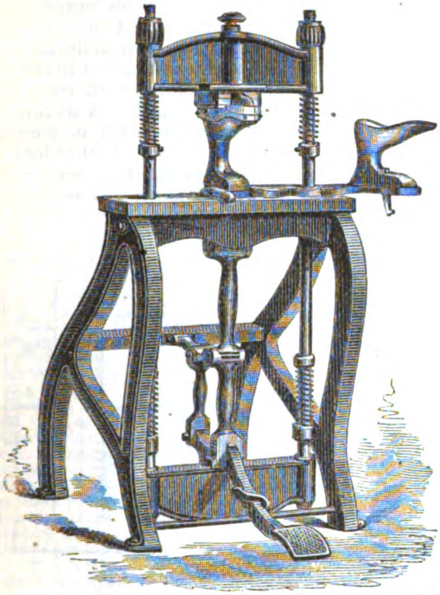
b. An additional piece on the lower end of a rudder, to make it level with the false keel.

10. (*Joinery.*) The lower surface of a plane.

Sole-beat'ing Ma-chine'. (*Shoemaking.*) A machine for finishing boots and shoes, — pressing the sole and laying the channel. The swinging bed has two forms, in order that a shoe may remain under pressure upon one while the operator is placing another shoe upon the second. The pressure is given by the treadle, which brings down the upper platen upon the channeled sole.

Sole-chan'nel-ing Ma-chine'. A machine for cutting a groove in the sole of a shoe in which the

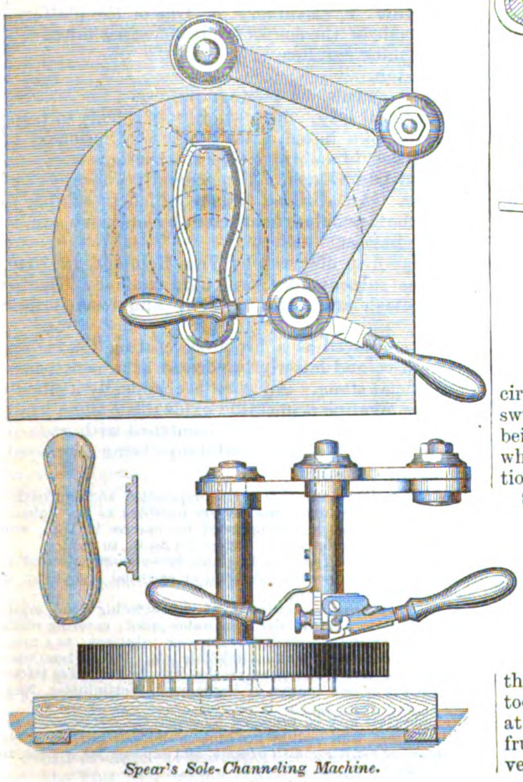
Fig. 5305.



Beating-out Machine (Shoe-Machinery Manufacturing Co.).

sewing-stitch may lie and be protected. In Spear's machine, the sole being fastened to the turn-table, the tool to be used for channeling or beveling is

Fig. 5306.



Spear's Sole-Channeling Machine.

slipped into the end of the jointed arm, which arm holds the tool in a perpendicular position. Then the operation of channeling or beveling is performed by drawing the tool around the sole, using the edge of the sole as a guide to determine the cut of the knife or knives, the shoulder on the tool resting against the edge of the sole as the tool is forced along, turning the table as is necessary.

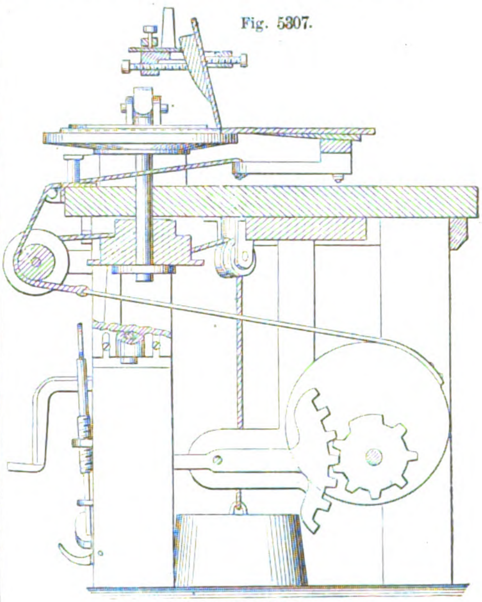
Sole-cut′ting Ma-chine′. One in which sole-shaped pieces are cut from the side or from strips of leather.

The ordinary hand-cutters have dies the shape of the sole, driven by a mallet. Or a sheet-metal pattern is laid on the leather, and its edge followed by a knife.

In machines, several plans are adopted. One has a vertically moving sole-shaped die, which is brought down upon the leather fed upon a table beneath. Or a roller has projecting blades shaped alternately like the respective sides of the sole. The strip is passed along the bed, beneath the roller, and issues as soles and waste scraps.

Another sole-cutting machine is one in which the leather and the metallic pattern are clamped to a

Fig. 5307.

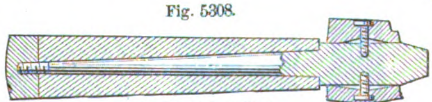


Sole-Cutting Machine.

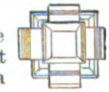
circular revolving table. The knife is supported on swivelled arms and follows the edge of the pattern, being actuated by a cam and a toothed foot-lever, which also raises a weight to perform the return motion. See also SOLE-ROUNDING MACHINE.

Sole-fin′ish-ing Tool. A burnishing-tool for

Fig. 5308.



Sole-Finishing Tool.

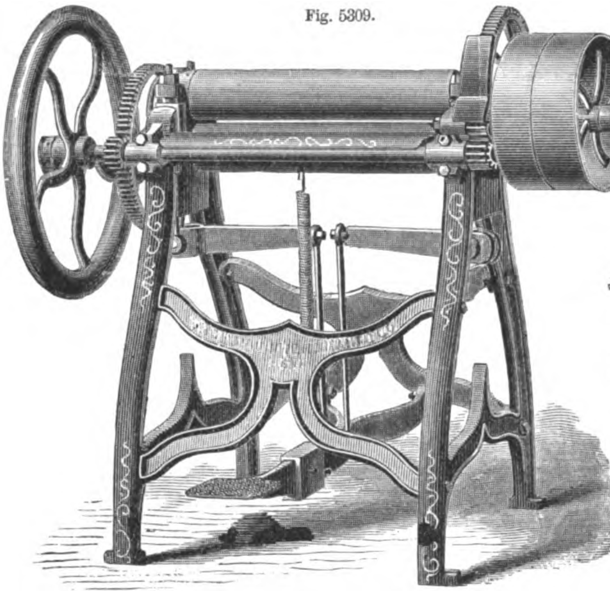


the edges of soles. In the example, the tool-head is a four-sided prism, except at its guide, where it approximates to a frustum of a four-sided pyramid. A reversible edge-block is applied to each face of the

head revolving thereon, and has finishing ends of different sizes and shapes. The edge-block is connected with the head by adjustable clamp-screws. See also EDGE-TOOL, page 773.

Sole-leath′er Roll′ing-ma-chine′. A machine to compact and consolidate leather, either in the side or strip or after being cut out and shaped. The pressure of the rolls is regulated by the treadle and intermediate levers.

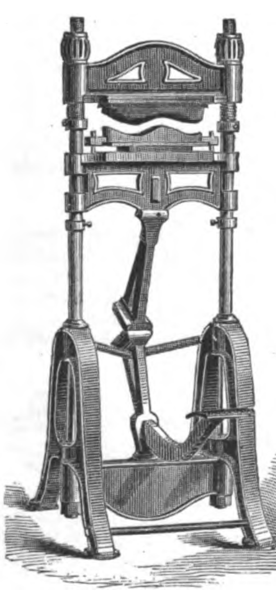
Fig. 5309.



Sole-Leather Rolling-Machine.

Sole-mold′ing Ma-chine′. (*Shoemaking.*) The operation of this machine comes before the parts are assembled upon the last. The sole is molded by it to fit the bottom of the style of last which is in use. The lower platen is forced against the upper by the treadle and toggles, and is retracted by springs.

Fig. 5310.



Sole-Molding Machine.

So′len. (*Surgical.*) *a.* A cradle for a broken limb.

b. A tent or tilt of splits or wands to hold the bed-clothes from contact with a broken or sore limb.

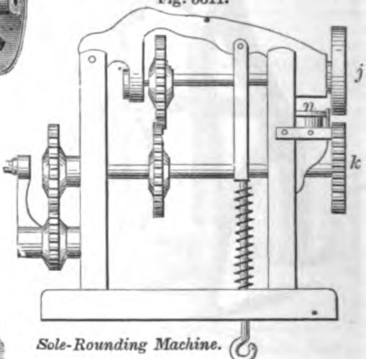
Sole-plate. 1. (*Steam.*) The *foundation-plate* or *bed-plate* of an engine. See SOLE.

2. (*Hydraulic Engineering.*) The back portion of a water-wheel bucket. It is frequently formed by a continuous inner cylinder concentric with the axis of the wheel, and upon it the buckets are built.

Sole-round′ing Ma-chine′. A machine for giving the curved contour to strips of leather designed for soles. The pattern is attached to the top of the blank, and kept in contact with the guide while the feed-rollers *j k* are turned, and the blank is cut to form by the knife attached to the block *n*.

Sole-shap′er. See SOLE-MOLDING MACHINE.

Fig. 5311.



Sole-Rounding Machine.

Sole-tree. (*Mining.*) A piece of wood belonging to a small windlass to draw up ore from the mine.

Sol′id New′el. (*Joinery.*) A post into which the ends of winding stairs are built. A *hollow newel* winds around a well-staircase.

Sol′lar. 1. (*Mining.*) *a.* One of the platforms at the ends of the successive ladders in a mine.

b. A mine entrance.

2. A loft.

So′lo-graph. A photograph.

Sol′u-bil′i-ty. Susceptibility of a body to being dissolved in a liquid. See Storer's "Dictionary of Solubilities," Cambridge (Mass.), 1864.

Sol′u-ble Glass. Also generally known as *water-glass.* An alkaline silicate which is soluble in water, but remains unaffected by ordinary atmospheric changes.

It was first observed by Von Helmont, in 1640, and was subsequently, in 1648, made by Glauber from potash and silica, and by him termed fluid silica.

It is employed as a fire-proof coating for various substances, and latterly important as a constituent of artificial stone. All glass is chemically a silicate of some alkaline or metallic oxide; but those kinds alone in which the silica is combined with soda or potash without a third substance being employed, are soluble in water.

For much that is valuable in the preparation and application of water-glass or soluble glass, we are indebted to Dr. Johann Fuchs, of Munich. He announced his success in 1825, and published a pamphlet shortly before his death, in 1856.

Mr. Ransome, of Ipswich, England, has also contributed to the success of the process. It forms an essential ingredient of Ransome's artificial stone.

It has been used in painting on glass; surfacing stone, wood, and other materials to render them water-proof; covering roofs, for the same purpose; glazing scenery or paintings; as a menstruum for carbon, in making indelible ink. It has been used to arrest the wear of the stone, on the Cathedral of Notre Dame, Paris, and the new houses of Parliament, Westminster, England.

Soluble glass may be prepared by either the *wet* or *dry* way. In the former, flint nodules are broken and calcined, added to a solution of caustic potash or soda, and exposed for a time to intense heat.

In the dry way the constituents are fused together in the solid state, and afterward dissolved. Four kinds are employed, known as the *potash*, *soda*, *double*, and *clear* silicates. The first is composed of 15 parts pulverized quartz, 10 purified potash, 1 pulverized charcoal. These are well mixed, and exposed to a strong heat in a glass-melting pot until thoroughly fused. When cool, the mass is broken in pieces, and boiled for about 3 hours in 5 times its weight of water, more water being occasionally added to replace that lost by evaporation. When thoroughly dissolved, it is viscid, and may be used in this state or still farther diluted. It should be preserved in well-stopped vessels.

The soda silicate is composed of 45 parts pure quartz, 23 anhydrous carbonate of soda, and 3 pulverized charcoal; these are fused and treated in the manner just described. By substituting the anhydrous sulphate for the carbonate of soda and using about 8 times more charcoal, a cheaper compound is produced. Buchner's formula for soda water-glass is, pulverized quartz, 100; calcined glauber salts, 60; carbon, 15 to 20 parts. The double silicate is composed of 100 parts quartz, 28 purified potash, 22 neutral anhydrous carbonate of soda, and 6 powdered charcoal. This mixture fuses more easily than either of the others. In its place three parts of the first and two of the second solutions, which mix freely together, may be employed

The mixed silicate forms with sand an excellent cement, converting it into a stone-like mass, and is also useful for filling cracks in walls. Marble dust, or chalk made into a paste with water, dried and saturated with the silicate, forms a mass little inferior in hardness to marble, and capable of taking a fine polish. A mixture of marble dust and the silicate of soda forms a cement which adheres either to stone or wood. Oxide of zinc combines with the silicate, forming a paste, which may be rolled into sheets resembling slate.

The *clear* silicate is applied for fixing the colors of pictures. It is made by fusing 3 parts pure anhydrous carbonate of soda with 2 of powdered quartz, the compound being boiled as before. This is kept in a concentrated solution, and for use 1 part is mixed with 4 parts of the concentrated potash silicate completely saturated with quartz.

The *fixing* water-glass of Von Fuchs is used for fixing the colors in stereochromy, and is composed of silica well saturated with potash, water-glass, and a silicate of soda, obtained by melting together 3 parts calcined soda and 2 of pulverized quartz.

The prepared water-glass of commerce is made by boiling the powdered water-glass in water, forming solutions known as of 33° and 66° respectively, those amounts denoting the respective amounts by weight of solid water-glass contained in 100 parts of the solution.

Wall paintings are fixed by water-glass in a much more durable manner than ordinary frescoing. The ground may be similar to that employed for frescos, or a water-glass mortar may be employed, composed of about 10 parts dry sharp sand, 3 quicklime, and 2 dry pulverized chalk or limestone, worked to the proper consistency with dilute water-glass. Water-colors, not too heavily laid on, are applied, care being taken to reject organic colors, which are fugitive, and such others as have a tendency to combine with the glass. When the picture is finished, the whole is fixed by an application of the water-glass in thin jets from a rose nozzle syringe. The process has received the name of *stereochromy*.

Water-glass is also used as a vehicle for painting upon glass, various metallic oxides and salts being employed as the coloring mediums, the compound becoming chemically united with the silicious surface of the glass, so as to resist the action of water.

It also is made up into a paint or cement with clay, whiting, chalk, calcined bones, powdered glass, or litharge in various combinations. It makes a very strong and adhesive compound.

The theater of Munich, Bavaria, was painted with a composition in which 10 per cent of yellow clay was added to soluble glass.

Dobereiner's formula gives a soluble glass suitable for coating woodwork:

Carbonate of potash	70
Carbonate of soda	54
Ground flints or quartzose sand	152
	276

Another formula given is: —

Carbonate of soda (or carbonate of potash, 10)	8 parts.
Pure sand	15 parts.
Charcoal	1 part.
	24 parts.

The product dissolves in boiling water.

The addition of hydrochloric acid causes the silica to separate as a transparent, tremulous jelly. This is hydrate of silica, is not soluble in water or acids, may be preserved in a gelatinous condition, but crumbles when dried.

Som'er-set. (*Saddlery.*) A saddle padded before the knee and behind the thigh; originally made for Lord Fitzroy Somerset, who had lost his leg below the knee at the battle of Waterloo, and from whom it takes its name.

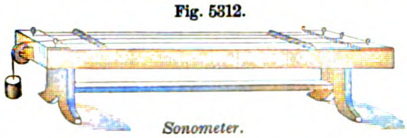
Son'i-fer. An acoustic instrument for collecting sound and conveying it to the ear of a partially deaf person. It is an instrument of metal, of a bell shape, and is placed upon a table with its mouth in the direction whence the sound proceeds; the volume of sound is collected in the bottom of the instrument, and conducted by a flexible pipe to the ear.

Son-nette'. (*Music.*) A *clapper* or *castanet* having a movable tongue, which strikes the stick and forms a clinking accompaniment to music or the dance.

A bell used in a band as a tinkling accompaniment.

So-nom'e-ter. An instrument devised by Marloye for determining the number of vibrations made by a string emitting any musical sound. It is provided with a series of weights, to vary the tension of the central string, the others being tuned by pegs, and has three divided scales, one corresponding to the modified chromatic gamut, another to the true chromatic gamut, and the third the French meter divided to thousandths.

Fig. 5312.



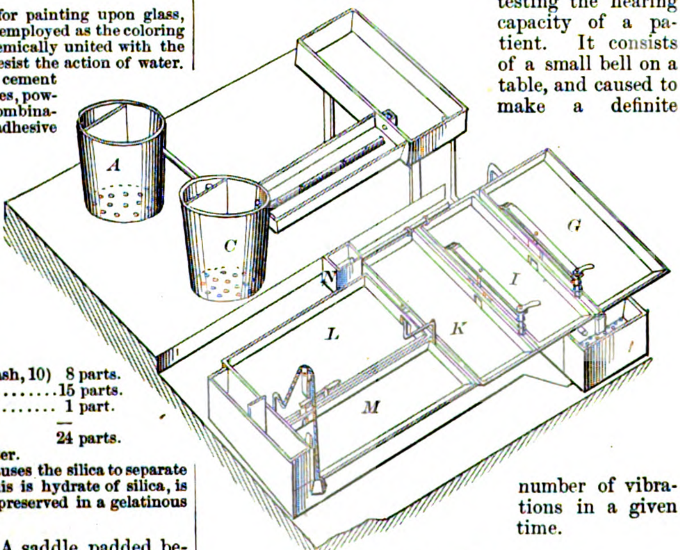
Sonometer.

The following table gives the notes, the number of their vibrations, and the duration of their residual sensations. (The French notation, used by König, is adopted.)

Note.	No. of Vibrations per Second.	Duration of Residual Sensation of the Sound.
C_1	64	$^1/_{16}$ second
C_2	128	$^1/_{26}$ "
C_3	256	$^1/_{47}$ "
G_3	384	$^1/_{60}$ "
C_4	512	$^1/_{75}$ "
E_4	640	$^1/_{95}$ "
G_4	768	$^1/_{109}$ "
C_5	1,024	$^1/_{135}$ "

2. A device for testing the hearing capacity of a patient. It consists of a small bell on a table, and caused to make a definite number of vibrations in a given time.

Fig. 5313.



Arrangement of Sugar Filters and Pans.

Soo′cey. (*Fabric.*) An Indian mixed striped fabric of cotton and silk.

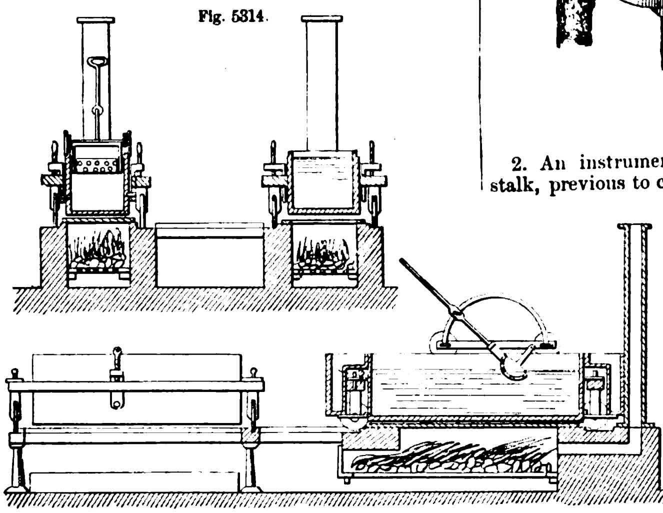
Sor′dine. (*Music.*) A little implement placed on the bridge of a stringed instrument, in order to deaden the sonorousness and give it a mournful sound. A *mute.* See Plate LXI., Bonanni's "Istromenti Armonici," Roma, 1776.

Sor′ghum-e-vap′o-ra-tor. A furnace with pans for boiling the expressed juice of the sorghum or imphee.

Fig. 5313 shows an apparatus consisting of a series of filters and pans. The juice is first purified in the filters *A C*, passes to settling-troughs, is conducted by pipes to the pan *G*, where it is brought to a boil, passed through a hot filter, and thence to pans *I K L M* in succession, by which it is condensed.

Figs. 1888, 1889, 1890, pages 812, 813, show evaporators with pans in succession and in steps; also a rocking-pan with a sinuous track for the juice.

Fig. 5314.

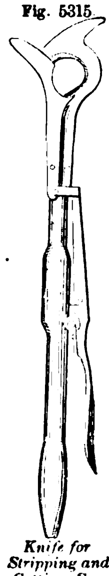


Sorghum-Evaporator.

Fig. 5314 shows an arrangement of pans on carriages by which they may be brought into the required position or succession over the furnaces. Each evaporating-pan is pivoted to a truck, by which it may be moved along tracks from one furnace to another, or from the place of filling to that of deposit. The supporting casters may be turned 90° to allow of running over all portions of the rectangular track. The pans may be tilted to discharge their contents.

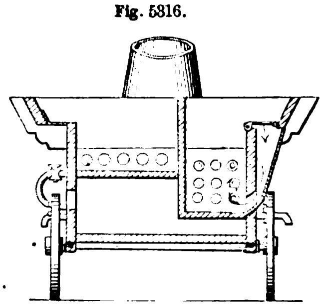
In Fig. 5316, an outside filtering pocket is filled with wool; as the juice boils over, it cools and sinks in this pocket, and reaches the pan again, parting with the scum and feculencies which are retained by the wool. This keeps up a continued circulation and straining process.

Fig. 5315.



Knife for Stripping and Cutting Sorghum.

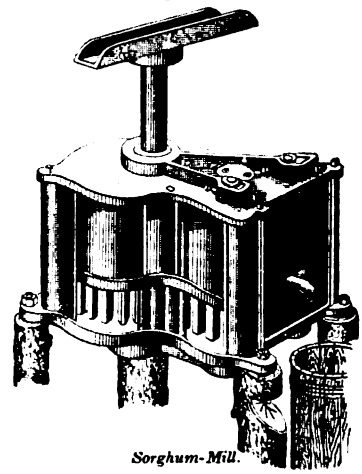
Fig. 5316.



Pan and Self-Skimming Arrangement.

Sor′ghum-knife. 1. A sword or machete for cutting sorghum-stalks.

Fig. 5317.



Sorghum-Mill.

2. An instrument for stripping leaves from the stalk, previous to crushing.

Fig. 5315 combines the two. The movable jaw is opened and the stalk gripped; a motion downward strips off the leaves, and a draw motion cuts the stalk at the ground.

Sor′ghum-mill. A machine for grinding the stalks of the *sorghum* (*Holcus* or *Sorghum saccharatum*) or imphee. One variety is also known as the Chinese sugar-cane. The imphee is probably African. There are many varieties. It is closely allied to the *dourra* and the broom-corn.

The cane is pressed between vertical rollers, and the juice is collected in the bed-plate, which has a ridge around it, and is thence discharged into tub, bucket, or cistern. See also CANE-MILL; SUGAR-MILL.

The use of the "Turkish" and the "American corn" stalks for yielding a saccharine juice was recommended in an English magazine of April 1, 1800. The former appears to have been a *sorghum* or *imphee*, as the brushy top was farther recommended for brooms. The author also recommends the American green corn, "*split into quarters and fried in batter like young artichokes.*" Cob and all it should seem!!

The subject of the use of maize-stalks for yielding molasses is considered in the Agricultural Reports of the Patent Office, about 1846; see also M'Culloch's Report on Sugar and Hydrometers, 1846.

Sor′ghum-strip′per. (*Husbandry.*) A knife for stripping the blades from cane-stalks. See CANE-KNIFE, page 444; SORGHUM-KNIFE.

Sor-ren′to-work. Fret carving, done by a jig-saw. As a lady's employment, it is rather a miniature form of the usual productions of the scroll or fret saw. Brackets, card-cases, and the more delicate articles of household adornment are thus made, the effect being much enhanced by carving.

Sort. (*Printing.*) Any letter, figure, point, space, or quadrat belonging to the compositor's case.

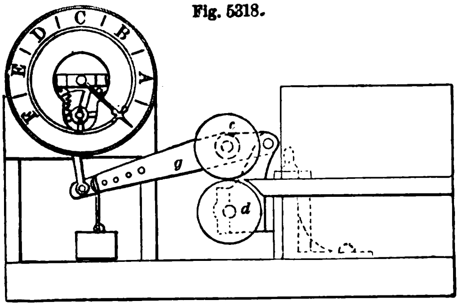
Out of sorts means that some are exhausted.

To *run upon sorts* is with work which requires an unusual number of certain kinds; as an *index*, which requires a disproportionate number of capitals, or a tabular statement in figures, which makes a run upon the figures, etc.

Sort′ing-ma-chine′. Fig. 5318 is a machine for gaging leather strips as they are cut from the

hide to certain regulated sizes. The strips pass between two rollers *c d*, the lower one of which turns in fixed bearings, and the upper is journaled in a lever *g*, which operates a rack and a pinion carrying

Fig. 5318.



Leather-Sorting Machine.

an index, which indicates upon a dial the degree of separation of the rollers corresponding to the thickness of the leather then passing between them, and enabling the operator to assort the strips.

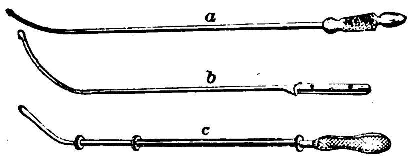
Sough. 1. (*Civil Engineering.*) A small drain at the foot of an embankment, to convey the surface water from it into a side drain.

2. (*Mining.*) *a.* An *adit* or *day level* for carrying off water.

b. The entrance to a mine.

Sound. (*Surgical.*) (Fr. *Sonde*, a canula or director.) A long instrument (*a b*, Fig. 5319), usually of metal and partaking of the nature of a probe. Used especially in making explorations in the bladder in search of stone. It is inserted through the

Fig. 5319.



Sounds.

urethra, and a peculiar click is heard when it comes in contact with stone.

c is Skene's uterine sound. The end of the probe being in contact with the fundus, the section having a button on the end is projected telescopically until it comes in contact with the cervix, and the distance from the button to the end of the sound is the length of the womb.

Leaden sounds are used to follow the curved path of a glancing ball. See PROBE.

Sonde de Anel; a silver stylet with awl-point, used in probing the lachrymal passages.

Sonde de Belloc; an instrument for plugging the nasal fossæ in cases of hemorrhage. A curved silver canula, open at both ends, and furnished with a button, to which the epistaxis plug is attached, and with which the posterior nostril is stopped.

Sonde Brisée; a probe in two sections, which screw together. It is blunt at one end, and has an eye at the other, so as to be used as a probe or seton needle.

Sonde à Conducteur; a guide for a catheter. It is introduced in company with a catheter of small size, open at the beak. The catheter being withdrawn, leaving the Sonde in position, the latter acts as a director in introducing a larger catheter.

Sonde de Saforest; a small nasal probe, or crooked canal, for throwing injections.

Sonde, or *Pincers of Hunter;* a silver canula, containing a wire, which is fenestrated, and has a pair of scoops which spring apart as they emerge from the beak of the canula, and by retraction clasp calculi in the urethra.

Sound-board. 1. (*Music.*) The upper surface board of a *wind-chest* in an organ.

It is pierced with channels, which communicate with the ducts below the respective pipes of the organ. These channels are guarded by spring valves, which are depressed by their appropriate keys on the *manual*, allowing air to escape from the wind-chest to the particular pipe or pipes as the keys are moved. The valves play between thin bars of wood, which divide the under surface of the *sound-board* into a series of parallel partitioned spaces.

On the upper side of the *sound-board* are grooves pierced with holes, which are commanded by the register slides of the respective stops. As the slide is pulled to open the holes, the communication is permitted to the pipes of a given stop, when the valve is depressed by the key of the manual. When more than one slide is opened, the opening of a given valve by the key admits air to so many pipes, which sound the corresponding notes according to their pitch and quality. See SOUNDING-BOARD.

2. A canopy over a pulpit, to direct the sound toward the audience.

3. (*Carpentry.*) Deadening. A partition or an additional division between two apartments, to prevent the propagation of sound from one to the other.

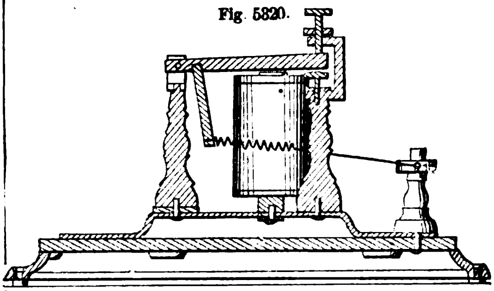
Sound-board'ing. (*Building.*) Short boards disposed transversely between the joists, in order to hold the pugging, which is designed to prevent the transmission of sound.

Sound-bow. That part of the bell on which the clapper strikes. The sound-bow is the point of greatest thickness, and is considered as unity in stating the proportions of the bell.

Sound-bow in thickness	1
Diameter at the mouth	15
Diameter at the shoulder	7.5

Sound'er. A device used in telegraphy in lieu of a register, the communications being read by sound alone. It consists of an electro-magnet with an armature having a lever attached thereto. The movement of the armature as it is attracted by the electro-magnet or withdrawn by a spring being lim-

Fig. 5320.



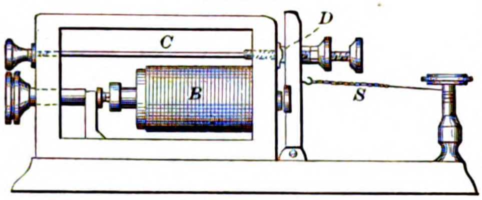
Sounder.

ited by two stops, between which the end of the lever plays and by the striking of which the sound is produced. In Fig. 5320, the posts which support the armature lever and the contact screws are mounted upon a bridge-plate supported at its ends upon an insulator-board, so as to give greater resonance to the blow of the armature.

Sound'er-mag'net. (*Telegraphy.*) The magnet which operates the sounder in the receiving apparatus. In Fig. 5321, the coil *B* is inclosed in a metallic box, the ends of which are maintained in a state of tension by means of a screw-rod *C*, which carries the anvil *D* on its end, the object being to increase the sonorousness of the vibrations caused by the pivoted sounder striking the anvil, and which are propagated through the box. *S* is the spring which draws back the sounder after each impulse of the magnet.

Sound'ing-ap'pa-ra'tus. (*Nautical.*) The

Fig. 5321.



Sounder-Magnet.

tackle or apparatus employed by mariners for ascertaining the depth of water and for bringing up specimens of bottom. The depth and the character of the ground, when on soundings, generally enables the navigator to ascertain approximately the distance from land and the position of his ship.

The lead and line are still in universal use. The former is elongated, has an eye at one end to receive the line, and a cavity, which is partially filled with an *arming* (tallow), at the other, to which the ground, especially if it be sand, shells, or fine gravel, adheres when the lead strikes the ground.

The common *hand-lead* for sounding weighs from 7 to 11 pounds, and is used with 20 fathoms of line.

The leadsman stands in the channels and casts the lead forward. The line is marked to fathoms below 5, and at 7, 10, 13, 17, 20 fathoms; the numbers between are called *deeps*, being estimated by the *dip* of the line. Thus: *by the mark, twain; by the deep*, 6. When great accuracy is required, the line is marked to fathoms and feet, and the leadsman is required to call out the sounding to the nearest foot. See Marks and Deeps, page 1401.

The *deep-sea lead* weighs 25 or 30 pounds, and has a much longer line, marked every 10 fathoms. The lead is dropped from the forepart of the vessel; the line being carried outside of the rigging from the after-part, where it is held.

For the deepest soundings the ship is hove to, and carefully constructed apparatus is used.

"A deeper sea than that of Sardinia has never been sounded, measuring, as it does, according to Posidonius, about 1,000 fathoms." — Strabo, Book I. Chap. 3.

The *catapirater* of the ancients differed in no respect from our sounding-lead and line. Its use is mentioned by Herodotus, St. Paul, and others.

Previous to some 25 years ago few attempts had been made to obtain bottom at depths beyond 200 to 300 fathoms.

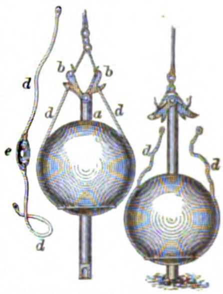
In 1849, the United States schooner "Taney" was fitted out for the purpose of looking up a number of the rocks, shoals, and "vigias" which had long disfigured the charts of the Atlantic Ocean, and for ascertaining, if practicable, its depth; for this purpose she was provided with a large quantity of wire, to be used in lieu of sounding line; this was to be cut when bottom had been reached, involving the loss of the wire and sinker. A number of unsuccessful casts were made, the materials and methods employed proving unreliable.

In 1851, the United States brig "Dolphin" was fitted out for the same objects, under the command of Lieutenant (now Admiral) S. Phillips Lee, twine being furnished in lieu of wire; after numerous experiments it was found that by sounding from a boat and taking proper precautions, bottom could be obtained with reasonable certainty at depths exceeding 3,000 fathoms; a line of soundings was run from near the middle of the Atlantic to the Cape de Verde Islands, thence to the coast of South America, and thence again to the United States, the greatest depth attained at which bottom was reached being 3,825 fathoms to the southward and eastward of Bermuda. One, two, or sometimes even three 32-pounder shot were used as sinkers, and when bottom had been reached, the boat, anchored thereby, was used for testing currents at and below the surface.

A subsequent cruise in 1852-53, when the vessel was provided with the sounding-apparatus then just invented by passed midshipman J. M. Brooke, United States Navy, confirmed the results previously obtained.

This consists of a rod *a*, having pivoted horns *b b* at its upper end, to which the sounding-line *c* is secured. Two wires *d d* extend from the horns, around the shot or lead, which is perforated for the reception of the rod, and are secured to a washer *e* beneath it. On striking bottom, the rod is thrown up, releasing the wires from the shot and enabling the rod to be drawn up by itself. A small Stellwagen cup may be attached for procuring specimens of bottom. This was the first device by which specimens of bottom from great depths — 2,000 fathoms or more — were secured. These were found to consist principally of minute infusorial shells, which were then supposed to be denizens of the upper regions of the sea, and had sunk to the bottom after death. The latest researches, however, prove the existence of low forms of animal life at the greatest depths which have yet been reached.

Fig. 5322.



Brooke's Sounding-Apparatus.

Reference has been made in various works to a sounding of 7,706 fathoms, said to have been obtained by Captain Denham of H. M. S. "Herald," off the river Plate; there can be little doubt, however, that when this amount of line had been run out the ship was miles to leeward of the sinker (a 9-pound lead), and no subsequent sounding in any part of the world leads us to infer that the ocean anywhere attains nearly this enormous depth.

The latter cruise of the "Dolphin" and soundings subsequently made by other vessels established the existence of a plateau extending from Newfoundland to the coast of Ireland, having a nearly uniform depth of somewhat over 2,000 fathoms; upon this the transatlantic cables have been laid.

A similar investigation is now being made of the bed of the North Pacific. The United States steamer "Tuscarora," Commander Belknap, has ascertained that the depth of water gradually increases with a gentle slope from a point 115 miles west of San Diego, California, in 1,915 fathoms, to a point 400 miles east of Honolulu, where it reaches 3,054 fathoms: at the shore ends of this line the soundings are more irregular, indicating the presence of submarine mountain-ranges.

The Pacific will also form the cruising-ground of the "Challenger," which vessel, being provided with ample apparatus, not only for sounding, but for obtaining specimens of bottom, and having fully demonstrated the practicability of procuring living organisms at depths exceeding 2,500 fathoms, will no doubt throw much light on the sea depths and their inhabitants.

The British admiralty now employs a cast-iron sinker, weighing 3 cwt. (for soundings of 2,000 fathoms and upward), through which is passed a valved tube for bringing up specimens; the weight is detached on reaching the bottom, but it is now proposed to raise it; in either case steam is employed for hauling in the line. In making a sounding of 2,000 fathoms, some 35 minutes is required for the descent, and 45 minutes in hauling in. The line employed is $\frac{7}{8}$ inches in circumference, and will bear $\frac{1}{2}$ ton weight.

Sir William Thomson proposes the use of steel wire. With this, using a 30-pound lead, he states that he obtained bottom in the Bay of Biscay at 2,700 fathoms.

In the sounding-apparatus of Professor Trowbridge, the coil of line is inclosed in a hollow cylindrical case, which is connected with the lead, and unwinds from the center as the latter descends, avoiding the friction of the water and securing a uniform and rapid rate of descent. The time of descent proper to any given depth may be ascertained by experiment and tabulated, so that the time which elapses between heaving the lead and its striking the bottom becomes a measure of the depth. In order to ascertain the precise instant when the lead touches bottom, a fine insulated wire is connected with the lead, and also with an alarm or chronoscope, and a battery in the boat from which the observation is made. The impact of the lead on the bottom completes an electric current, and the time of descent is thus ascertained.

Professor Trowbridge has also employed a pair of Saxton's current meters in connection with the tube containing the line. This instrument consists of a delicately pivoted helix, which is turned by the action of the water, and registers the number of revolutions made on a series of dials. Two of these helices are employed, turning in opposite directions for the purpose of eliminating any error which might occur from the twisting of the line or other similar cause. Arrangements are provided for disconnecting the registering apparatus when the lead reaches bottom.

The helix of Massey, such as that employed in his patent log, has also been used, but owing to its want of delicacy does not give as satisfactory results as those of Saxton's current meter.

In sounding at extreme depths, it is not expected to recover the plummet, but arrangements are made for detaching the registering apparatus or the devices for obtaining specimens of bottom, which may then be hauled up with comparative ease and safety.

It has been proposed to dispense with the sounding-line altogether, and employ a buoyant self-registering apparatus, which is detached from the plummet when the latter strikes bottom. Hollow spheres of glass have been proposed for this purpose. It is said that these have been made capable of resisting a crushing force of seven tons to the square inch, corresponding to the pressure at a depth of about six miles. In connection with these it has been proposed to employ a pressure-gage, registering the maximum hydrostatic pressure to which the apparatus has been subjected.

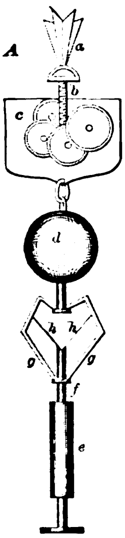
It has also been proposed to ascertain depths by a method founded on the compressibility of water. The unreliability of these latter modes of sounding, and the practical difficulties

in carrying them into execution, have precluded their use, so that they may be looked upon as little more than ingenious theoretical devices.

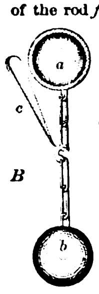
An instrument invented by Messrs. S. E. and G. L. Morse, of New York, and termed by them the bathometer, is designed for measuring the depth without the aid of a sounding-line. It consists of a buoy attached to a sinking weight, from which it is disconnected on reaching bottom, and containing a graduated meter tube, into which mercury is forced by the compression of water or other fluid consequent upon the pressure at a great depth. The buoy is provided with a rod, to which reflectors are attached, rendering it visible for a considerable distance on arriving at the surface.

Other expedients have been proposed for dispensing with the line required in making deep-sea soundings by causing a float to be detached from the sinker when bottom is reached, the depth being registered by an apparatus which rises with the float, or inferred from the length of time occupied by the float in descending and again ascending to the surface.

Fig. 5323.



A (Fig. 5323) is a device of the former kind, proposed by a writer in the English "Nautical Magazine" in 1832. It consists of a set of spiral vanes *a*, which, during the descent of the apparatus through the water, turn an endless screw *b* operating registering-wheels on the plate *c*; from this is suspended a hollow ball *d*. The sounding-lead *e* is placed on a rod *f*, having pivoted or easily detachable arms *g g*, which rest on the flanged bottom of a stem projecting from the lower part of the ball *d*. On striking bottom, struts *h h* at top of the rod *f* throw the arms *g g* outward, detaching the float, which, with the attached registering apparatus, rises to the surface.

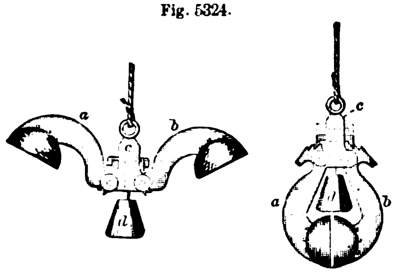


Sounding-Apparatus.

B is a device proposed in 1833, in which a registering apparatus is dispensed with. Two balls, one (*a*) hollow, the other (*b*) solid, are connected by links and by a flattened arm *c* attached to one of the links fastened to the lower ball, and having a hook which catches in one of the upper links. During the descent of the apparatus the action of the water on the flat surface of the arm *c* would cause it to project upwardly, tending to hold the two balls together, but on striking bottom the arm falls, the float is detached and rises to the surface. The time elapsing between the moment of its being cast overboard and its reappearance, the exact rates of ascent and descent being of course previously determined, affords a measure of the depth. Should it not, however, be found for several weeks, or perhaps months, having perhaps drifted many hundred miles in the mean time, the candid mind must admit that the depth derived from calculations based on the above data would be slightly in excess of the truth. We are inclined to think that most persons who have seen a cast of say 2,000 to 4,000 fathoms made at sea would never expect to see the float again, unless it became detached at a comparatively short distance beneath the surface.

The device (Fig. 5324) was invented by M. Toselli, an Italian engineer officer. It consists of two arms *a b*, having hemispherical cups at their ends and pivoted to the support *c*, to which the sounding-line is attached. A cross-head at the upper end of a stem, to which the weight *d* is attached, engages the ends of the arms, keeping them apart until bottom is reached, when they are released by the upward movement of the weight, and come together, securing some of the bottom between them: when lifted from the ground the weight again falls, the branches of the cross-head engaging notches in the upper ends of the arms, and holding the cups together.

Fig. 5324.



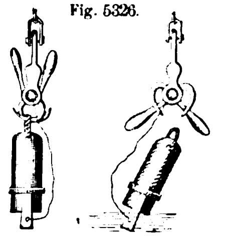
Toselli's Sounding-Apparatus.

For bringing up specimens from moderate depths, the ordinary STELLWAGEN CUP (which see) is very efficient; but for greater distances, devices which more certainly prevent the surrounding water from washing out the mud or other substance are preferred. One of these, invented by Dr. Wallich, was employed on the "Bulldog"; it consisted of two hemispherical cups, upon which the sinker rested during its descent; these were kept apart during the descent of the sinker, but were caused to close together when bottom was struck, inclosing and protecting the matter which they had scooped up, the lead being at the same time detached (Fig. 5325).

The "hydra" of Captain Shortland is now generally used in the British service. It consists of a strong tube with upwardly opening valves, which admit the mud or sand composing the bottom when the sinker strikes, but are closed by gravity during the upward movement.

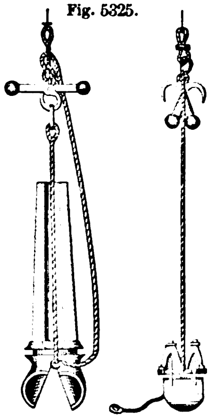
Fig. 5326 is an apparatus employed at one time in the British navy; the weight of the sinker suspended from the weighted jaws holds them together until bottom is reached, when the sinker capsizes, the jaws fall over, and it becomes detached, allowing a wedge-shaped specimen cup to be withdrawn, for the purpose of bringing up a portion of the ground.

Fig. 5326.



British Navy Apparatus.

Fig. 5325.



"Bulldog" Apparatus.

An apparatus devised by Commander Belknap, United States Navy, consists of two cylinders, the upper of which slides within the other; the lower has a cup at its lower end which penetrates the ground when bottom is reached; the upper cylinder then telescopes into the lower, forming a protecting cover to the specimen. Upwardly opening valves permit the water to pass freely through during the descent of the lead, and close when the line is hauled in.

Sound'ing-board. (*Music.*) A thin board over which the strings of a piano, violin, guitar, etc., are stretched, and which propagates and enhances the sound. It is made of the best pine, free from knots and flaws. It is cut in a particular direction of the grain. See also SOUND-BOARD.

Sound'ing-bot'tle. A vessel employed for drawing up water from considerable depths in the sea, for examination and analysis. It frequently contains a thermometer for ascertaining sub-surface temperatures. See Fig. 5327.

A usual form is of wood, and has upwardly opening valves at top and bottom. It is bent on to the sounding-line above the lead, the water passing freely through during the descent, but being prevented from escaping during the upward movement by the valves, which close by gravity. See THERMOMETER.

Sound'ing-lead. (*Nautical.*) The weight used at the end of a line in sounding. See next article. See also SOUNDING.

Sound'ing-line. (*Nautical.*) The line which holds the sounding-lead.

The *hand*-lead weighs from 7 to 11 pounds, and has a line of 20 fathoms.

The ordinary *deep-sea* lead weighs 25 to 30 pounds, and has a length of 200 fathoms. See SOUNDING.

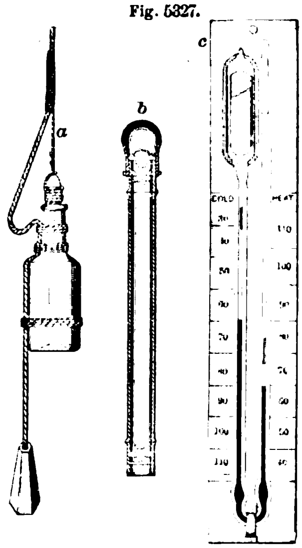
Sound'ing-post. (*Music.*) A post set beneath the bridge of a violin, violoncello, etc., for propagating the sound to the body of the instrument.

Sound'ing-rod. (*Nautical.*) A graduated iron rod, used for ascertaining the depth of water in the well on board ship.

Sound'ing-ther-mom'e-ter. A thermometer for registering temperature at great depths in the sea.

c (Fig. 5327) represents an instrument of this class. It is a bent thermometer, with a large bulb at one end and a small elongated bulb at the other. The large bulb contains a mixture of creosote and water; the small one contains compressed air, below which there is a little creosote and water; the bend of the tube is filled with mercury, which bears a small steel rod on either surface, capable of sustaining itself in the tube by friction until moved by the mercury. When heated, the expansion of the liquid in the large bulb drives the mercury down in that tube and up in the other, both ends marking the degree of heat on the reversed scales. When the thermometer is sunk in deep water, the index moves back and registers the lowest temperature on the side of "cold." To prevent compression of the larger bulb, it is surrounded by a stronger vessel, partly filled with alcohol, which transmits the temperature to the inclosed bulb.

Fig. 5327.



Water-Bottles and Thermometer.

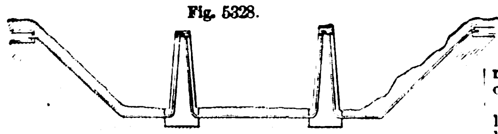
Sou'ple. (*Husbandry.*) That part of the flail which is beaten upon the grain. It is joined by the *hooding* to the *hand-staff.*

Sour'ing. A part of the process of bleaching in which the goods, having been previously placed in a solution of chloride of lime, are exposed to a dilute solution of sulphuric acid, which sets free the chlorine and whitens the cloth. It also neutralizes the alkalies, which have been used in previous treatment of the cloth.

Sour-ket'tle. A vessel used in souring bleached cloth.

Sou'ter-a-zi'ci. (*Hydraulic Engineering.*) The Turks introduced into Europe a mode of crossing ravines by a series of siphons, which consisted of earthen pipes deriving their supply from an upper reservoir, thence descending a hillside, running along part of a valley, and mounting into an intermediate reservoir, supported upon piers of masonry at a rather lower level than the first reservoir. From this second

Fig. 5328.



Souterazici.

source of supply, pipes were conducted down the opposite side of the pier, again along the valley, and successively into a third, or more, reservoirs, at gradually decreasing elevations, and so on to the opposite side of the valley. Their object seems to have been to save the outlay necessary for the construction of masonry bridges; and it is stated that it was intended to diminish the chances of rupture in the earthenware pipes of which the siphons were formed.

A large work of this description is erected upon the ruins of one of the great bridge aqueducts of ancient Constantinople, and which was destroyed during one of the sieges of the city.

Sow. (*Founding.*) The main trough (or the body of metal contained therein) leading from the tap-hole of a cupola or smelting-furnace, and from which ramify the passages leading to the separate molds in casting; or to the shallow ditches in the floor which receive the *pigs* of cast-metal.

Sow'er. Among the ancient Egyptians the modes of seeding were various. It was common to sow on the mud left by the retiring Nile as he receded within his banks, — Osiris retiring from the lap of Isis, according to the mythology of that great and learned nation. The seed was then tramped in by driving goats or sheep over the soil, as we see by paintings in tombs near the pyramids. The more usual practice, however, was to cover it by the plow or hoe. A painting in a pyramid at Memphis shows the sower carrying a basket and sowing broadcast in advance of the plow.

The Hebrews sowed grain broadcast. Sometimes from a basket, probably, as in Egypt, and sometimes from a pocket made by a fold of the garment. This was a common receptacle for things to be carried, such as a measure of wheat or a lamb.

"Good measure, pressed down, and shaken together, and running over, shall men give into your bosom." — Luke vi. 38.

"He shall gather the lambs with his arm, and carry them in his bosom." — Isaiah xl. 11.

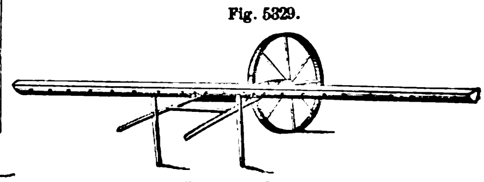
In Ohio it is common to use a two-bushel bag; the bag-string is tied to one lower corner, the bag carried over the right shoulder and under the left arm; the left hand holds the mouth open, so that the right hand may be readily reached into it to gather a handful of seed, — a cast for each step of the right foot.

"Doth the plowman plow all day to sow? doth he open and break the clods of his ground? When he hath made plain the face thereof, doth he not cast abroad the fitches, and scatter the cummin, and cast in the principal wheat and the appointed barley and the rye in their place?" — Isaiah xxviii. 24, 25.

Seed in ancient Greece was sown by hand and covered with a rake. — THEOPHRASTUS, 371 B. C.

One form of broadcast sower consists of a long hopper, provided at bottom with small openings, through which the seed passes. The openings are adjustable in size by means of a register plate, and are fed to the openings by a perforated plate above, which is reciprocated by a lever. The hopper may be 10 or 12 feet long, and is slung by a strap over the back of the

Fig. 5329.



Broadcast Sower.

neck, leaving one hand free to steady the hopper, while the other operates the trigger.

The same device is mounted on a barrow, and the feeding-lever operated by a trigger, cam, or other device put in motion by the wheel.

In Rogers' broadcast sower, operated by hand, the seed passes from a bag fixed upon the shoulder of the person sowing, to a revolving scatterer connected with the bag, and rotated alternately in opposite directions by a strap worked by a reciprocating rod, the seed being thrown out by centrifugal force. See BROADCAST SOWER; FERTILIZER SOWER, SEED-SOWER; DRILL, etc.

Sow'ing-ma-chine'. (*Husbandry.*) See SOWER; DRILL; PLANTER; GRAIN-DRILL.

Space. (*Printing.*) A thin piece of type-metal, shorter than a type, and used to separate the letters in a word or words in a line, so as to *justify* the line.

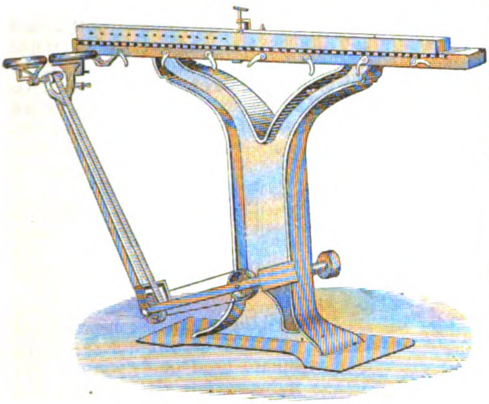
A *lead* separates the lines where the matter is *displayed.*

Space-line. (*Printing.*) A thin strip of metal, not so high as the type, used to separate and display the lines. A *lead.*

Space-rule. (*Printing.*) Fine rules of the hight of the type, of any length, and used for setting up tabular matter, etc.

Spac′ing and Bor′ing Ma-chine′. (*Wood-working.*) A machine for boring blind-stiles, sashes, etc., at accurately equal distances. The work is se-

Fig. 5330.



Blind-Stile Spacing and Boring Machine.

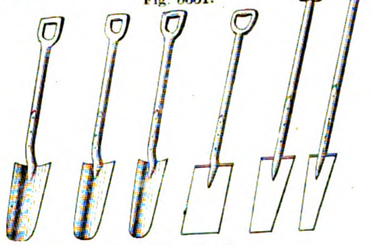
cured to the table by a thumb-screw. At the front edge of the table is a strip having notches and spaces at equal distances apart, the notches serving to retain the bit in proper position while boring.

The bit is attached to a jointed frame pivoted on the driving-shaft, so that a continuous rotary motion is imparted at whatever part of the stile it is applied. The operator grasps the handle and commences boring at either end.

Spad′dle. (*Husbandry.*) A small spade. A *spud.*

Spade. 1. (*Husbandry.*) A square-bladed digging implement, in which two hands and one foot are engaged.

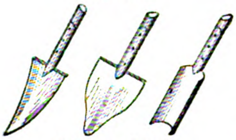
Fig. 5331.



Draining-Spades.

Spades for ditching assume many forms, especially in England, where the blade is made to correspond to the shape of the cross-section of the ditch. This is all very well to a certain extent, but all such ditches may be made by machines drawn by horse-power, either as plows or excavators. Where the ground admits, the team may be hitched to the machine; in wet soil the machine may be drawn by a rope from a capstan moved by a horse walking in a circle See CAPSTAN.

Fig. 5332.

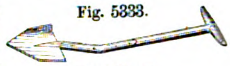


Ditching-Spades.

In the United States, ditches too large for the ditching-plow are made by the usual spade and shovel, or in some cases — and this will move more soil for the same money than any other mode — the ground is plowed and then moved away by the scraper. It may be finished by the shovel. This plowing and scraping does not give the symmetrical, steep bank so much coveted, but is a vast saving of manual labor.

The turf-spade is adapted for cutting sods, one upturned edge severing the sod while the blade cuts the roots. The use of turf in many parts of the British Islands is common, for fuel and for filling in the walls of shelters. The business of getting the winter supply of turf for fuel interests millions in that country, and probably some others with which we are not so well acquainted. It is stacked and thatched after having been cut, dried, and carted. It makes a good hot fire, something like peat, which it resembles in appearance and constituents.

Fig. 5333.



Turf-Spade.

The thistle-digger is a pronged tool, intended to catch the root below the crown, and then pry out the plant. The iron portion of the tool has a foot-tread, and a prong which rests on the ground to form a fulcrum; a blade cuts the root if the fork fail to withdraw the plant.

Fig. 5334.

Thistle-Digger.

The spade, as a digging instrument, does not seem to have been known in ancient Egypt. Its place was supplied by a heavy hoe. (See HOE.) Shovels are illustrated in ancient Egyptian paintings in connection with the moving of grain and gold-washing.

The ancient Greek spade had two cross-pieces for the foot, so as to dig right or left handed. The modern Irish spade has a single cross-bar for use with the right foot. It has a very long curved blade, and a long handle, with or without a bow, for a hand-hold.

The Japanese spade has a wooden handle, and a blade shod with iron.

The Roman *pala* or spade was shod with iron, and had a cross-bar for the foot in digging; this enabled it to be driven farther into the ground than when the foot rested on the blade. The same tool, called *vanga,* is yet used in Italy.

The spades of the Feejees, when first discovered, were poles of

Fig. 5335.

Ancient Greek Spade.

Fig. 5336.

Irish Spade.

Fig. 5337.

Japanese Spade.

the mangrove-tree, slanted off at the end, to form a sort of chisel. A group of three or four men, each with such a tool, stood in a circle, and with repeated strokes loosened a circular piece of earth of about 2 feet surface diameter; the spades were then used as levers to raise the mass, which was then broken up by boys.

The Maori implement of New Zealand was substantially similar. Digging with a sharp hand-spike. The same of Tahiti.

2. (*Seal-engraving.*) A soft iron tool, 3 or 4 inches long, and with the end filed to an angle of 45° and charged with diamond-powder. It is used to dress

Fig. 5338.

Rice's Spade-Bayonet.

off irregularities from the rounded surface of a cameo figure.

3. (*Nautical.*) A cutting implement used in flensing the whale. A *blubber-spade.*

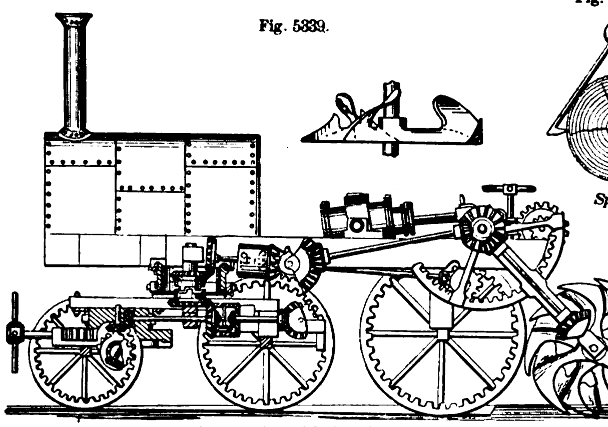
Spade-bay'o-net. (*Military.*) A broad-bladed bayonet, which may be used in digging shelter-holes or rifle-pits. A TROWEL-BAYONET (which see).

Spade-han'dle. (*Machinery.*) A pin held at both ends by the forked ends of a connecting rod.

Spa'der. A DIGGING-MACHINE (which see).

In the locomotive-spader (Fig. 5339), the crank-shaft of the engine is connected by gearing with each pair of wheels. Equalizing gears between the axles permit each wheel to adopt its proper speed in turning curves. The front truck-wheels and the driving-wheels at the rear have clutches by which they may be thrown in or out of connection with the engine. The spades also may be uncoupled and elevated when required. The sharp-pointed spades enter the ground nearly vertically, like a pick, and have wings which lift and turn over the clod after the manner of a plow's mold-board. They rotate in the direction in which the machine moves, and assist the draft of the wheels.

Fig. 5339.



Locomotive with Spading-Apparatus.

Spad'ing-ma-chine'. See DIGGING-MACHINE, pages 702, 703.

Spa-droon'. A light cut-and-thrust sword.

Spake-net. (*Nautical.*) A crab-net.

Spald'ing-knife. One used in splitting codfish.

Spale. 1. (*Shipbuilding.*) A strengthening cross-timber.

2. A lath. A *pale.*

Spall. (*Masonry.*) A chip of stone, removed by the hammer.

Spall'ing. 1. (*Mining.*) Breaking by a hammer the ore previous to *cobbing.* It follows the operation of the heavier hammer, called *ragging.* The *spalling* is for the purpose of removing portions of gangue and valueless rock. The subsequent *cobbing* is for the reduction of the blocks of ore to a smaller size.

2. (*Masonry.*) Reducing irregular blocks of stone to an approximately level surface by oblique blows of a stone hammer, which detaches flakes of stone from the mass.

Spall'ing-ham'mer. (*Masonry.*) An axe-formed, heavy hammer, used in rough-dressing stones.

Span. 1. (*Architecture.*) The chord or reach of an arch. The distance between *imposts* at the *springings* of the arch.

2. (*Nautical.*) *a.* A rope secured at both ends to an object, the purchase being hooked into the bight.

For hoisting in boats they are fitted with a hook at each end; on the bight is either a traveling thimble or a thimble strapped at the center, into which the purchase is hooked.

b. A leader for running rigging, which is conducted through a thimble at each end of the span, which is secured to the stay by a lanyard at the bight. The main-braces are thus spanned to the mizzen rigging to keep them clear of the boat davits.

c. To *span the booms* is to confine them by lashings.

d. The *span of the shrouds* is the length of the shrouds from the *dead-eyes* on one side over the mast-head to the dead-eyes on the other side of the ship.

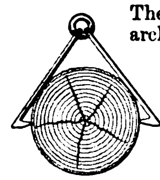
Span-beam. (*Mining.*) The horizontal beam into which the upper pivot of the axis of the whin is journaled.

Span-block. (*Nautical.*) One attached to each end of a span or length of rope which lies across a cap and hangs down at each side.

Span'cel. (*Manege.*) A hobble.

Span-dogs. A pair of dogs linked together and used to grapple timber, the fangs of the extended ends being driven into the log.

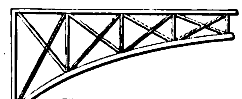
Fig. 5340.



Span-Dogs.

Span'drel. (*Architecture.*) *a.* The space over the haunch of an arch and between it and the out-scribing rectangle; between the extrados of an arch and the square head or drip-stone over it.

Fig. 5341.



Timber-Spandrel.

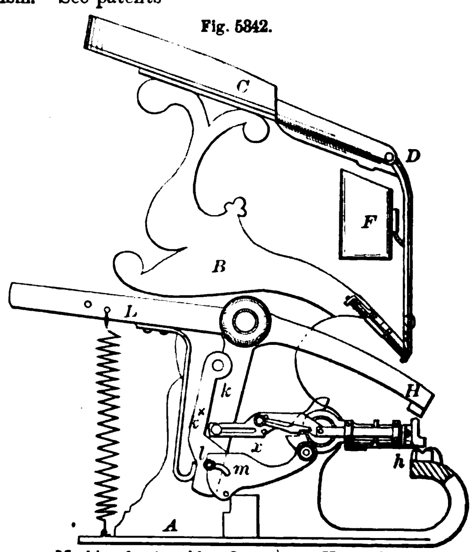
b. The space between the outer moldings of two arches and the string-course above them.

When timber arches support a roadway, the spandrels contain upright posts with diagonal stays. The posts transmit the load to the arch.

Span'drel-wall. (*Masonry.*) One built on the extrados of an arch.

Span'gling-ma-chine'. A machine for setting and securing the clasps or *spangles* by which the wires and tapes of hoop-skirts are secured together. The spangles are placed in a hopper, and automatically take their place in line in an inclined feeding-chute, which leads them to the clinching mechanism. See patents —

Fig. 5842.



Machine for Attaching Spangles to Hoop-Skirts.

No. 35,666.	Beck	June 24, 1862.
No. 36,877.	DeForest	Nov. 4, 1862.
No. 37,124.	Baird	Dec. 9, 1862.
No. 37,992.	Wilmot	Mar. 24, 1863.
No. 50,728.	Olmstead	Oct. 31, 1865.
No. 54,939.	Neumann	May 23, 1866.
No. 64,543.	Komp	May 7, 1867.
No. 71,492.	Jenkinson	Nov. 26, 1867.
No. 79,810.	Carter	July 14, 1868.

In Fig. 5342, the frame *A* carries a standard *B*, supporting the inclined trough *C*, into which a quantity of the spangles are placed. These slide down by gravity, and on reaching the throat of the spangle-guide *D*, those which are not in proper position for fixing are arrested, not being able to pass between the side of the guide and a projecting rib, which acts as a separator, and are dropped into a receptacle *F*. The others continue to slide down the channel of the guide until reaching its lower extremity, where a sliding-gate is provided to arrest them.

The lever *L* is rocked by a treadle, and has a lower branch *k* carrying a rocking arm k^x, provided with a pin *l*, which enters a slot in the lever *m*, establishing a loose connection between the two, and serving, when the end *L* of the lever is depressed, to lift the spangle-carrier *h* up to the mouth of the spangle-guide, where, the sliding-gate being opened by the same movement, a spangle is fed into the spring-jaw of the spangle-carrier, which is reciprocated by a slotted piece *x* engaged by a pin on the arm *k*. The opposite movement of the lever brings down the spangle-carrier upon a horn, where the skirt is held, and forces the spangle through the tap, while by a farther movement the carrier is drawn out of the way, while the hammer *H* falls and clinches the spangle.

Span'ish Bur'ton. (*Nautical.*) A *single* Spanish burton has three single blocks or two single blocks and a hook in the bight of one of the running parts. See Fig. 996, page 413. See also PULLEY, page 1819.

A *double* Spanish burton has one double and two single blocks.

Span'ish Stripes. (*Fabric.*) A kind of woolen fabric.

Span'ish Tu-ta'ni-a. An alloy composed of 24 parts tin, 2 antimony, and 1 steel.

Span'ish White. Finely powdered and levigated chalk, used as a pigment.

Span'ish Wind'lass. (*Nautical.*) One turned by a rope with a rolling hitch and a handspike in the bight.

Spank'er. (*Nautical.*) A four-cornered, *fore-and-aft* sail, whose *head* is extended by a *gaff*, and

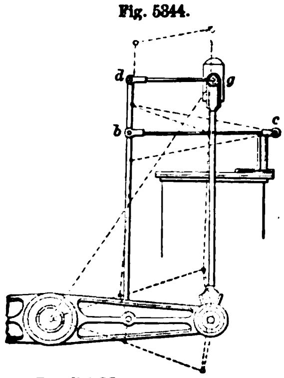
Fig. 5343.

Spanners.

its foot by a *boom* or a *sheet*. Sometimes called a *gaff-sail*, fore or main. Specifically, the *trysail* on the mizzen-mast. A *driver*.

Span'ner. 1. A fireman's wrench by which he fastens or unfastens the couplings of the hose. The curve follows the shape of the coupling, and the eye is caught over the stud on the collar, so as to wrench it fast or loose it, as the case may be.

Fig. 5344.



Parallel Motion for Side-Lever Engines.

Another form of spanner has merely jaws which fit upon nuts or faceted collars. See MONKEY-WRENCH, Fig. 3214, page 1473. See also WRENCH.

2. (*Steam-engine.*) A bar used in the parallel motion of the side-lever marine-engine. *b c*, *radius-rod*; *d g*, *spanner*. See PARALLEL MOTION, Fig. 3549, page 1631.

Span-piece. (*Carpentry.*) The collar-beam of a roof.

Span-roof. (*Building.*) One having two inclined sides.

Span-saw. A frame-saw.

Span-shack'le. (*Shipbuilding.*) *a.* A large bolt driven through the forecastle and spar-deck beams and forelocked before each beam with a large square or triangular shackle at the head for receiving the end of the davit.

b. A bolt driven through a deck-beam, and having a shackle for securing a boat, boom, or anchor.

Spar. 1. (*Nautical.*) A long, wooden beam, generally rounded, and used for supporting the sails of vessels. It assumes various functions and names, as a *mast*, *yard*, *boom*, *gaff*, *sprit*, etc.

2. In hoisting machinery, *spars* form the *masts* and *jibs* of derricks, and the elevated inclined timbers which form *sheers* for masting and dismasting vessels.

3. In building, *spars* are used as *rafters*, as *scaffold-poles*, as *ledgers* to rest on the *putlogs*.

A common rafter is sometimes called a *span*.

4. A pole lashed to a disabled carriage as a substitute for a wheel.

5. (*Mining.*) An earthy, lustrous mineral, which is often associated with ores, such as lead, copper, and tin, forming the gangue or matrix of the ore. It is known among miners by its characteristic color, as *white* spar, *black* spar, etc.

The word has many interesting mineralogical significations, such as *fluor spar*, a beautiful, crystalline fluoride of lime, the double-refracting *Iceland spar*, etc., etc.

Spar'a-ble. A cast-iron nail driven into soles of boots and shoes, and so called from its resemblance in shape to a *sparrow-bill*.

Spar'a-drap. (*Pharmacy.*) An adhesive plaster spread upon linen or paper.

Spar-a-dra'pi-er. (*Pharmacy.*) A machine for spreading plasters. It is a table with two raised pieces, movable and furnished with points by which the cloth may be stretched, and a spatula for spreading the composition.

Spar-deck. (*Nautical.*) Originally one of a temporary character, consisting of spars supported on beams. Now, the upper deck, with an open waist, or flush-deck. The term is somewhat loosely applied.

Spare An'chor. (*Nautical.*) A supplementary anchor, the size of the bower.

Spare Gear. (*Machinery.*) Extra parts carried in steamers to replace any portions of the machinery which may be broken or injured at sea.

The following is a list of tools and spare gear for a naval tender, and may serve as an illustration: —

LIST OF TOOLS AND SPARE ARTICLES FOR ENGINES (WITH SCREW-PROPELLERS) OF 450 HORSE-POWER.

Engineers' Tools.

	No.
Brushes, for boiler-tubes, to every 100 horse-power	20.
Drifts, short and long, to every 100 horse-power	1 each.
Fire-irons	12
Mandrels, to every 100 horse-power	1 each.
Scrapers, circular and forked, to every 100 horse-power	5 each.
Spanners and wrenches, of sorts	24
Stocks, taps, and dies, from ¼ to 1¼ inch	1 set.

Spare Gear.

Air-pump side-rods, with straps and brasses complete (if so fitted)	2
Air-pump rod	1
Air-pump cross-head (if so fitted)	1
Bars, furnace	½ set.

	No.
Bearers	3
Boiler-plates	6 cwt.
Bolts and nuts for engines, properly assorted	120
Cylinder-lid	1
Cylinder cross-head (if so fitted)	1
Ferrules for boiler-tubes, to every 100 horse-power	50
Piston and rod	1
Propeller and shaft complete	1
Rod, connecting, with strap and brasses complete	1
Rod feed-pump (if so fitted)	1
Rod bilge-pump (if so fitted)	1
Rod-slide	1
Screws, packing, for slides, complete for one engine	1 set.
Springs for each piston (if so fitted)	1 set.
Springs for other parts of engines, for one engine	1 set.
Tubes, boiler, to every 100 horse-power	10
Tubes, glass, for barometers	2
Valve, foot, without seat	1
Washers, iron	100

The term is equally applicable to the parts of any machine which may be duplicated.

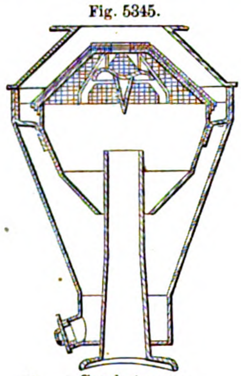
Spare Sail. (*Nautical.*) A duplicate of any of a ship's sails, reserved for use in case one already bent is carried away or is unbent for repairs.

Spar′ger. A sprinkler; usually a cup with a perforated lid, or a pipe with a perforated nozzle. Used for damping paper, clothes, etc.

Spark-ar-rest′er. A device placed upon the chimney of a locomotive or a portable engine, to prevent the passage of sparks from the chimney. Also called a *spark-consumer*. It has usually a wire cage to prevent the passage of sparks, but, in order to prevent impairing the draft, it is usual to depend upon catching the sparks after the first rebound and collecting them in some place out of the danger of being again carried away by the draft.

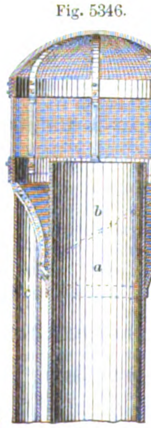
In Fig. 5345, the inner casing forms a hood over the pipe, and is covered with wire gauze, below which is suspended a conical deflector, by which the sparks are directed downward into the inner casing, from whence they pass into the reservoir below through the annular opening between the pipe and the casing.

Fig. 5345.



Spark-Arrester.

Fig. 5346.



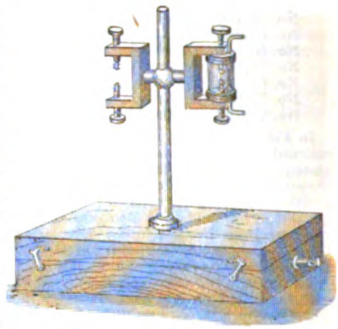
Spark-Arrester.

Fig 5346 is a view of a chimney-cap designed for portable engines for thrashing, where there is danger of communicating fire. The draft carries the smoke and sparks directly upward through the pipe *a* against the fine wire-netting, whose meshes are too small to allow sparks to pass. They rebound to the inclined conveyor *b*, and gravitate through the cinder-pipe *c* to a receptacle on the ground.

Spark-con-dens′er. 1. (*Electricity.*) An instrument having a glass cage in which a spark may be passed between the battery connections. It is used for burning metals or obtaining the spectra of gases, and is designed to isolate the atmosphere in which the experiment is conducted, so as to eliminate accidental disturbing causes; also to enable the experiment to take place in an atmosphere of any required condensation or tenuity.

2. (*Railway.*) A means of carrying away sparks from a locomotive chimney to a chamber where they are extinguished. A pipe from the locomotive over the top of each car to the rear has been proposed.

Fig. 5347.



Spark-Condenser.

Spar-piece. (*Carpentry.*) The collar-beam of a roof. A *span-piece*.

Spar′row-bill. *Sparable.* A shoe-brad.

Spat′ter-dash. A leather legging for equestrians.

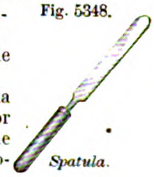
Spat′tle. (*Pottery.*) A tool for mottling a molded article with coloring matter.

Spat′tling-ma-chine′. (*Pottery.*) One for sprinkling earthenware with glaze, or colored slip, to make party-colored ware.

The liquid glaze contained in a trough is pumped up into an upper chamber, from which it is drawn from a faucet and falls through sieves, which divide it so that it falls in spray upon the ware which is passed underneath. This is performed in a *bonnet* to save waste, and the superfluous liquor is collected by a trough in the bonnet and returned to the reservoir.

Spat′u-la. 1. A knife with a broad, thin, flexible blade, used by druggists, color-compounders, painters, etc., for spreading plasters and working pigments.

Fig. 5348.



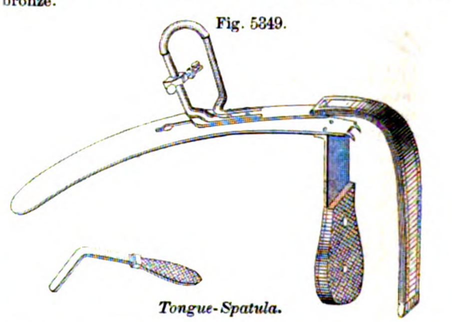
Spatula.

For some purposes spatulas are made of wood. See also PALETTE-KNIFE.

2. (*Surgical.*) The tongue-spatula is a flat instrument (angular or straight) for depressing the tongue and keeping it out of the way, in operations about the throat or larynx.

An ancient Egyptian spatula of iron has been found at Sakkarah. It is one of the few implements of iron which have withstood the rust of centuries These instruments were usually of bronze.

Fig. 5349.



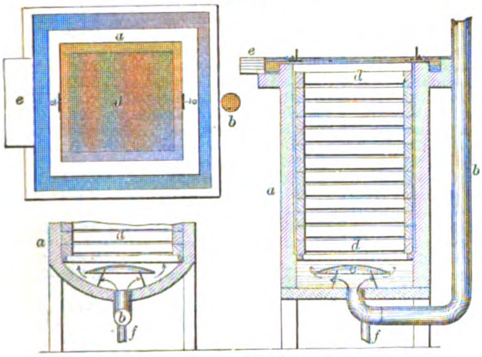
Tongue-Spatula.

Spatulas of copper and bronze were found in 1819 in a house in Pompeii. They were somewhat of the halbert shape. Cauteries were found at the same place and time.

Spawn-hatch′er. An apparatus for preserving and developing the spawn of fish.

Holton's (Fig. 5350) is more particularly designed for winter hatching. It consists of an upright box *a*, preferably about 2 feet in diameter and 2 to 4 feet high, into which a gentle flow of water is admitted at bottom through a pipe *b*; a deflecting plate *c* just over the pipe opening moderates and distributes the flow; *d d* are a series of trays with wire-gauze bottoms, on which the spawn is evenly distributed, and they are lowered one by one by means of attached straps into the case *a*; the water ascends through the meshed bottoms of the trays, finally

Fig. 5350.



Spawn-Hatcher.

overflowing into a channel surrounding the upper end of the case, and is discharged by a trough *e*.

The bottom of the box is segmental, or hopper-shaped, and is provided with a pipe *f* and valve for withdrawing any sedimentary deposits which may accumulate.

Speak'ing-trum'pet. A conical, flaring-mouthed tube employed for intensifying the sound of the human voice, as in giving commands or hailing ships at sea, by firemen, etc.

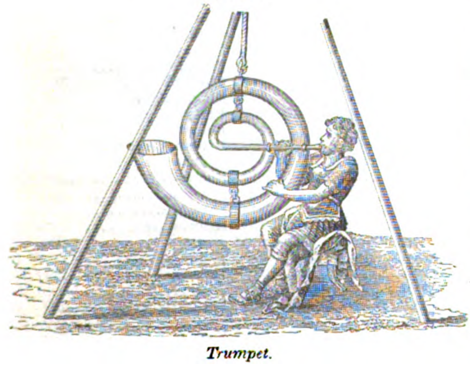
The speaking-trumpet was used by Alexander the Great, 235 B. C. Tradition long reported that the hights of the Caucasus, reaching from the Caspian to the Euxine, were occupied by the armies of Iskender (Alexander), the dread Doolkarnein or Two-Horned, so called from his being the conqueror of East and West. The illusion was said to have been caused by enormous trumpets, placed on the marvelous series of ramparts known in fable as the Wall of Gog and Magog, and craftily disposed so as to sound when the wind blew in certain directions. See Leigh Hunt's poem, "The Trumpets of Doolkarnein."

It is claimed by the modern school that the great horn, described in an old manuscript in the Vatican Library as having been used by Alexander the Great to assemble his army, at a distance of 100 stadia or 8 Italian miles, was not really a *speaking*-trumpet, as it is not expressly stated that he spoke through it. We prefer the tradition as it stands, for Alexander was well acquainted with Egypt, and the blast of trumpets was not unknown there.

Morland, who was born in 1625, and died in poverty in 1695, is believed to have given the speaking-trumpet its present form, though his claims are warmly contested by Kircher. Morland's pamphlet of 8 pages was published in 1671. His first trumpet was made of glass. The next was of brass; 4½ feet long, 12 inches in diameter at the large end and 2 inches at the small end, which had a mouth-piece constructed like a bellows to move with the lips. With this he rendered his voice distinct at a distance of half a mile. His third trumpet was curved, made of copper, and had a length of 16 feet 8 inches; 19 inches diameter at the flaring end, and 2 inches at the smaller. It rendered his speech audible at 1¼ miles. One of his largest carried the voice a distance of 2 or 3 miles at sea.

Fig. 5351 is an illustration of a spiral trumpet, described in Père Kircher's work, and pictured in Père Bonanni's curious work, "Descrizione Degl' Istromenti Armonici," Roma, 1776. It is designed rather for augmenting the voice than for musical

Fig. 5351.



Trumpet.

effects. It is intended to be elliptical in cross-section, and it is claimed to have been suggested by the shape of the exterior aural canals of various animals. Father Kircher takes occasion in this connection to mock the conclusions of Baptista Porta and Cornelius Agrippa that a sound might be made and then imprisoned in a tube by shutting up both ends, and then letting it out as required. A very remarkable instance of this was afterward cited in the veracious history of Baron Munchausen, whose tunes became frozen in his trumpet on a bitter cold day, and afterward issued when the instrument and its contents were thawed by the warmth of the tavern fire.

Speak'ing-tube. A pipe for conveying the voice from one apartment or floor to another.

Spear. 1. (*Weapon.*) A very ancient instrument of war, consisting of a blade on the end of a long shaft. It still survives among savage nations, and under the name of *lance* is used by cavalry among those comparatively civilized.

The spear of antiquity was sometimes provided with the *amentum* or thong for throwing.

Herodotus distinguishes the nationality of some of the nations in the army of Xerxes by describing the peculiar ornaments on the ends of their spear-shafts.

For a dissertation on the spears of the ancients, see article "Hasta," in Smith's "Dictionary of Greek and Roman Antiquities." The spear was the principal weapon of the Macedonian phalanx. The lance was introduced from Tartary into Poland, and thence found its way into the army of Frederick the Great, and into the Austrian service, where its name (*ulan*, from Turkish *oglân*, a youth) indicates its derivation. See LANCE

2. A *fish-gig*.

3. The long transverse pieces fixed transversely to the beam or body of a *cheval de frise* are called *spears*.

4. (*Mining.*) A pump-rod.

Spear-nail. One with a spear-shaped point.

Spe-cif'ic Grav'i-ty. The relative weight of a ponderable substance compared with another which is taken as a standard. For solids and liquids, *water*, and, for gases, *air*, are universally adopted as the standards. It took a long time to find out that air really was a ponderable substance.

The specific gravity of a body is ascertained by weighing the body in air, and then in water. Subtract the weight in water from the weight in air, and divide the weight in air by the difference. The quotient is the specific gravity required. The bulk of the object must agree with that of the standard of comparison if the result is to be stated in relative terms. See SPECIFIC-GRAVITY BALANCE.

In obtaining the specific gravity of fluids, a bottle is obtained, whose capacity is 1,000 grains of distilled water. This is filled with water, and balanced on the scales. The water is then removed and the fluid substituted, and the bottle and contents again weighed. The weight of the fluid divided by the weight of the water gives the specific gravity required.

Archimedes invented the plan for determining specific gravity by displacement of water. He also enunciated the doctrine of the "center of gravity."

Alhazen the Saracen, A. D. 1100, improved upon the hydrometer, which had been in use in Alexandria 600 years previously. See HYDROMETER.

Abu-r-Raihan of Kharizim, about A. D. 1000, compiled a table of specific gravities, which is quoted by Al-Khâzinî in his "Book of the Balance of Wisdom," translated from the Arabic by Chev. Khanikoff, consul-general of Russia, at Tabriz, Persia It was in reference to this table that Al Khâzinî uttered his pious hope that, "in the day of judgment, the All-Merciful will take pity on the soul of Abu-r-Raihân, because he was the first of the race of men to construct a table of specific gravities." The table is recorded in connection with the modern data on pages 84, 85 of the "Journal of the American Oriental Society," Vol. VI., New Haven, 1860. See also page 212, article BALANCE.

Al-Khâzinî states that when a body is weighed in air and afterward in the water-bowl, the beam of the balance rises in proportion to the weight of the water which is displaced, which is equal to the entire weight of the body weighed.

The "Balance of Wisdom," as the instrument is called by its describer, in the fanciful style common in the literature of that day, was a turned brass tube with closed ends, and so weighted as to float upright in a liquid. Graduations on the side were marked above and below a line that was termed the equator of equilibrium, to which line the instrument sank when plunged in the liquid — water of a certain description — which formed the unit of calculation. It is, as to this feature, a hydrometer, such as described by Synesius, and is credited by Al Khâzinî to Archimedes.

The conical instrument of Abu-r-Raihan is described by Al Khâzini, and has a conical body, a narrow vertical neck, and a curved spout leading from the latter, by which the water dis-

placed by a solid body was conducted to the bowl of a balance, by which it was weighed.

Al Khàzinî says in his book, of the eminent teacher 'Abû-Hâtim 'al-Muzaffar Bin 'Ismâil of 'Isfazâr, who was adapting the specific-gravity balance to the determination of the specific gravity of metal by graduations on the beam calculated for liquids of immersion of different densities: "He passed away, to meet the mercy of the Supreme God, before perfecting it, and reducing all his views on the subject to writing."

The first person *in Europe* to make a tabular statement of computations in this line was Athanasius Kircher, 1602-80; after him Galileo, 1657; Boyle (born in 1627). The calculations of the latter of the specific gravity of mercury—13.76 and 13.357—are both less exact than those of the scientific Arab in the retinue of Mahmoud of Ghuzna, A. D. 1000; he made it 13.56. The modern figure is 13.557.

The following table gives the *specific* gravity of a number of gaseous, liquid, and solid substances. See also Clark's "Constants of Nature," Smithsonian Institution Collections, December, 1873.

Gases, Air = 1.

Hydrogen	0.069	Oxygen	1.106
Marsh gas	0.559	Sulphuretted hydrogen	1.191
Steam	0.623	Nitrous oxide	1.527
Carbonic oxide	0.968	Carbonic acid	1.529
Nitrogen	0.971	Sulphurous acid	2.247
Olefiant gas	0.978	Chlorine	2.47
Nitric oxide	1.939		

Non-Metallic, Solid, Elementary Substances, Water = 1.

Boron	2.68	Iodine	4.948
Bromine	2.98 - 2.99	Phosphorus, common	1.826
Carbon, diamond	3.529 - 3.550	Selenium	4.760 - 4.808
Carbon, graphite	2.105 - 2.585	Silicon	2.004 - 2.493
Carbon, from gas-works	1.885	Sulphur, roll	1.868 - 2.000
Carbon, charcoal, variable from 0.280 for that from soft wood freshly burned in the stick, to 1.573 for oak charcoal, pulverized and compressed.		Sulphur, flowers	1.913 - 2.086

Metals, etc.

Aluminium, cast	2.50	Molybdenum	8.49 - 8.60
Aluminium, hammered	2.67	Nickel	7.807 - 9.261
Arsenic	5.763	Nickel wire	8.88
Barium	4.00	Osmium	21.40
Bismuth	9.67 - 9.83	Palladium	10.923 - 12.148
Cadmium	8.54 - 8.67	Platinum, cast	19.5
Calcium	1.55 - 1.8	Platinum, hammered	20.3
Cerium	5.5	Platinum wire	21.0 - 21.7
Chromium	6.81 - 7.3	Platinum sponge	21.47
Cobalt	8.48 - 8.95	Potassium	0.865
Columbium or Niobium	6.0 - 7.37	Rhodium	11.0 - 11.2
Copper, cast	8.78 - 8.83	Rubidium	1.52
Copper, rolled	8.88 - 8.95	Ruthenium	11.0 - 11.4
Copper wire	8.93 - 8.95	Silver	10.362 - 10.575
Glucinium	2.1	Sodium	0.972
Gold	19.2 - 19.4	Steel, cast	7.802 - 7.825
Indium	7.362	Steel, blister	7.720
Iridium	21.78 - 21.83	Steel, puddled	7.640 - 7.707
Iron, pure	7.83	Strontium	2.4 - 2.58
Iron, cast	6.928 - 7.330	Tantalum	10.08 - 10.78
Iron, bar	7.658 - 7.760	Tellurium	6.115 - 6.343
Iron, rolled plate	7.570 - 7.732	Thallium	11.777 - 11.900
Iron, hammered	7.868	Thorium	7.657 - 7.795
Iron wire	7.6 - 7.83	Tin	7.278 - 7.304
Lead	11.07 - 11.445	Tungsten	17.6 - 19.261
Magnesium	1.69 - 2.04	Uranium	18.33 - 18.40
Manganese	8.01	Vanadium	5.5
Mercury	13.568	Zinc	6.861 - 7.21

Alloys.

Brass		Brass wire	8.214
Copper, 84; zinc, 16.	8.832	Bronze gun-metal	8.700
Copper, 67; zinc, 33.	7.820	Gold, English standard, 22 carats fine	18.888
Brass plate	8.380		

Ores.

Copper, compact vitreous	4.129	Iron, brown hematite	3.789 - 4.029
Copper, Cornish	5.452	Iron, specular	4.934 - 5.218
Copper, pyrites	4.080 - 4.344	Iron, sparry	3.64 - 3.81
Iron, chromate	4.057	Iron, ironstone	2.952 - 3.863
Iron, pyrites	4.789	Lead, carbonate	6.00 - 7.20
Iron, magnetic	4.2 - 4.9	Lead, sulphide (Galena)	7.22
Iron, red hematite	4.740 - 5.005	Tin, Cornish	5.8 - 6.45
		Zinc, calamine	3.525

Stones and Mineral Substances.

Agate	2.348 - 2.637
Alabaster	2.611 - 2.876
Amethyst	2.750
Asbestus	0.680 - 0.993
Asbestus, starry	3.073
Barytes	4.00 - 4.865
Basalt	2.421 - 3.000
Beryl	2.723 - 3.549
Brick	1.367 - 1.900
Brick, fire	2.201
Brick-work in mortar	1.600 - 2.000
Brick-work in cement	1.800
Carnelian	2.597 - 2.630
Cement, Portland	1.300
Cement, Roman	1.560
Chalcedony	2.586 - 2.664
Chalk	1.520 - 2.784
Chrysolite	2.782 - 3.489
Clay	1.93 - 2.16
Coal, anthracite	1.436 - 1.640
Coal, cannel	1.238 - 1.318
Coal, Cumberland, Md.	1.355
Coal, Newcastle	1.270
Coal, Welsh	1.315
Coke	1.000
Corundum	3.710 - 3.981
Cryolite	2.692 - 3.077
Diamond, Oriental	3.521 - 3.550
Diamond, Brazilian	3.444
Dolomite	2.800
Earth	2.194
Earth, loose	1.500
Earth, rammed	1.600
Earth, moist sand	2.050
Emerald	2.600
Emerald, Brazilian	3.155
Flint	2.586 - 2.664
Garnet, common	3.576 - 3.688
Garnet, precious	4.000 - 4.352
Granite	2.613 - 2.956
Gypsum	1.872 - 3.310
Gypsum, ordinary, about	2.3
Hornblende, common	3.600 - 3.830
Hyacinth	4.000 - 4.620
Jade	2.959 - 3.389
Jasper	2.566 - 2.816
Jet	1.259 - 1.300
Limestone	2.700 - 2.837
Limestone, green	3.182
Marl	1.700 - 2.944
Malachite	3.572 - 3.994
Marble	2.516 - 2.858
Mica	2.546 - 2.934
Millstone	2.484
Mortar	1.384 - 1.750
Mud, about	1.630
Opal	1.958 - 2.144
Peat	0.600 - 1.329
Pitchstone	1.970 - 2.720
Plaster of Paris	1.176
Plumbago	1.967 - 2.267
Porphyry	2.670 - 2.790
Pumice-stone	0.915
Quartz	2.64 - 2.66
Rock crystal	2.605 - 2.888
Ruby, Oriental	4.283
Ruby, Brazilian	3.531
Sand	1.392 - 1.800
Sandstone	2.08 - 2.52
Sapphire	3.991 - 4.283
Sardonyx	2.594 - 2.628
Serpentine	2.429 - 2.999
Shale	2.600
Slate	2.672 - 2.965
Spar, calc	2.715
Spar, feld	2.693 - 2.704
Spar, fluor	3.138 - 3.183
Spar, other varieties	2.43 - 3.873
Steatite	2.61
Stone, building, varieties	1.386 - 2.945
Stone, building, common	2.520
Stone, building, Bath, England	1.961
Stone, building, Bristol, England	2.510
Stone, building, Norfolk, England (Parliament House)	2.304
Stone, building, Portland	2.368
Stone, building, Caen, Fr.	2.076
Stone, building, Notre Dame Cathedral	2.378
Stone, building, Breakneck, N. Y.	2.704
Stone, building, Kip's Bay, N. Y.	2.759
Stone, building, Staten Island, N. Y.	2.976
Stone, building, Sullivan Co., N. Y.	2.688
Talc	2.08 - 2.90
Trap	2.72
Topaz	3.155 - 4.061

Woods, Dry.

Alder	.800
Apple	.793
Ash	.800
Ash, American	.514 - .736
Bass	.482 - .502
Bay, Spanish	.822
Beech	.852
Beech, American	.672 - .735
Birch	.567
Box	.900 - 1.030
Brazil-wood	1.031
Campeachy (logwood)	.913
Cedar, American	.560
Cedar, Indian	1.315
Cherry	.715
Cherry, American	.579
Chestnut, Amer.	.469 - .545
Cocoa	1.040
Cork	.240
Cypress, Spanish	.644
Cypress, American	.553
Dogwood	.756 - .852
Ebony, Indian	1.209
Ebony, American	1.331
Elder	.695
Elm	.671
Elm, American	.723 - .775
Fir, Norway	.512
Fir, Oregon, yellow	.559 - .630
Fir, Oregon, red	.462
Fir, Oregon, white	.468
Gum, black	.615
Gum, blue	.843
Gum, water	1.000
Hackmatack	.590
Hawthorn	.910
Hazel	.606 - .860
Hemlock	.368 - .453
Hickory	.826 - .992
Holly	.760
Holly, American	.641
Juniper	.556
Lancewood	.720
Larch	.544 - .560
Lemon	.703
Lignum-vitæ	1.257 - 1.333
Lime	.804
Linden	.604
Locust	.728 - .826
Logwood	.913
Mahogany	.720 - 1.063
Mahogany, San Domingo	.727
Mahogany, Honduras	.560
Maple	.681 - .755
Maple, bird's-eye	.576
Maple, Oregon	.491
Mulberry	.897
Oak, African	.823
Oak, Canadian	.872
Oak, Dantzic	.759
Oak, English	.932
Oak, white	.682 - .882
Oak, live	1.021 - 1.103
Olive	.927
Orange	.705
Pear	.661
Persimmon	.710
Pine, pitch	1.060
Pine, red	.590
Pine, white	.360 - .461
Pine, yellow	.528 - .672
Plum	.785
Poplar	.432 - .498
Poplar, white Spanish	.529
Quince	.705
Redwood, Cal	.387
Rosewood	.728
Sassafras	.482
Satin-wood	.885
Spruce	.436 - .444
Sycamore	.623
Tamarack	.383
Teak	.961
Walnut, black	.529 - .649
Willow	.486 - .585
Yew	.788 - .807

Miscellaneous Solids.

Amber	1.078 - 1.085	Gutta-percha	.980
Ambergris	.866	Horn	1.689
Beeswax	.965	Ice	.918
Bone	1.66	Indigo	1.009
Butter	.942	Isinglass	1.111
Camphor	.988	Ivory	1.825 - 1.920
Caoutchouc	.903	Lard	.947
Fat, beef, mutton	.923	Mastic	1.074
Fat, hog	.936	Myrrh	1.360
Flesh	.890	Opium	1.071
Gum-arabic	1.452	Spermaceti	0.943
Gunpowder, loose	900	Starch	1.505 - 1.560
Gunpowder, shaken	1 000	Sugar, Cane	1.593 - 1.606
Gunpowder, solid	1.550 - 1.800	Tallow	.941

Liquids.

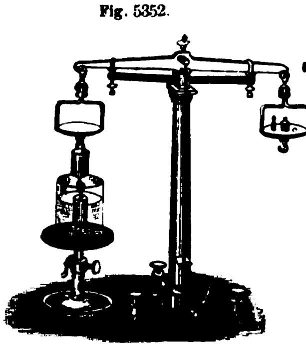
Acids: —		Blood	1.040 - 1.954
Acetic	1.063	Honey	1.45
Carbolic	1.065	Milk	1.032
Fluoric	1.036	Sea-water	1.026 - 1.027
Hydrochloric	1.270	Sea-water (Dead Sea)	1.240
Hydrocyanic	.700	Tar	1.015
Nitric	1.554	Vinegar	1.080
Sulphuric	1.970		
Aqua regia	1.23	Oils: —	
		Codfish	.923
Alcohol: —		Linseed	.940
Absolute	.749	Olive	.915
95 per cent	.816	Palm	.969
80 per cent	.863	Petroleum	.830 - .890
50 per cent (proof)	.934	Rapeseed	.914
40 per cent	.951	Sunflower	.926
25 per cent	.970	Turpentine	.870
10 per cent	.986	Whale	.923

Spe-cif'ic-grav'i-ty Bal'ance. For determining specific gravities. The arrangement (Fig. 5352) illustrates the principle discovered by Archimedes, that every body immersed in a liquid loses a part of its weight equal to the weight of the liquid displaced. See page 2255.

From one of the scale-pans of an accurate balance is suspended a hollow cylinder of copper, and beneath this a solid cylinder of the same metal precisely equal in volume to the interior of the upper cylinder. These are balanced by weights in the other scale-pan, and the solid copper cylinder is then immersed in a vessel of pure water. This disturbs the equilibrium of the scale, which is again restored by pouring water in the upper cylinder. The quantity required is exactly equal to that displaced by the lower cylinder, and its weight divided into that of the latter gives the specific gravity of the copper.

In the case of liquids, a body not liable to be attacked by the liquid is suspended from one of the scale-pans. The body is weighed first in the liquid to be examined, and afterward in water. The weight in water divided into the weight in the other

Fig. 5352.



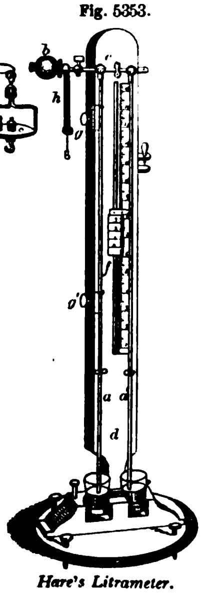
Specific-Gravity Balance.

liquid gives the specific gravity of the latter. See "Mohr's Specific Gravity Balance," pages 39, 40, "Griffin's Chemical Handicraft."

Spe-cif'ic-grav'i-ty In'stru-ment. Professor Hare's litrameter, for ascertaining the relative density of liquids, is shown in Fig. 5353.

Two equal glass tubes *a a'* communicate with each other and with an elastic bag *b* by means of a pipe *c* terminating in a cock, to which the mouth of the bag is tied. The tubes are both attached to an upright standard *d*, provided with a graduated scale *e*, divided into 220 parts, which may be read to tenths by a vernier *f*. Two indexes *g g'* on the tube *a* correspond respectively to the graduations 100 and 200 on the scale. One of the tubes *a'* being immersed in a vessel of water, and the other *a* in a vessel containing the liquid to be tested, the bulb *b* is compressed, partially forcing out the air contained in the tubes. On releasing the bulb the fluids ascend in the tubes. If the fluid to be tested is heavier than water, the expulsion of the air is so regulated that it shall stand a little above the level of the lower index; the cups are then removed, and sufficient air admitted to the tubes by a valve arrangement *h* to reduce its level exactly to that of the lower index *g*; the columns in the two tubes are now supported by the excess of atmospheric pressure over that of the air in the upper parts of the tubes, which, of course, is precisely equal in both. The vernier then, being adjusted to the level of the water in the tube *a'*, indicates the specific gravity of the other liquid. If a liquid lighter than water is to be examined, its level is brought to the hight of the upper index, and the reading of the scale halved.

Fig. 5353.



Hare's Litrameter.

Spe-cif'ic-grav'i-ty Beads. Small spherical bodies of known weight in proportion to their bulk, used for determining the specific gravity of liquids. A form of hydrometer.

Just as a farmer's wife tests the strength of lye for making soap, considering it of the right strength when a fresh hen's egg floats as large as a quarter-dollar above the surface of the liquid.

Spe-cif'ic Heat. The amount of heat required to raise the temperature of a certain weight (as a pound or kilogramme, of a substance) a definite amount, as 1° Cent. or 1° Fah. Water is taken as the standard of comparison; the Centigrade degree and kilogramme being universally adopted on the Continent of Europe, while the avoirdupois pound and degree of Fahrenheit are in common use in England and the United States, though the Continental system is that generally employed by scientific men.

Spe-cil'i-um. (*Surgical.*) An instrument for examining wounds, fistulas, and for passing setons. A *probe*. It is usually of silver, and is terminated by a spherical button.

Speck-block. (*Nautical.*) One used in *flensing* or stripping the blubber off a whale. Through it the *speck-fall*, a purchase, is rove, the blocks being made fast to the *blubber-guy*.

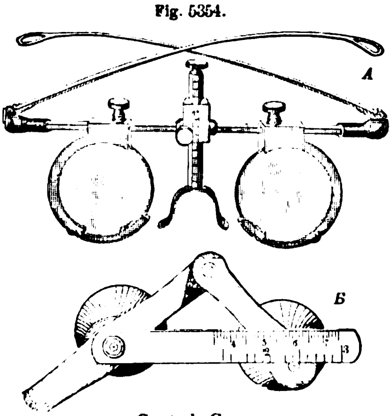
Speck-falls. (*Nautical.*) The ropes of the speck-block for getting blubber aboard.

Spec'ta-cle-fur'nace. (*Metal-working.*) A furnace with two tap-holes, one above the other.

Spec'ta-cle-gage. A device for determining the proper distance apart at which the glasses should be placed to exactly suit each individual case.

In *A* two glasses are fixed in spring-holders, which slide on a square graduated rod, and may be held by set-screws. These

Fig. 5354.



Spectacle-Gages.

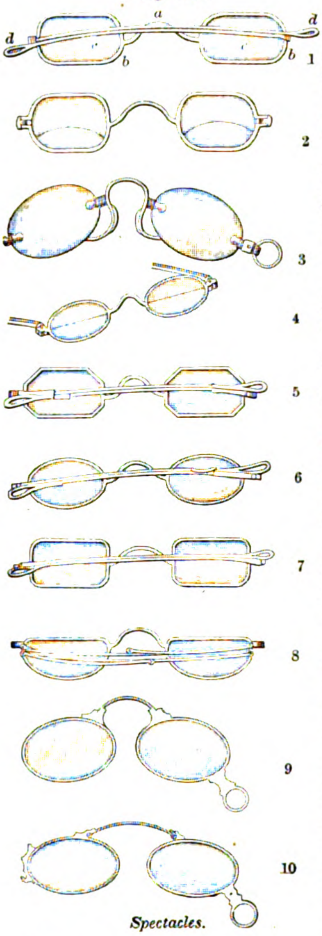
are moved inward or outward, until an object is distinctly seen by both eyes through the centers of the glasses; being then fixed by the set-screws, the distance is read off on the graduated rod; their hight is adjusted by a central sliding nose-piece.

In *B* the object is viewed through a pair of goggles, having minute perforations, and attached to two jointed arms; the distance between the two visual axes is indicated on a scale.

Spec'ta-cles. A pair of lenses in a frame to assist failing or imperfect sight.

In Fig. 5355, 1, the different parts are shown: —

Fig. 5355.



Spectacles.

a, *bridge*.
b, *eye* or *bow*.
c, *glass* or *lens*.
d, *side* or *temple*.

2 has segments of different foci; their line of junction is curved.

3, the metallic portions are riveted to the lenses.

4 has semi-lenses of different convexities; their line of junction straight.

5 has octagonal lenses.

6, oval.

7, oblong.

8, pulpit spectacles, to allow a reader to look over them more readily.

9, *spring eye-glasses*.

10, folding eye-glasses.

Strabismus spectacles have a small central opening to aid in curing the defect by exercising the muscle which brings the eyes into the normal position.

Spectacles with glasses of different refractive powers are made for those whose eyes have unequal foci.

An *astigmatic* glass is adapted for an eye which has different refractive powers at different parts of its cornea or lens.

In other spectacles each glass is made up of two half-lenses of different powers or characters, — one for reading, the other for ordinary use in walking or conversation.

Goggles are short tubes which exclude much light from the eye, especially lateral rays.

Wire-gauze spectacles are used to exclude dust and cinders.

Colored spectacles are used to temper the light, in mercy to weak eyes.

For *weak eyelids* spectacles are used which prop the upper eyelid.

The sides of spectacles are known as *single* or *turn-pin*; the latter having a jointed extension piece.

Spectacles are also known by other names indicative of color of lens, optical character, nature of lens, etc., as *green*, *blue*, *neutral tint*, *smoke* color; *double concave*, *double convex*, *periscopic*, *pebble*.

Periscopic glasses were invented by the eccentric Dr. Wollaston. The glasses are concavo-convex, and facilitate oblique vision.

Spectacles are said to be of Asiatic origin, and are of great antiquity in China. A spectacle lens was discovered in the Stabian Street at Pompeii in 1854. Alhazen appears to have referred to them. Roger Bacon, in his "Opus Major," writes: "This instrument, a plano-convex glass or large segment of a sphere, is useful to old men and to those who have weak eyes, for they may see the smallest letters sufficiently magnified." Bacon was born at Ilchester, in Somersetshire, in 1214, the year before the signing of Magna Charta; was educated at Oxford, then studied in Paris, where he took his degree, which was subsequently confirmed by the Oxford University; in 1240 he took the vows of a Franciscan at Oxford. His talents and originality caused him to be suspected by his brethren, and he was imprisoned in 1268, and closely confined for ten years. He returned to Oxford, and died in 1292. The claim to the invention of spectacles, asserted in behalf of Alexander de Spina, a monk of Pisa, who died in 1313, is believed to be anticipated by this date of Bacon's.

Fig. 5356 is from the tapestry of Nancy, of the latter part of the fifteenth century, and represents a scribe with spectacles on nose, and with all his apparatus of writing, — pen, penknife portable case, book, and paper.

Fig. 5356.


Scribe with Spectacles (Tapestry of Nancy, France).

Chaucer and Lydgate refer to spectacles. John Baret, of Bury St. Edmunds, left by will, in 1463, to one of the monks, his ivory tablets and a pair of silver-gilt spectacles.

"I this morning did buy me a pair of green spectacles, to see whether they would help my eyes or no." — PEPYS' *Diary*, 1666.

Feeling encouraged: —

"Bought me two new pair of spectacles of Turlington, who, it seems, is famous for them." — PEPYS' *Diary*, 1667.

"The residents in Sikkim [says Hooker], in the Himalayas, seek protection for their eyes from the glare of the newly fallen snow, some with veils, others with shades of brown paper, or of hair from the yaks' tails, whilst a few have spectacles of woven hair; and the Lepchas loosened their pigtails, and combed their long hair over their eyes and faces."

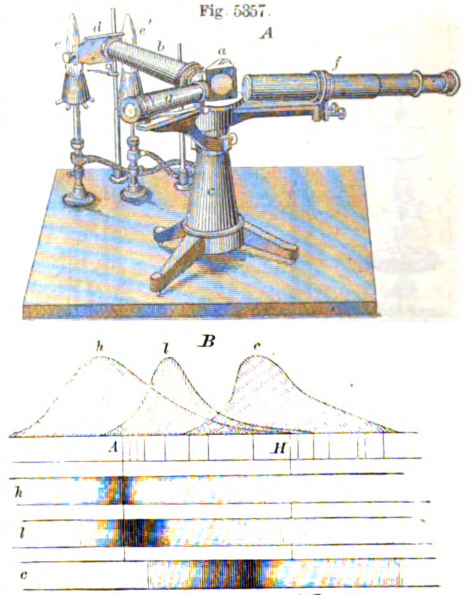
Cohn, an oculist of Breslau, has made an estimate of the number of workmen in metal who have been injured in the eye by minute pieces of metal. Among 1,283 workmen, he found that 90 per cent had suffered thus to some extent, and 40 per cent had been under medical treatment therefor; 59 were permanently injured, and 21 had lost the use of one eye. He introduced mica spectacles with great success. The frame is made to fit around the eye, like goggles.

Spec-trom'e-ter. (*Optics.*) An instrument described by Valz in "Comptes Rendus," Vol. LVII. pp. 69, 141, for viewing the spectrum by direct vision, and so arranged as to reduce the dispersion of the rays as little as possible.

Spec'tro-scope. An instrument for viewing the spectra formed by the solar rays and by those of other bodies in an incandescent condition.

Newton, 1675, determined the fact that the solar light was composed of six different and unequally refrangible colors. (See PRISM.) He also found that these colors, which combined to form white light, could not be farther separated by undergoing a second refraction. In 1781, Scheele, who discovered the fact that light exercises a chemical action upon chloride of silver, found that the compound was blackened most toward the violet

Fig. 5357.

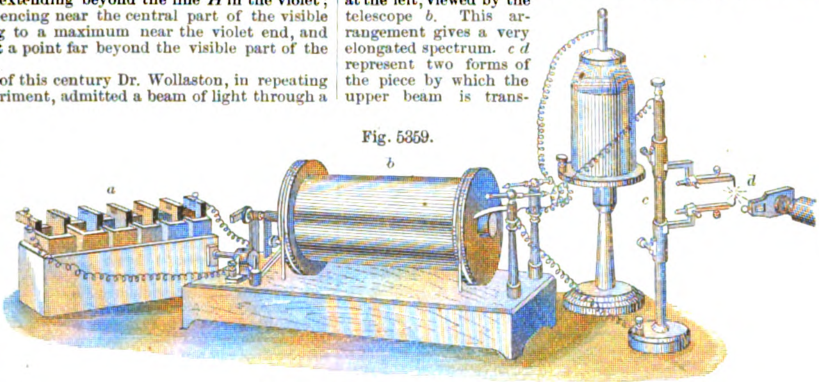


Steinheil's Spectroscope and Spectrum.

end of the spectrum. Subsequent researches have shown that the solar spectrum is apparently composed of three parts, which are, throughout a portion of their extent, superimposed one upon the other (*E*, Fig. 5357); thus the part *h* exhibits the maximum *heating* effect; the part *l* is that which produces light; and the part *c* exerts the greatest *chemical* or actinic action. The curves indicate the respective maxima and minima of heat, light, and actinic force respectively; the first being greatest at a point entirely without the visible end of the spectrum; the second commencing just beyond the line *A* near the end of the red, and extending beyond the line *H* in the violet; and the third commencing near the central part of the visible spectrum, increasing to a maximum near the violet end, and only disappearing at a point far beyond the visible part of the spectrum.

At the beginning of this century Dr. Wollaston, in repeating the Newtonian experiment, admitted a beam of light through a very narrow slit instead of a round hole, and detected a number of black lines in the spectrum; and in 1814, Fraunhofer, pursuing the investigation, had discovered and located 576 of these lines. He also observed that these were uniformly the same in light received directly from the sun and reflected from the planets, and that light from the self-luminous fixed stars contained black lines differing from those of the solar light. He thence concluded that these variations were due to causes existing outside of our atmosphere, — a conclusion which has been since amply confirmed.

Fig. 5359.



Spectroscopic Apparatus and Battery.

Melville, in 1752, noticed the yellow flame due to sodia; and in 1822 Sir John Herschel remarked that "the colors contributed by different objects to flame afford in many instances a ready and neat way of detecting extremely minute quantities of them."

Mr. Fox Talbot, in 1834, distinguishes the difference between the red lines produced by the flames of strontia and lithia, and in 1845 Professor W. A. Miller experimented upon the spectra of the alkaline earth metals.

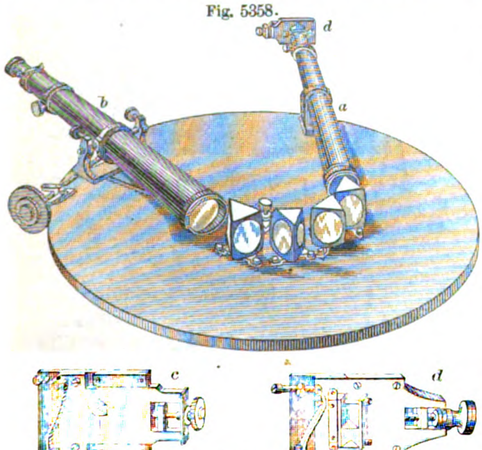
Professor Bunsen, however, so far advanced the subject that he, in conjunction with Kirchoff, may be almost said to have invented spectrum analysis as it now exists.

Through its instrumentality Bunsen discovered, in 1860, the new metals cæsium and rubidium; Crookes, in 1861, discovered thallium; and in 1864 Reich and Richter discovered indium.

In Fig. 5357, *A* represents the improved spectroscope of Steinheil. It consists of a stand *c* carrying the flint-glass prism *a*, having a refracting angle of 60°. The stand has two arms, one of which carries the telescope *f*, and the other the tube *g*, containing a lens in the end nearest the prism, and at the other end a scale which can be seen through the telescope by reflection from the surface of the prism.

The light *e* is admitted to the tube *f* through an adjustable slit in the piece *d*, the upper part only of which is open; the light *e'* is reflected from a prism within the piece *d* below the slit, so that the spectra of the two lights appear one above the other in the telescope *f*, the scale in the tube *g* being illuminated when required by a lamp in front of it; the adjustments consist in properly focusing the telescope and so arranging the tubes *b g* and the lights that their spectra and the micrometer scale are all distinct in the same field.

Fig. 5358.



Kirchoff's Spectroscope.

In Fig. 5358, the arrangement used by Kirchoff, a train of four prisms is employed; the rays passing through the slit in *d* are rendered parallel by a lens in the tube *a*, and, being decomposed successively by the prisms, are, on emerging from that at the left, viewed by the telescope *b*. This arrangement gives a very elongated spectrum. *c d* represent two forms of the piece by which the upper beam is transmitted and the lower reflected through the tube *a*. The width of the slit may be varied by means of screws.

Fig. 5359 shows the apparatus employed for volatilizing the metals in order to obtain their spectra; it consists essentially of a voltaic battery *a*, induction coil *b*, and a stand *c* having adjustable arms, carrying the points between which the substance *d* is held while being subjected to the action of the current. The luminous image of the burning metal is transmitted through a slit and tube to the prism and viewed by a telescope.

Faraday ascertained that the electric spark is but the effect of the combustion of minute particles of the terminals and the air or other matter through which it passes from one to the other.

The spectroscope has already given us an insight of the elements present in the sun and some of the fixed stars, and of the nature of the components of other heavenly bodies, as the nebulæ and comets.

It has also been employed to determine the exact moment proper for adding the spiegeleisen and for stopping the conversion in the Bessemer steel process. See pages 277, 613.

It is as yet comparatively in its infancy, and will no doubt some day be of great service in practical metallurgy, as it has already been in qualitative chemical analysis.

Mr. Norman Lockyer has successfully used the spectroscope as a means of quantitative analysis for testing alloys in the British mint. His apparatus consists of an electric lamp, in the lower carbon of which a recess is made to receive the alloy to be vaporized. The spectrum is thrown on a screen in a closed box and is photographed, admitting of ready comparison with the previously photographed spectra of other alloys containing known proportions of the metals. By means of a delicate scale attached to the instrument, the coincidence or variation of the lines in the different spectra, arranged one above the other, is determined, the relative length, strength, and position of these lines indicating the proportion of each metal contained in the alloy.

Huggins has applied spectroscopic observation to the determining of the proper motion of the heavenly bodies, by observing the displacement of the spectral lines.

Spec′u-lum. 1. (*Surgical.*) An instrument for dilating certain passages of the body, in order to enable examinations or access of instruments for operation.

Speculums are known by their construction, as *bivalve*, *four-bladed valve*, etc., or by the part of the body to which they are applicable, as —

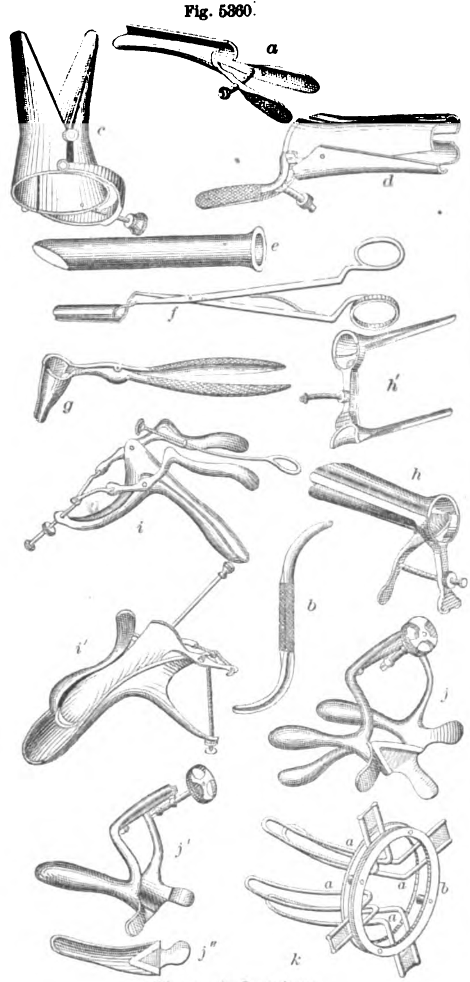
Anal,	Eye,	Nasal,	Vaginal,
Ear,	Mouth,	Rectum,	Uterine, etc.

Some of these names are synonyms, and, besides, there is another class of instruments known as *dilators*, and still another set of names ending in -scope, as *otoscope*, *laryngoscope*, *metroscope*, *rhinoscope*, etc.

a is a two-valved speculum, the parts hinged together and having a set-screw to maintain distention without the aid of an assistant. It is shown in Pitney's patent of 1841. *b* is a speculum of a favorite form found in the same patent.

c is Webber's magnifying bivalve ear-speculum.
d is a four-valve speculum.
e is a glass-mirror speculum.
f is Elliott's intra-uterine speculum.

Fig. 5360.



Tiemann's Speculums.

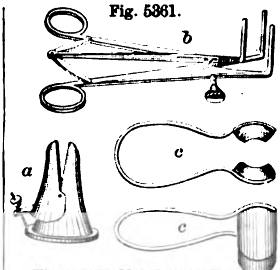
g is Kramar's bivalve ear-speculum.
h h', closed and open views of the Storer vaginal speculum.
i i', Nott's duck-bill speculum.
j j' j'', Bozeman's speculum, three views.

Bivalvular and trivalvular speculums are shown in Plaet XVII., "Magazyn oste Wapen Huys der Chirurgyns door Dr. Johannes Scultetus," Doordrecht, 1658.

k, Knaffl's speculum. It consists of a number of bent movable fingers a a a a, whose outer ends are passed between two connected rings b. In use, the fingers a a a a are slid close together and introduced into the canal, and then each pushed outwardly by the finger of the operator. The pressure of the walls of the canal on their inner extremities causes them to bind between the two rings, and retains them in expanded position.

In Fig. 5361, a is Robert and Collins' nasal speculum.
b, Elsberg's nasal speculum.
c c, Thudichum's nasal speculum.
In Fig. 5362, d is Simrock's otoscope, with lens.
e, Spier's self-sustaining ear-speculum.
f, Whitehead's mouth-gag (showing cleft palate). See STAPHYLOGRAPHIC INSTRUMENT.
Fig. 5363 shows instruments for distending the eyelids during examinations and operations.

Fig. 5361.



Tiemann's Nasal Speculum.

Fig. 5362.

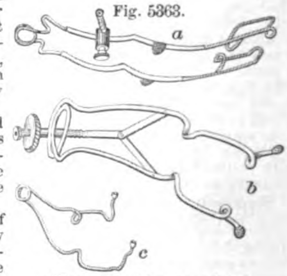
Speculums.

a (Fig. 5363), Graefe's eye-speculum.
b, Noyes' eye-speculum.
c, Hart's eye-speculum.

2. (*Optics.*) A metallic, concave mirror.

These were known to the ancients, and were probably used for lighting the sacred fires. The construction of the mirrors of Archimedes is not accurately known. It need not be doubted that he fired some of the vessels of Marcellus, who was then besieging Syracuse. The wonder is not that an arrangement of burning mirrors, so called, should be able to effect this, for this has been clearly proved by Buffon and others, but the wonder arises from our mis-preconceptions of the condition and talents of the men of former times. Kircher went to the historic spot and tried an arrangement of plane mirrors, which convinced him the account was entirely probable.

Fig. 5363.



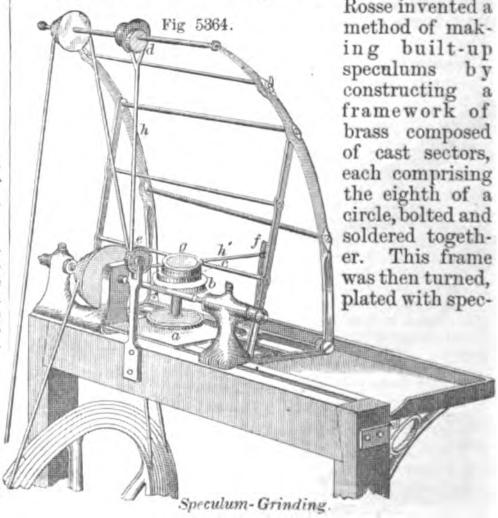
Tiemann's Eye-Speculums.

The ancients also used lens and glass spheres filled with water to collect and concentrate the rays of the sun. See LENS.

During the siege of Byzantium by the navy of Vitalian, the same defense was made by the besieged, and with the same result, for Zonaras informs us the ships were actually consumed. See MIRROR. Also page 410.

Spec'u-lums, Cast'ing and Grind'ing. Lord Rosse invented a method of making built-up speculums by constructing a framework of brass composed of cast sectors, each comprising the eighth of a circle, bolted and soldered together. This frame was then turned, plated with spec-

Fig 5364.



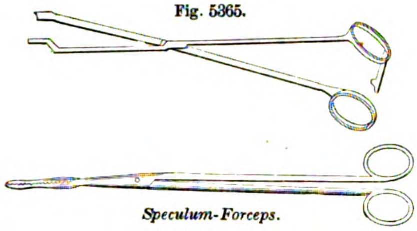
Speculum-Grinding.

ulum-metal, a number of the plates having their joining edges accurately fitted together and soldered with an alloy of zinc and copper having exactly the same expansibility as speculum-metal. The face was then polished.

Fig. 5364 illustrates an apparatus for grinding and polishing speculums of small size. It is attached to an ordinary foot-lathe, and operated by the movement of its treadle. The cast-iron frame *a* is secured back of the lathe-bearers, and carries a vertical mandrel, to the top of which the chuck *b* is fixed. The edge of the chuck is cut as a worm-wheel, to which a slow rotary motion is given by a screw mounted between the mandrel and the puppet-head of the lathe. The speculum *c* is cemented to this chuck, and as it rotates the polisher *g* is caused to traverse back and forth across its face by means of an eccentric *d* carrying a cord *h* attached to one side of a ring inclosing the polisher and passing under a guide-pulley *e*, and a cord *h'* connected to the opposite side of the ring and to the spring *f*.

Spec'u-lum-for'ceps. (*Surgical.*) Long, slender forceps, used for dressing wounds or operating on parts not accessible except through speculums.

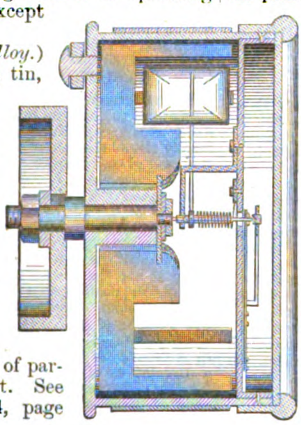
Fig. 5365.



Speculum-Forceps.

Spec'u-lum-met'al. (*Alloy.*) Lord Rosse's: copper, 126.4; tin, 58.9.

Another formula: copper, 7; tin, 4; zinc, 3. Or, copper, 6; tin, 2; arsenic, 1. Or, antimony, 1; tin, 1. See ALLOY, page 63.



Speech. Of a wheel. The hub with the spokes, without the fellies and tire.

Speed-cones. (*Machinery.*) The double cone-pulleys, used for varying and adjusting the velocity ratio communicated between a pair of parallel shafts by means of a belt. See CONE-PULLEY, *C*, Fig. 1424, page 610.

Speed'er. (*Cotton-manufacture.*) A machine invented by Mason as a substitute for the *bobbin and fly frame*, by which *slivers* of cotton from the *carding-machine* are slightly twisted, and thereby converted into *rovings*.

The sliver is *drawn* between rollers, as in the *bobbin and fly frame*, but the bobbins are arranged horizontally and rotated by rollers on which they revolve. Being rotated by their peripheries, their rate of winding is constant, and the *copping* rail is dispensed with. The *twist*, which is given in the *bobbin and fly frame* by the rotation of the spindle and flyer, is given in the *speeder* by an endless belt, which rapidly rotates the guiding tubes of the sliver as it comes from the drawing rollers.

The bobbin is made into a cop with conical ends, as in the other machine, each successive layer being shortened, as its diameter increases, so that each shall have the same length of yarn.

Speed-gage. A velocimeter.

English patent No. 2,692 of 1855 is for a speed-indicator for locomotives or railway-trains, and consists of a governor driven by a cord from an axle of the engine or car. As the balls rise with increased speed, they actuate a lever and that a piston which elevates a colored liquid in a graduated glass tube. The hight of the liquid is therefore the measure of the speed.

See also English patent No. 2,141 of 1860 and 581 of 1867.

A different idea is involved in those indicators which have a dial on which are inscribed all the stations, switches, crossings, etc., of a journey, and a pointer, which is driven by a wheel of the car, and indicates to the engineer or conductor the position of the train on the line. See English patents Nos. 11,619 of 1847, 890 of 1858.

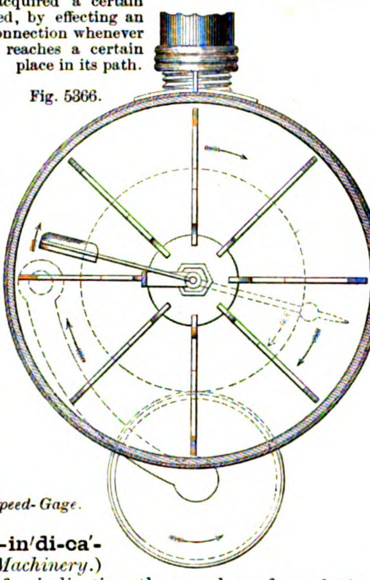
The marine velocimeter is a registering-log. See LOG. See also English patent 8,645 of 1840.

English patent 2,892 of 1856 is to indicate the position of a hoisting-cage in a mining-shaft.

Osborne's speed-gage is for the purpose of determining the rate of speed at which shafting or wheels are rotating. It has an index-hand or pointer, a graduated dial, a current-receiver, and retarding-spring with a current-generator, whereby the force of the current produced in any fluid acted upon by the generator can be indicated upon the dial, which may be so graduated as to express the number of revolutions which the generator makes per second or minute, whereby the trouble of counting and rating the speed by time is avoided. It is applicable for determining the speed of printing-presses, spinning and grinding machinery, paper-mills, centrifugal machines, and shafting; for determining the proper cutting speed of lathes and planers. It is also applicable to the determination of the speed of steam and other land carriages, of marine engines, and of the belting of machinery generally.

It may be made to give an indication or alarm, whenever a shaft has acquired a certain rate of speed, by effecting an electrical connection whenever the pointer reaches a certain place in its path.

Fig. 5366.



Osborne's Speed-Gage.

Speed-in'di-ca'-tor. 1. (*Machinery.*) A device for indicating the number of revolutions made by a shaft in a given time.

In Fig. 5367, the spindle carries a worm, engaging an interior system of gearing, which moves the hands of two dials, one of which registers single revolutions up to one hundred, while the other indicates the hundreds up to one thousand.

The point of the spindle is gently pressed centrally against the end of the shaft, causing the spindle to rotate therewith; the time that it is held in contact with the shaft is noted by a watch, and an inspection of the dials shows the number of revolutions made. See SPEED-GAGE; SPEED-RECORDER.

Fig. 5367.

Speed-Indicator.

2. (*Nautical.*) A log consisting of a spiral vane turned by the passing water, and registering its revolutions. See VELOCIMETER; LOG.

Speed-meas'ur-er. An instrument invented by Mr. Carey, for meas-

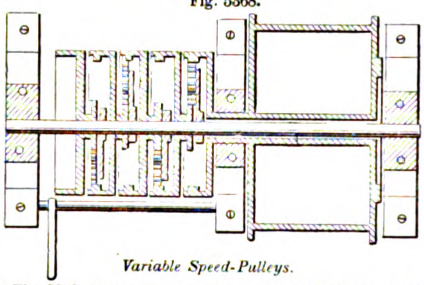
uring the number of revolutions made by the wheel of a carriage. It is secured by straps to one of the spokes near the hub, and has clock-work mechanism for registering the number of revolutions. See ODOMETER; SPEED-GAGE; SPEED-RECORDER.

Speed-mul′ti-pli′er. (*Gearing.*) An arrangement of gearing by which pinions are driven from larger wheels, the pinion-shafts carrying large wheels, and so on. It is seen in the motion work beneath the dial of a watch, by which the motion of the center arbor is geared up to drive the minute-hand and seconds-hand. It is the inverse of the watch-movement proper, in which the relatively slow-moving wheel, which receives the first impulse of the spring, becomes the quicker motions of the wheels in the direction of the escapement.

This *gearing-up* or *gearing-down*, or *speed-multiplying* or *decreasing*, is found in many kinds of machinery.

Fig. 5368 is an arrangement of gearing within a series of pulleys, upon which the driving-belt may be shifted to increase the power or speed of the drum. See also Nos. 73,424, 75,677, 81,248.

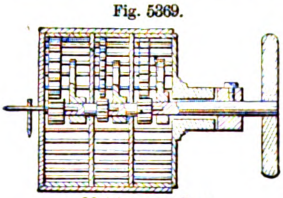
Fig. 5368.



Variable Speed-Pulleys.

In Fig. 5369, the motive shaft has arms which carry spur-wheels engaging the inner gear of the drum, and a pinion which is fast to the second shaft, having similar arms and spur-wheels engaging a pinion on the third shaft. This may be extended as far as desired; the proportion between the planet-wheels and their pinions regulates the increase of speed gained.

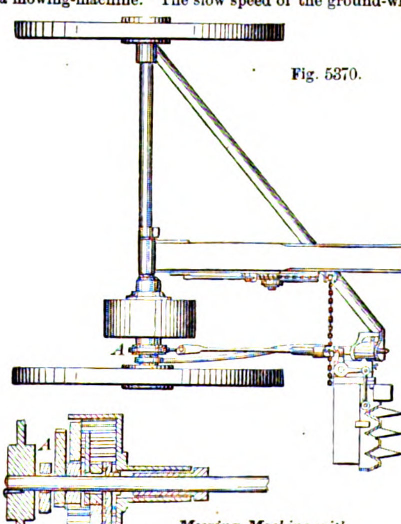
Fig. 5369.



Multiplying Gear.

Fig. 5370 shows the application of the principle to a mowing-machine. The slow speed of the ground-wheels is geared up to give a rapid reciprocation to the cutter-bar. The pinion to which the cam *A* is attached terminates a system of speed-multiplying gear mounted upon the main axle; from this gearing motion is communicated to the cutter through the medium of a yoke surrounding the cam, a pitman-rod, crank-lever, etc.

Fig. 5370.



Mowing-Machine with Speed-Multiplying Movement.

Speed-pul′ley. (*Machinery.*) A cone-pulley. One having several faces of varying diameter, so as to give different rates of revolution.

Fig. 5371.

Speed-Pulley.

Speed-re-cord′er. A contrivance for recording the speed of a carriage, railway-car, vessel, or the revolutions or pulsations of a machine. The record is made up of the progress in a given time; in the case of vehicles of any kind, it is made up of distance and time. An *odometer* or other *velocimeter* usually has a train of wheels similar to those of a GAS-METER or ARITHMOMETER (which see), the reading being taken of the number of revolutions, for instance, within the space since the last reading was had. Such a machine is, after all, a mere *counter*, and does not fulfill the conditions of a *speed-recorder*.

Some of the cab-odometers combine the factors of distance and time, so that when the cab is moving a record is made by a train of wheel and pointers of the distance traveled; and when the cab is at rest, while still hired, a time-measurer is set in motion, which keeps a record of the period of rest. This does not yet fulfill the conditions of the problem, as it is but a double register, and the result is derived from the sum of the two, they not being contemporaneous in action. Cab-odometers are to be found in English patents —

No. 14,176, of 1852.	No. 1,035, of 1863.
No. 2,131, of 1856.	No. 2,082, of 1863.
No. 883, of 1857.	No. 1,217, of 1864.
No. 2,894, of 1857.	No. 2,354, of 1868.

An instrument to be applied or attached to a moving body to indicate to the eye the rate at which it is traveling is a SPEED-GAGE (which see). Such a one is not necessarily a *register*, but merely shows the rate at the time of application or of observation, as the case may be. The indications may be recorded, and thus it becomes a *recorder*. One instrument, to indicate the actual speed of a locomotive, is described in English patent No. 2,692, of 1855. See SPEED-GAGE.

The true speed-register is to be found in those devices designed accurately to register the speed of locomotives or trains of cars at all times between any two points, to show the time taken to travel any distance between the ends of the route, and to indicate the stoppages and delays of trains.

An apparatus of this kind may be found in English patent No. 11,619, of 1847. It has dial-indicators which show the speed of the engine and the position of the train on the line in reference to proximity to stations or sidings. It registers a description of the journey, time occupied at, and the rate between, stations, mile by mile. The record is made upon a strip of paper marked with perpendicular lines, which represent miles, and with horizontal lines, which represent minutes. The paper winds on a cylinder, and is marked by a pencil traversed by a chronometer. The distance traveled in a given time determines the movement of the paper, and the motion of the pencil in the said time combines to make a mark, the result of the two factors. The paper is detached at the end of the journey to be examined, and kept as a record of the trip

English patent, No. 1,673, of 1857, has also a pencil under the control of a clock, and a traveling paper moved by a wheel of the train, the record being the joint product of time and distance.

English patent, No. 2,141, of 1860, indicates the speed of a train by a colored fluid raised or lowered by a lever acting upon a diaphragm, the lever itself being worked by a ball-governor driven by connection to an axle of the engine. A pencil obeys the fluctuations of the fluid and makes a record.

United States patents, on the Governor principle. Benckert's, December 1, 1857. An *indicator.* It has an arrangement of governor-balls acting upon segment cams, which turn the pinion of the indicator finger.

Liernur, November 16, 1858. A speed-*recorder.* By band connection from the axle, the governor is rotated, and its inequalities of rate are made to lift or depress a pencil vertically. The pencil-point rests on a circular disk, which is rotated by clock-work. The radiating and circular lines on the paper are expressive of distance and speed, and the pencil-line is the product of the two factors.

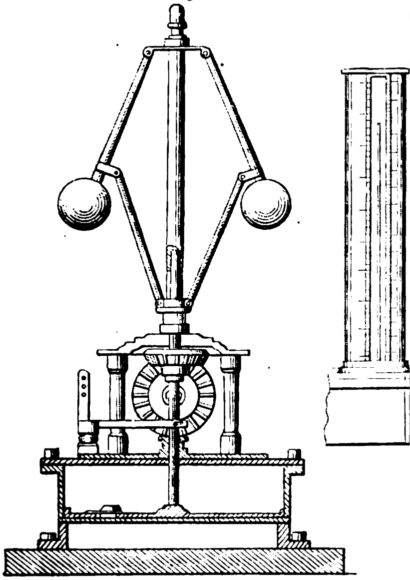
Billings' speed-recorder for railway-cars, March 27, 1860. A ball-governor, through the medium of a circular rack and gear-wheels, imparts motion to a hand, which points out upon a dial the number of miles per hour at which the train is travel-

ing at the moment. Another hand is carried forward by the first hand as the speed is increased, but does not recede with it when the speed diminishes. It thus registers the greatest speed attained during the trip.

Other connected mechanism actuates a set of prickers, which, penetrating at rare intervals an endless strip of paper as it is wound by clock-work machinery from one roll on to another, register the distance traveled; while a second set of prickers, similarly actuated, record the rate of speed at each mile on the same strip of paper. The mechanism is driven from a truck-axle, and is inclosed in a box with a glass front.

Keeler, April 4, 1864. An *indicator*. The balls and connecting arm of an ordinary governor, driven by gear or band connection from the axle, act upon a piston, which raises or lowers

Fig. 5372



Keeler's Speed-Measurer.

the movable bottom of a mercury chamber and elevates or depresses a column of mercury rising from the said chamber.

Bowsher, May 12, 1868. An *indicator*. It has a governor arrangement, the sliding collar actuated by the balls pulling upon a cord, which turns the spindle of the pointer-finger and directs it to figures on a dial.

Bilgram, August 22, 1871. An *indicator*. It has governor-balls, which actuate a sliding sleeve-rack, which revolves the pinion on the axis of the pointer.

Speed and Poage, May 12, 1874. A *recorder* for registering the speed of railway-trains. The governor is connected with a pencil, which rides over a recording sheet and indicates the speed, while the sheet is moved by the axle of the car and indicates the distance passed over.

The following are not actuated by governor-balls: —

English patent, No 1,407, of 1863, makes a diagram on a sheet of paper, showing the speed of a train, with the position and duration of its stoppages. The paper is advanced by clock-work at a uniform rate, and by means of motion derived from the train a pencil is advanced across its surface. The direction of the line made by the pencil will vary as it moves more or less quickly across the advancing paper.

English patent, No. 2,285, of 1863. A disk of paper is moved by a train of wheels from the crank-shaft of the machine. A stylus is raised and lowered at regular intervals, being driven by a chronometer. See also No. 2,912, of 1862.

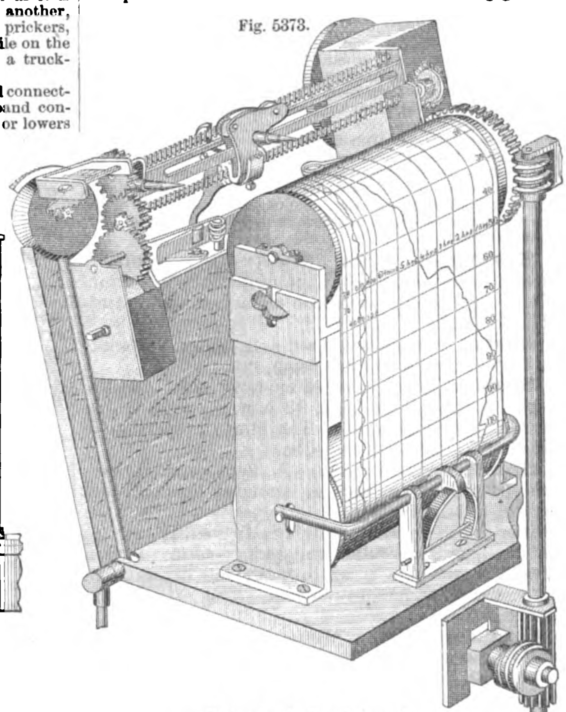
Lewis' velocimeter, November 26, 1867, has a train of gearing, which gives indications at regular intervals of the rate of speed. These are compared with a time-keeper in the same apparatus.

Horn's mileage register, May 5, 1868, has a ringing mechanism operated at each mile; a kind of *odometer*. A striker also marks on a surface traversed at a uniform rate across its path.

Guebhard and Tronchon, April 8, 1873, recording apparatus for cabs and carriages, have a drum driven by clock-work and receiving a record so connected with the vehicle as to give a strong and irregular line when the vehicle is moving, and a light and smooth line when it is at rest. By means of a screw-movement the pencil is carried in oscillating lines to and fro across the drums.

Richardson's speed-recorder, April 29, 1873. An endless revolving chart, driven by the wheels, is ruled with transverse lines to indicate distances, and with longitudinal lines to indicate the time consumed in traveling the said distance. A pencil is actuated by a clock, and made to traverse at a uniform speed across the chart. Thus the endless moving chart, operated by the car-wheel, records distance, and the reciprocating clock-actuated pencil records time. A third feature: a steam-gage has a

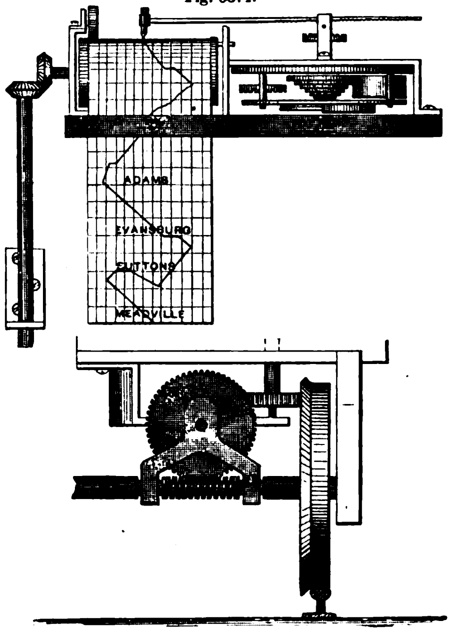
Fig. 5373.



Richardson's Speed-Recorder.

pencil attached to record the steam-pressure upon the chart, so that its variations are apparent for all the time occupied in the journey.

Fig. 5374.



Wythe's Speed-Recorder.

Wythe's speed-recorder for railway-trains, July 28, 1874. The chart is ruled with cross-lines, for distance and time respectively. It is moved by gear from the car-axle. The pencil is moved by clock-work. The result, when the car is moving, is a diagonal line, whose angle will depend upon the speed; the pencil always moves in its own proper direction at the same speed, and the paper slips beneath it at a rate corresponding to that of the car.

Brown's revolution *indicator*, September 1, 1874, has a mercury reservoir and a communicating pipe, which proceeds radially and then bends upwardly. As the device is revolved by the machinery, the mercury obeys the centrifugal impulse, and passing outwardly and up into the tube descends in the axial graduated tube, its sinking being the measure of the speed of rotation.

Elliott's tachometer, July 28, 1874, is for measuring the speed of vessels. It has a pipe extending through the hull of the vessel, to receive the impulse of the water, and another to be acted on by the suction; cocks are so contrived that either a water or a mercury gage can be put in connection with the water-pipes, for low or high speeds respectively. See also LOG; VELOCIMETER.

Speed'y-cut Boot. (*Saddlery.*) A peculiarly shaped knee-boot, designed to protect the knee from injury from the opposite foot of high-stepping trotting horses.

Spelk. A small rod, used as a splint. A spike in thatching. A rod in a loom, etc.

Spel'ter. A commercial name for zinc. *Spelter solder* is made from zinc, 12 ounces; copper, 16: or zinc, 16; copper, 16. The larger proportion of zinc is for a *soft* spelter solder.

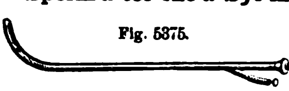
Spen'cer. (*Nautical.*) A four-cornered *fore-and-aft* sail, whose head is extended by a gaff and its foot usually by a sheet. Its position is abaft the *fore* or the *main* mast, and it is frequently bent to an auxiliary spar, called the *spencer-mast.* It is a *trysail* to the *fore* or *main* mast, and differs from a *spanker* or *driver* in position. The latter belong to the *mizzen.*

Spen'cer-mast. (*Nautical.*) A small mast abaft a lower mast for hoisting a trysail.

Spend. (*Mining.*) To break ground, to work a way.

Sperm'a-tor-rhe'a Syr'inge. (*Surgical.*) An instrument for injecting the male urethra with emollients, astringents, or caustic, as the case may require.

Fig. 5375.



Otis' Spermatorrhea Syringe.

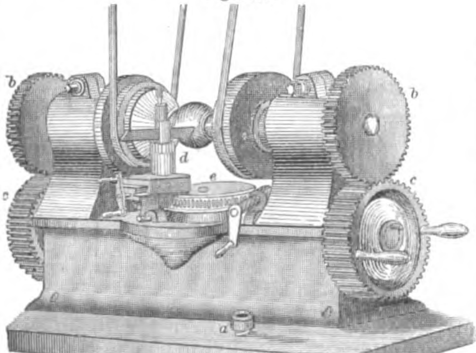
Spetch'es. The trimmings of hides, used for making glue.

Sphe'ra-nau'ti-ca. An old-time nautical instrument, mentioned in Frobisher's voyages.

Sphere. See GLOBE; ARMILLARY SPHERE.

Spher'e-o-type. (*Photography.*) A positive collodion picture taken upon glass by placing a mat before the plate, so as to give a distinct margin to the picture.

Fig. 5376.



Sphere-Turning Lathe.

Sphere-turn'ing Lathe. A lathe for turning billiard-balls and similar objects to a truly spherical form. In Hyatt's (Fig. 5376), the ball is held between chucks *a*, attached to opposite spindles, and moved toward each other by right and left hand screws. These are operated by two spur-wheels *b b* gearing into two other spur-wheels *c c* on a longitudinal horizontal shaft, so that the ball may be chucked centrally over the center around which the tool-post is carried. The tool-post *d* is attached to a disk *e* in the center of the lathe, having a threaded periphery engaged by a worm, by which a circular motion equal in amount to the width of cut of the tool is imparted to it at each revolution of the ball.

Spher'i-cal Boil'er. (*Steam.*) One of globular form or made up of a number of connected globes.

Harrison's steam-boiler consists of an aggregation of small and nearly spherical cast-iron shells, with connecting necks, through which pass bolt-stays holding the several "unit spheres" together; several *plates* of these spheres are connected and wholly immersed in the brick furnace. The inventor has since patented a method for constructing the unit spheres in wrought-iron. See STEAM-BOILER.

Spher'i-cal Case-shot. (*Ordnance.*) A thin, spherical shell filled with bullets. See SHRAPNEL.

Spher'i-cal Lathe. A lathe for turning spheres. (See SPHERE-TURNING LATHE.) See also patents, No. 52,244, Foster, January 23, 1866; No. 49,122, Knowlton, August 1, 1865.

Spher'i-cal Lens. A lens of a spherical shape. Perhaps the earliest form of lens, in the similitude of the drop of dew on a villous leaf, which so beautifully magnifies the filaments.

The spherical lenses have usually an equatorial groove in a plane perpendicular to the axis of the lens. This is closed by an opaque object, leaving a central stem. The object is to exclude light and lateral rays. See PERISCOPIC LENS; CODDINGTON LENS.

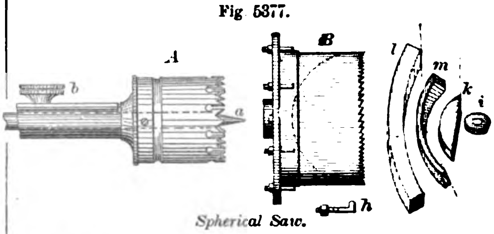
Spher'i-cal Mir'ror. A mirror used in some forms of the CATADIOPTRIC LIGHTS (which see).

Spher'i-cal Saw. An annular saw, as the trephine.

A, Fig. 5377. This usually has a guide-point *a* at the end of a rod, secured by a set-screw *b*, and passing through the tubular stem of the saw. See TREPHINE.

B is a crown saw. These are sometimes as large as 5 feet in diameter and 15 inches deep. In this case the saw is built up of three or four thin plates of steel bent to form portions of the

Fig. 5377.



Spherical Saw.

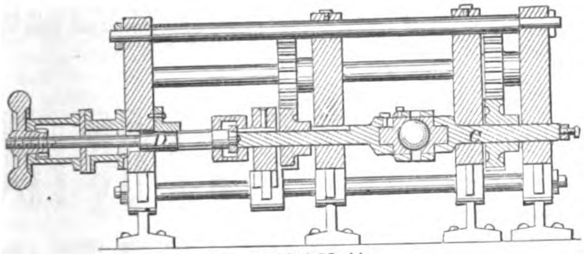
circle, and riveted to an annular ring, which is fixed to the surface chuck of a kind of lathe mandrel by means of hook-bolts *h*; the work is grasped in a slide-rest, which traverses within the saw and parallel to its axis.

i is a rough sheave cut by the crown-saw; *k*, a brush back; *l*, wheel-felly; and *m*, a chair-back, cut by the oblique action of the saw.

A saw of a dished shape, the segment of a sphere, has been used for sawing curvilinear work. The fence was made as the arc of a circle, and had a conductor to receive the work. The circular fence was attached to a three-bar parallel rule, so as always to keep the curvatures of the fence, conductor, and saw parallel with each other.

Spher'i-cal-shot Ma-chine'. A machine for imparting a truly spherical form to steel or iron can-

Fig. 5378.



Shot and Shell Machine.

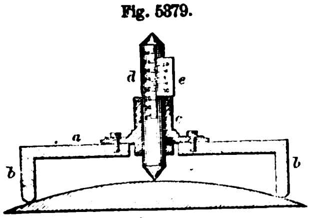
non-balls. The ball, hot from the molds or from subsequent heating, is placed in cups which are preferably caused to rotate in opposite directions and at different speeds. One of the cups is upon a spindle at the end of a shaft *D*, which has longitudinal motion by a tail-center, actuated by a hydraulic press or otherwise, and serves to press the cups together. The other cup-spindle *C* is fixed. The cups are slacked off at times during the operation, to bring fresh surfaces of the ball under operation.

Spher'i-cal Valve. See GLOBE-VALVE, page 988.

Spher'o-graph. An instrument invented for the mechanical application of spherics to navigation. By its aid any possible spherical triangle can be constructed without dividers or scale. — BRANDE.

Sphe-rom'e-ter. An instrument for measuring the curvature of surfaces. It consists of a three-armed frame, standing on three steel pins, which form with each other an equilateral triangle; in the center of the instrument is a vertical screw with a fine thread, and having a large graduated head. The screw is turned downward until its point reaches the surface on which the instrument stands; if this is a true plane, the index of the graduated screw-head should mark zero; if, on the contrary, it is either convex or concave, the corresponding positive or negative reading indicates the degree of sphericity.

Fig. 5379.



Spherometer.

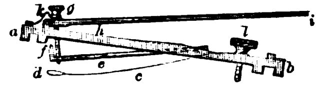
Fig. 5379 is an instrument for measuring the curvature of lenses or speculums or of the tools for grinding them. The arm *a* has two branches *b b*, whose ends are accurately turned and ground to a circular form. The socket *c* contains a sliding index-bar *d* with conical ends, which is divided to fiftieths of an inch; a vernier *e* enables it to be read to $\frac{1}{1000}$ of an inch, or, by estimation, to $\frac{1}{2000}$.

Sphyg'mo-graph. An instrument applied to the pulse to ascertain and record the quickness of its beating and its uniformity or irregularity, as the case may be; also, the degree of force with which the blood is driven through the arteries, — or, in other words, the contractile power of the heart. Of late years this apparatus has been used by physicians for purposes of diagnosis and in various physiological investigations.

It was originally devised by Vierordt, and subsequently greatly improved by Marey.

Marey's instrument, as originally constructed, consists of a long frame *a b*, to which is attached a strong steel spring *c*, about four inches long, and having at its free end a pad *d*, which presses upon the artery; an arm *e*, having a knife-edged

Fig. 5380.



Sphygmograph.

projection *f* at its free end, is attached to the spring *c*, and carries the regulating screw *g*, which governs the amount of vibration of the recording lever *h i*, also provided with a compressing spring *k*; this lever is of the third kind, is very light, and carries a thin steel pen or scratcher at its tip. A screw *l* determines the amount of pressure of the pulse-spring. A recording paper is fixed on a flat metal backing, connected with clock-work mechanism, which runs for about 10 seconds; the whole being attached to the frame *a b*. The instrument is bound on to the arm by a silken cord attached to pegs at its sides. The knife-edged projection *f* taps the lever *h i* at each pulsation with a force proportionate to the strength of the pulse; the lever describes an irregular curve on the paper, indicating the number and strength of the pulsations, and the momentary variations in their force.

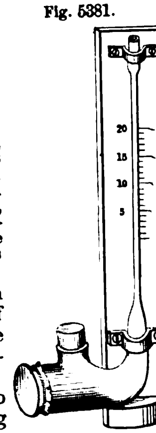
Sphyg-mom'e-ter. An instrument for counting the arterial pulsations.

Praxagoras of Cnidos wrote on the pulse, showing that it was a measure of the force of disease. Herophilus of Alexandria wrote on the pulse, and referred it to the contraction of the heart. Erasistratus, his colleague, described the action of the heart, but supposed that the arteries carried air and the veins blood. Santorio of Padua invented an instrument for measuring the force of the pulse. See his "Commentarius in Primum fere Primi Libri Canonis Avicennæ," Venet, folio 1626.

Sphyg'mo-scope. An instrument for rendering the arterial pulsations visible. It is said to have been invented by Galileo, who, by placing one end of a light mirror upon the artery leading to the thumb and the other upon a fixed object, caused the image of a sunbeam reflected from the mirror on an opposite wall to vibrate in unison with the pulse.

Fig. 5381 is a view of Pond's sphygmoscope, patented April 6, 1875. The essential parts of the instrument are a liquid reservoir or receptacle; an opening in the same, which, whether closed by an elastic and yielding membrane or not, is to be applied to or over the pulsating body; and a fine transparent terminal tube, communicating at one end with the reservoir or receptacle, into which tube the liquid, when the open end of the receptacle is pressed on the pulsating body, will enter, and will therein rise and fall to accord with the movement of the pulsating body, said movement being considerably magnified by the moving liquid, owing to the small diameter of the tube in which it is received.

Fig. 5381.



Pond's Sphygmoscope.

Spi'ca. (*Surgical.*) A form of bandage resembling a spike of barley. The turns of the bandage cross like the letter V, each leaving a portion uncovered.

Spice-mill. A mill similar to a coffee or drug mill, for grinding spices.

A pepper-mill of boxwood is mentioned by Petronius. It was used for black pepper from the East Indies, — a favorite ingredient. See SAUSAGE.

Spic'u-la-for'ceps. (*Surgical.*) A dentist's long-nosed forceps for removing small fragments of bone, etc.

Spi'der. 1. (*Machinery.*) *a.* A skeleton of radiating spokes; as a sprocket-wheel consisting of spokes on a rotating shaft, the ends of the spokes acting as cogs for the links of an endless chain.

b. The internal frame or skeleton of a gear-wheel,

for instance, on which a cogged rim may be bolted, shrunk, or cast.

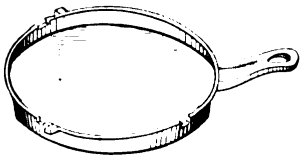
c. The solid interior portion of a piston to which the packing is attached and to whose axis the piston-rod is secured.

2. (*Nautical.*) *a.* An outrigger to keep a block from the ship's side.

b. An iron hoop around the mast for the attachment of the futtock-shrouds.

c. A hoop around a mast provided with belaying-pins.

Fig. 5382.



Spider.

3. (*Culinary.*) *a.* A kitchen utensil, with feet, adapted to be used on the hearth for baking or boiling.

b. A griddle.

4. A three-legged iron stool for supporting a pan or pot upon the hearth. A trivet.

Spi'der-line. (*Optics.*) A filament of spider's web used in micrometers.

Spie'gel-ei'sen. An iron with a natural alloy of from 10 to 12 per cent of manganese. The term is German, *spiegel* signifying a looking-glass, and has reference to the brilliant white luster of the metal.

Spig'ot. A plug to stop a vent or command the opening through a faucet.

Spig'ot (or Fau'cet) Joint. A pipe-joint formed by the insertion of one piece into another.

Spike. 1. A large nail, above 10*d.*

12*d.* spikes are 3¼ inches long, 45 to the pound.
16*d.* spikes are 3½ inches long, 28 to the pound.
20*d.* spikes are 4 inches long, 20 to the pound.
30*d.* spikes are 4½ inches long, 16 to the pound.

Railway-spikes are larger and are of several patterns.

Fig. 5383.

Spikes.

Spikes are known by shape, character, purpose, quality, or size, as —

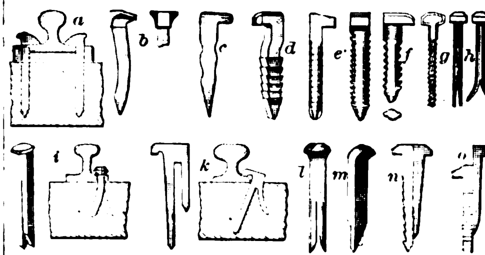
Flat,	Notched,
Narrow flat,	Barbed,
Wide flat,	Forked,
Grooved,	Cylindrical,
Swelled,	Square, etc.

Spikes (H. Burden, *Troy, N. Y.*).

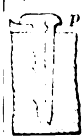
Boat Spikes.		Ship Spikes.		Hook Head.	
L'gth.	No. in Pound.	L'gth.	No. in Pound.	Length.	No. in Pound.
Ins.		Ins.		Ins.	
3	17.5	4	8	4 ×3/8	5.55
3½	14.68	4½	6.5	4½×7/16	4 14
4	12 57	5	4.37	5 ×1/2	2.52
4½	9.2	5½	4.3	5¼×1/2	2.41
5	7.2	6	4.2	5½×9/16	1.87
5½	6.3	6½	3.77	6 ×9/16	1.72
6	4 97	7	2.75	6 ×5/8	1.38
6½	4.78	7½	2 5	7 ×9/16	1.4
7	3 62	8	1.74	8 ×5/8	1.1
7½	3.37	8½	1.63		
8	2 95	9	1.55		
8½	2.9	10	1.15		
9	2.1				
10	1.98				

Patented forms of spike specially intended for securing railway-rails to the ties are numerous; in most it is sought to increase the holding power by serrating the edge of the spike or by causing its points to spread apart in driving.

Fig. 5384.



Spikes.



a (Fig. 5384) shows a rail composed of an upper rail and a grooved bedding-piece, secured by spikes of the ordinary kind.

b is curved, to cause it to bear more strongly against the rail, and the head has a shoulder at the back, which comes in contact with the wood before the hooked forepart touches the flange of the rail, in order to lessen and equalize the strain on the head, and prevent its being broken off in driving.

c, the sides are corrugated, so that the wood may swell into the indentations, but not hold the spike too tightly to prevent its being drawn.

d, a part of the shank has a winding surface, so as to cause the spike to twist, engaging the serrations in the wood.

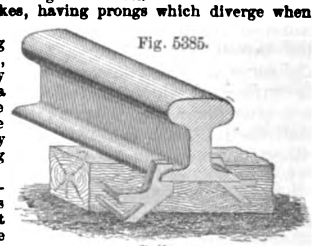
e, the spike has a winged point and spiral barbs upon two of its edges.

f, the shank has a serrated wing on each side.

g, a screw-spike, having the under side of its head so beveled as to bear firmly on the flange of the rail.

h i k l m, split spikes, having prongs which diverge when driven into the wood.

Fig. 5385.



Spike.

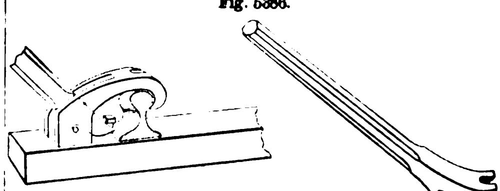
n o p, spikes having serrations on one side, and held firmly by keys; in the latter a projection on the spike enters a notch in the key to keep the key in place after being driven.

Redburn's railway-spike (Fig. 5385) has a body grooved to fit the lower flange of the rail, and two prongs, one above the other, which are driven into the tie, and cannot be withdrawn by the vertical vibratory motion of the rail.

2. (*Ordnance.*) Spikes are used to destroy the efficiency of cannon by plugging the vent. A rat-tail file is a good spike.

Spike-draw'er. A crow-bar with a claw for extracting spikes. The fulcrum piece is based upon the tie and hooked over the rail. The claw of the lever lifts the spike by the head.

Fig. 5386.



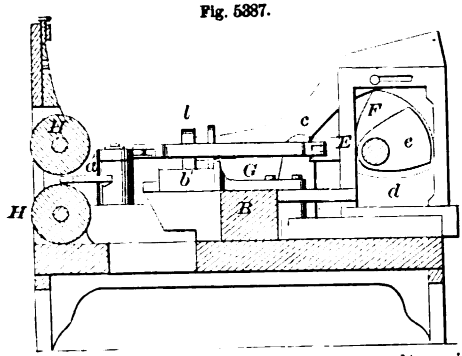
Claw for Drawing Rail-Spikes.

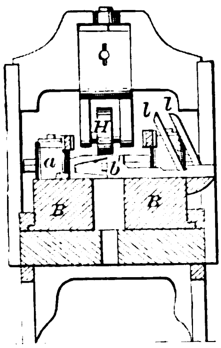
Spike-ex-tract'or. See Spike-drawer.

Spike-ma-chine'. A machine for making spikes from bar-iron.

In Fig. 5387, the rod is fed between the rolls *H H*, the upper one of which rotates in adjustable, and the lower in fixed bearings, and is presented to the action of a pair of cutters carried upon two vertical posts *a a'*, which, by means of a cam *d* and

Fig. 5387.



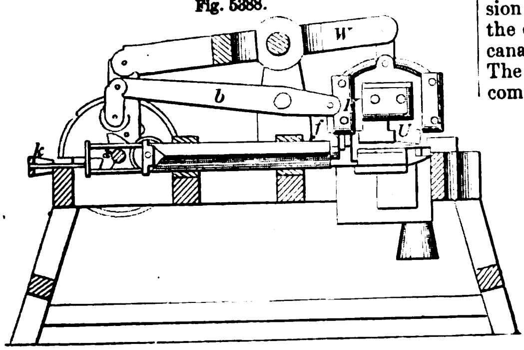


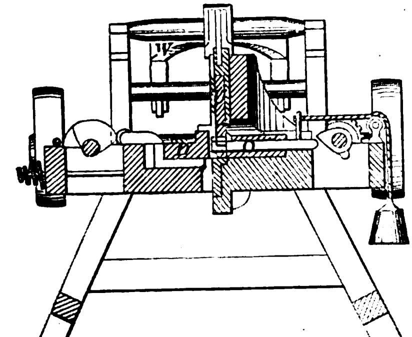
Spike-Machine.

connections, are opened to receive the rod, and closed to form the point of the spike and cut it off. A cam e turning in a yoke E imparts a traversing motion to the carriage B B, and a cam F rocks the lever c, which carries a die b', between which and the stationary die b the body of the spike is formed. The die b' is, by means of inclined parallel guides l l, partially rotated, so as to close gradually on the body of the spike. While the spike is clamped between the dies, the header G, having a slot i, into which passes a pin i', connecting it loosely with the bed, advances with the bed, and is brought in contact with the end of the blank, which projects beyond the dies, at the same time turning on its pivot, so that its pressure is first applied to one side of the head, and is gradually brought to bear squarely upon it at the completion of its stroke.

In Fig. 5388, a gage K is adjusted to determine the length of the spike or bolt, which is first grasped between two moving

Fig. 5388.





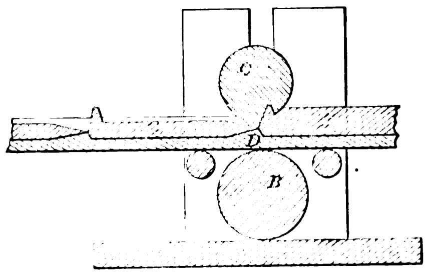
Spike-Making Machine.

dies C D that shape the body. A vertically moving die U, operated by the lever W, forms the point, and a second vertically moving die f, operated by the lever b, the head. The levers W b have pivoted arms, which are turned down, so as to be acted on by cams when spikes are to be made, but are lifted out of contact with the cams in making plain bolts.

A cutter O, advanced by a cam and retracted by a cord and weight, or a spring, severs the blanks.

In Fig. 5389, the bed D is traversed by gearing from the roller B, which also has gear connection with the cam-roller C. The bed is grooved to form the lower half of the spike, the upper

Fig. 5389.



Spike-Machine.

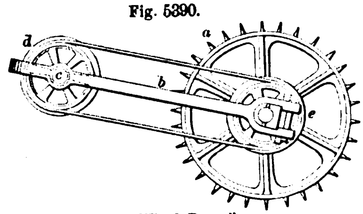
half being formed by the cam-roller, which has a transverse notch that shapes the head as the rod enters between it and the table, and the point is tapered as the spike emerges from between them. Small supporting rolls beneath steady the table and prevent it from tilting.

Spike-plank. (*Nautical.*) In arctic navigation, a platform projecting across the vessel before the mizzen-mast, to enable the ice-master to cross over and see ahead, so as to pilot her clear of the ice. It corresponds with the bridge in steamers.

Spike-tack'le. (*Nautical.*) That by which the carcass of a whale is held alongside while *flensing.* The carcass is turned by the *cant*-tackle, while the *speck* is hauled off by the *speck-purchase.*

Spike-wheel Pro-pel'ler. A mode of propulsion of canal-boats in which a spiked wheel driven by the engine is made to track upon the bottom of the canal and thus draw the boat. Invented by Seaward. The spike-wheel operates outside the boat or in a compartment inside open at bottom. In order to accommodate the wheel to the inequalities of the bed of the canal, the wheel a has its bearings in a swinging frame b, the other end of which is hung to a shaft c, driven by a steam-engine, and having a pulley d, which communicates by a band with a pulley e on the shaft of the spike-wheel.

Fig. 5390.



Spike-Wheel Propeller.

Spile. 1. A small plug of wood for stopping the spile-hole of a barrel or cask. The spile-hole is a small aperture made in the cask when placed on tap, usually near the bung-hole, to afford access to the air, in order to permit the contained liquid to flow freely.

2. A spout for sugar-water (the sap of the sugar-maple tree), which, being inserted in a hole bored in the tree, conducts the water to a trough or pan placed beneath to receive it.

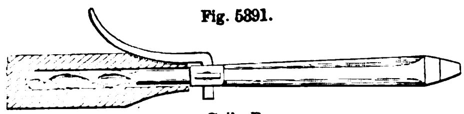
The spiles are sometimes little troughs made by splitting out pieces from a block with a gouge. The same gouge is used to drive into the tree and make a kerf to hold the sharpened end of the spile. A notch is cut by an axe in the tree above the spile, and the sap trickling thereinto is conducted to the bucket.

The tool is known as a *tapping-gouge*.

3. (*Hydraulic Engineering.*) A PILE (which see).

Spile-bor′er. An auger-bit to bore out stuff for spiles. To the shank of the auger that bores the spile is attached an obliquely set knife to taper the end thereof.

Fig. 5891.



Spile-Borer.

Spil′ing. (*Shipbuilding.*) The edge curve of a plank or strake.

Spil′ings. (*Shipbuilding.*) Dimensions taken from a straight-edge or rule to different points on a curve.

Spill. 1. A spile.

2. A roll of paper for lighting. An *alumette.*

3. A small bar or pin of iron.

4. (*Shipwrighting.*) A small peg used to stop the hole left by a spike when drawn out.

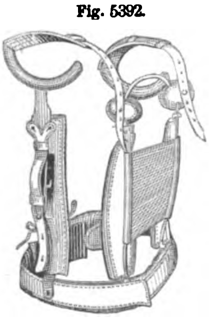
Spill′er. A kind of fishing-line.

Spill′ing-line. (*Nautical.*) A line to spill the wind out of a sail, by keeping it from bellying out when clewed up.

Spill-trough. (*Brass-founding.*) The trough against which the inclined flask rests while the metal is being poured from the crucible. The crucible is above the trough, so that any metal which dribbles or spills is caught into the spill-trough. See BRASS-CASTING, Fig. 877.

Spi′nal Brace. (*Surgical.*) A brace for remedying posterior curvature of the spine (Pott's disease). It consists of a pelvic belt made broad in front to compress the protruding abdomen, two elastic crutches, which tend to elevate the body by pressure against the margins of the scapulæ, and two side-bars, on which are elastic and padded springs that adapt themselves to the sides of the spinal column, and tend to keep the body in an erect position. The bars are connected by a broad elastic band, which exerts a constant pressure on the protuberance. See also TORTICOLLIS BRACE; SCOLIOSIS BRACE; SPINAL-DISTORTION APPARATUS.

Fig. 5392.



Spinal Brace.

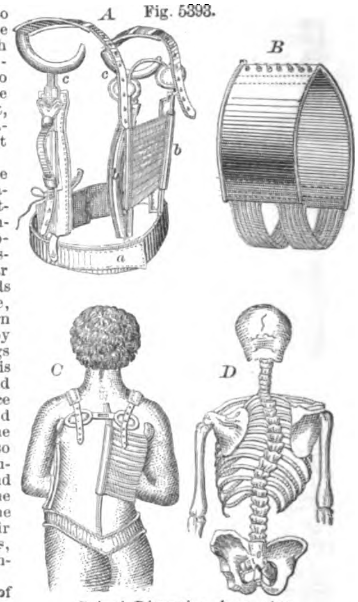
Spi′nal-Dis-tor′tion Ap′pa-ra′tus. (*Surgical.*) An apparatus designed to gradually restore the spine to its normal condition when it has become curved.

A is intended to remedy backward protusion. The belt *a* passes around the pelvis region; the front is made broad to compress the protruding abdomen. An elastic band of silk and rubber, stretched between the side-bars *b b*, bears against the protuberant spine, and to the side-bars are attached elliptic padded springs, which press on each side of the spine, but yield to the motions of the body. Two elastic padded crutches *c c* tend to elevate the body, pressing principally under the margin of the scapulæ, to avoid compression of the axillary veins. The elastic belt *B* is intended to give additional pressure, if needed, but principally to compress the sternum, which generally protrudes. It is also designed to be worn at night, when the apparatus itself is not applied.

C is the brace for lateral curvature, as illustrated at *D*. It consists of a belt supporting a posterior upright bar carrying two pads for the scapulæ, and a leathern band attached by elastic webbings and buttons; this is passed around the protuberance obliquely, and buttoned to the belt in front, so as to exert a gentle pressure, and at the same time tend to turn the ribs around their vertebral axes, thus straightening the spine.

D, the trunk of the human skeleton, illustrating a case of lateral distortion of the spine.

Fig. 5393.

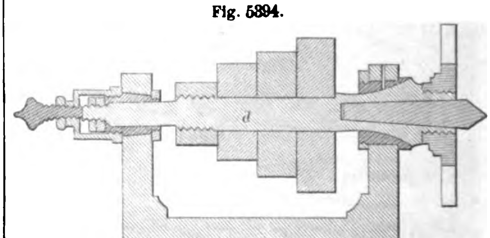


Spinal-Distortion Apparatus.

Spin′dle. A shaft or mandrel which supports a rotating object.

1. (*Lathe.*) The *arbor* or *mandrel* in a lathe. *D* is the live spindle rotating in boxes in the front and rear standards of the *head*. The *live* spindle is in the *head-stock*; the *dead* spindle is in the *tail-stock*, where its function is merely to center and support the object, and not to partake of its movement or impart motion.

Fig. 5394.



Lathe-Head.

2. (*Mill.*) A vertical shaft supporting the upper stone or *runner* of the pair in a flouring-mill.

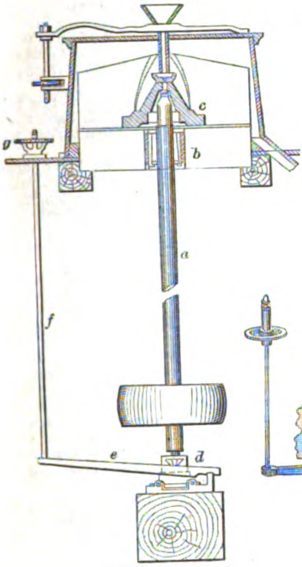
The shaft *a* passes through the lower stationary stone *b*, is connected to the *rynd c* of the upper stone, which it rotates, being driven by gearing or by band-and-pulley connection with the prime motor, and is usually stepped in a block *d*, which, in the present instance, is adjusted to vary the distance between the stones, by means of the lever *e* and rod *f*, screw-threaded at top, and raised or lowered by a nut and hand-wheel *g*.

The parts are known as follows: —

a, spindle.	*g*, damsel.
b, slip-driver.	*h*, backlash-spring.
c, trampot.	*i*, fulcrum.
d, lever.	*k*, pinion.
e, lighter screw.	*l*, set-screw.
f, bail, or balance-rynd.	

3. (*Vehicle.*) The tapering end or *arm* on the end of an axle-tree. The hub of the wheel is slipped on the *spindle*, and is secured there by a linch-pin in some cases, and by a nut in others. See AXLE.

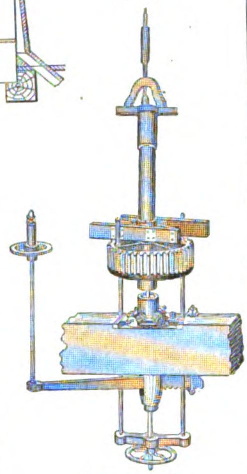
Fig. 5395.



Mill-Spindle.

In the example, the spindle has a collar upon it, with a packing-ring on each side.

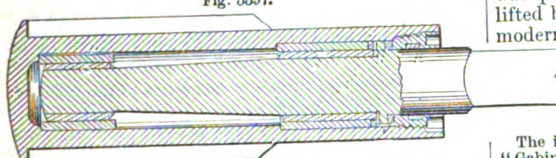
Fig. 5396.



Mill Spindle.

The collar furnishes bearing for the holding-nut attached by an outside screw to the box. The spindle has two collars of hardened steel, and the box two rings of the same, which come in contact and take the friction of the journal.

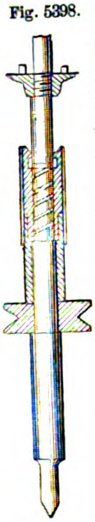
Fig. 5397.



Wagon-Spindle.

4. (*Spinning.*) *a.* A skewer or an axis upon which a bobbin is placed to wind the yarn as it is spun.

Fig. 5398.



Spinning-Spindle.

The kinds, of which there are many varieties, are the —

Live spindle, in which the bobbin is fast on the spindle, and rotates with it.

Dead spindle. A skewer, not movable, on which a bobbin revolves to wind the yarn. The *drag* of the bobbin depends upon its tightness on the spindle, and is adapted to the degree of twist required.

Ring-spindle, one which has a traveling ring upon it. See RING AND TRAVELER.

b. The distaff and spindle — the oldest known form of spinning-machinery, if such it can be called — were familiar to Egyptians, Phœnicians, Hebrews, Arabians, and Hindus, in the time of Abraham, and also to the Greeks in the time of Homer.

In Fig. 5398, the helical oil-elevating groove is cut in the spindle, and ends above in an annular groove in the latter and a coincident groove in the bolster.

c. A *measure of length.* A *spindle* of 18 *hanks* of cotton yarn is 15,120 yards. A *spindle* of 24 *heers* of linen yarn is 14,400 yards.

5. (*Weaving.*) The skewer in a shuttle on which a bobbin or cop of yarn or thread is impaled.

6. The stem of a door-knob, which actuates the latch.

7. A shaft, as of a fusee. The axis of a capstan.

8. The rod which forms the axis of a vane.

9. A round, connecting piece in a chair, as those vertical pieces uniting the seat and slat top.

10. (*Shipwrighting.*) The upper main piece of a made mast.

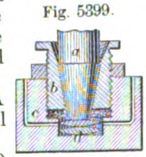
11. (*Founding.*) The pin on which the pattern of a mold is formed.

12. (*Building.*) A newel-post.

Spin′dle-lathe. A lathe with a spindle or mandrel in the *head-stock*, receiving its motion from a band. At one end of the spindle is a point on which the work is centered; the other center is on the *tail-stock*. For hollow turnery, the work is held in a chuck screwed to the mandrel. See LATHE.

Spin′dle-step. The lower bearing of an upright spindle. Used in mill and spinning spindles. (See SPINDLE.) The example has a conical socket and slipping step.

Fig. 5399.



Henry's Spindle-Step.

Fig. 5400.

Spindle-Valve.

Spin′dle-valve. A valve having an axial guide-stem.

Spine. 1. (*Machinery.*) A longitudinal ridge. A fin.

2. A longitudinal slat of a riddle.

Spin′el. Bleached yarn for the manufacture of the broad linen tape known as *inkle.*

Spi-nelle′. A kind of ruby.

Spin′et. (*Music.*) A small instrument of the *harpsichord* kind. It had a single wire for each note, and this was vibrated by a quill. The quill was placed in a *jack*, a vertical piece which was lifted by the key. The keys were arranged as in the modern piano. It probably had catgut strings at first, but afterward had about 30 brass wires for the lower notes and 20 steel ones for the upper. It was used in France as early as A. D. 1515.

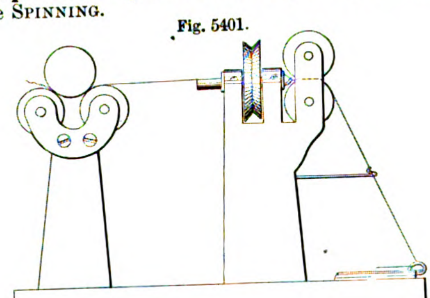
The illustration *q*, Plate XL. page 1692, is from Bonanni's "Gabinetto Armonico," 4to, Rome, 1722. The *spinet* was always triangular, and occupied a place in point of time between the *virginal* and the *harpsichord*. Unlike the former, its strings were strained over a bent bridge, and were struck by quills; and, unlike the latter, it had but a single string to a note. See history of the development of the piano-forte, pages 1690, 1691.

Lord Bacon says: "In *spinets*, as soon as the *spine* is let fall to touch the string, the sound ceases."

The name was also applied to a supplementary instrument tuned an octave above the harpsichord, and placed on or inside that instrument, in some cases sliding therein like a drawer.

Spin′ner. A general term for a spinning-machine. See SPINNING.

Fig. 5401.



Spinner.

Specifically applied to a form of drawing and twisting device, as in Fig. 5401. The twisting devices are placed in proximity to the bite of the drawing-rollers, to enable them to seize hold of and draw the twisted roving evenly from the point of

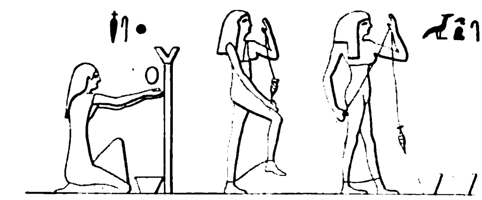
delivery of the feed-rolls to the draw-rolls, and to deliver the same properly drawn to the mechanism which gives the final twist. See also SPINNING-HEAD; DRAWING-HEAD.

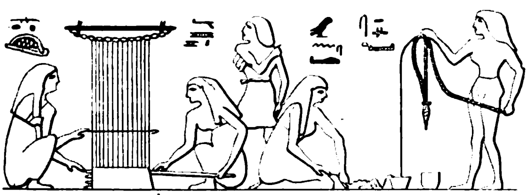
Spin'ning. The process of twisting fiber into a thread or cord.

The earliest representations of the art are in Egypt, to whose ancient inhabitants we are much indebted, and who have left on their temples and tombs enduring monuments of their arts and manners.

With the Egyptians, as with most other nations, the duty of spinning devolved principally on the females. The accompanying illustration is from a tomb at Beni Hassan. The woof was introduced by a hooked stick instead of a shuttle, and was laid double or single.

Fig. 5402.

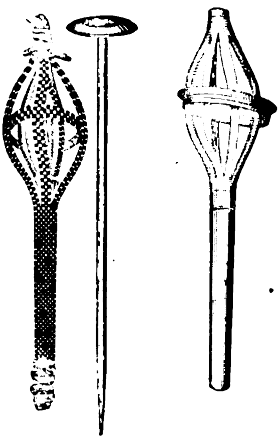




Spinning and Weaving in Ancient Egypt.

The spindles of the ancient Egyptians were made of wood or cane, and the head was made of gypsum or other material, to make it more weighty to increase the impetus in turning. Some were of light plaited work, made of rushes or palm-leaves, stained of various colors. A number of them are in the museums of Europe. One of them, found by Mr. Wilkinson, had some linen thread adhering to it.

Fig. 5403.



Egyptian Spindles.

"Well skilled to cull
The snowy fleece, and wind the twisted wool."

ILIAD, Book III. (*Pope's version*).

The earliest mode of spinning was probably by the distaff and spindle.

The distaff was a cleft stick, about 3 feet long, on which wool, flax, or cotton was wound. It was held under the left arm, the fibers being drawn from it and twisted by the thumb and fore-finger of the right hand. The thread was wound upon a spindle, which was suspended and rotated by the action of the thumb and finger, descending as the thread lengthened until it touched the ground. The *length* was then wound on to the spindle, and the thread secured in a cleft of the reed which formed the spindle. See DISTAFF, page 710.

The notices of spinning in the Bible are restricted to a few passages, which show that the distaff and spindle were employed, and furnish us nothing beyond the practices of the Egyptians.

While the first worker in brass and iron, and the first handler of the harp and organ, are noted in Genesis, we have nothing in regard to the person who first spun and wove. There can be little doubt that it was a gradual work, the growth of centuries of trials; and we may infer that Tubal Cain and Jubal were distinguished links in a chain of inventors and improvers in the metallurgic and musical arts.

The extreme fineness of the Indian cotton fabrics is no new thing, for two Arabian travelers of the ninth century (A. D.) state that "their garments are wove to that degree of fineness that they may be drawn through a ring of moderate size." Marco Polo, in the thirteenth century, mentions the Coromandel coast, and especially Masulipatam, as the home of the finest work.

Tavernier (middle of seventeenth century) states of the turbans of the Indian Mohammedans, that "the rich have them of so fine a cloth, that 25 or 30 ells of it put into a turban will not weigh 4 ounces."

A piece brought to England, from Dacca, by Sir Charles Wilkins, in 1786, "weighed $84\frac{3}{10}$ grains; its length was 5 yards 7 inches, and it consisted of 196 threads. The whole length of thread was 1,018 yards 7 inches. This was about 29 yards to a grain; 203,000 yards to a pound avoirdupois of 7,000 grains; that is, 115 miles, 2 furlongs, and 60 yards." — *Memorandum by Sir Joseph Banks.*

Cotton yarn has been spun in England 350 hanks to the pound, each hank measuring 840 yards, and the whole pound having therefore a length of 167 miles. The extreme fineness of yarns for muslins spun in England is 250 hanks to the pound ($119\frac{1}{4}$ miles), but it is very rarely finer than 220, which is a little coarser than the thread of the Dacca "*web of woven wind.*"

The invention of the spinning-wheel was an era in the history of the art, but we have no name or date to record. It is said to have been introduced into England about the time of Henry VIII., say 300 years ago, but had been used for ages in Hindustan.

The essential improvement consisted in a means for rotating the spindle, the fiber being either presented in carded rovings or from a distaff.

The usual practice with cotton was to card it with coarse wire brushes until the fibers were arranged in one direction, and to present the rovings thus attained, one by one, to the spindle, which was then rapidly revolved by the large wheel by means of a band which ran over the spool of the spindle. The roving was allowed to slip between the finger and thumb of the left hand, while the right turned the wheel, the roving being twisted as it became longer and harder, gradually assuming the condition of yarn or thread. It was then wound upon the reel, another roving attached to the end of the former one, and the spinning resumed.

This is the plan yet adopted in many country places with wool, where the supply for the family, for woolen clothes and stockings, is yet made into yarn by the spinning-wheel, the work being previously carded and made into rovings in the factories, with which the country is well supplied. See SPINNING-WHEEL.

The first successful attempt to spin cotton by machinery was by Wyatt of Lichfield, 1730.

Lewis Paul's patent for spinning by rollers	1738
Lewis Paul's second patent	1758
Arkwright's first patented spinning-frame	1761
Hargreaves' spinning-jenny patent	1763
Arkwright's water-frame patent	1767
Arkwright's combined machines	1775
Crompton's mule	1779
Cotton machinery introduced into France	1787
Cotton machinery introduced into America by Slater, at Pawtucket, R. I.	1789
Hammond's application of the stocking-frame to the weaving of lace	1768
Horton's knotted-frame	1776

James Hargreaves, one of the "martyrs of scientific industry," invented the *spinning-jenny* in 1763. He was persecuted by his fellow-workmen, his machine was broken into pieces by a mob, and he was driven from his native town.

The *jenny*, as at first formed, contained 8 spindles, which were made to revolve by means of a band from a horizontal wheel. Subsequent improvements raised the number to 80 spindles. Then came the mob. After the work on the "jenny" had been resumed, the mob broke forth afresh, and destroyed the carding-machines and jennies throughout Lancashire.

Hargreaves derived the idea of the spinning-jenny from observing the action of a hand-wheel which had been accidentally upset. The spindle being vertical, and continuing to revolve, he drew the roving of wool toward him, into a thread. He then applied himself to invent a contrivance which should hold the roving as it was held by the finger and thumb, the contrivance to run backward on wheels and carry with it a number of threads from as many spindles. This he succeeded in doing. See SPINNING-JENNY.

Hargreaves' place in the history of spinning consists in his being the first to contrive a means whereby one person could attend to the making of several threads simultaneously. In the furtherance of this purpose, he set the spindles upright and held the rovings by a clasp, which answered to the action of the left hand of the spinster. See SPINNING-JENNY.

Still the cotton thread produced was of so soft a nature that it was only used for *weft*, the warp of all English-made cotton goods being of linen, although imported calicoes from the East Indies were of cotton, *warp and weft.*

The next improvement, in order of time, was Arkwright's

spinning-frame, which made a hard-twisted yarn suitable for *warps*.

The progression of the art now introduces us to the great era when *continuity of action* was established, the fiber being fed in a continuous *sliver* through successive pairs of rollers, which move at different rates of speed, and ultimately deliver the roving at such a degree of attenuation as may be desired, the roving passing at once to the spinner, by which it is twisted and wound into a *cop*.

In a more improved form of the invention, the *sliver* is drawn by several successive pairs of drawing-rollers and delivered on to spools or reeds in a condition called *roving*. These are transferred to the spinning-frames, where the rovings are again drawn, twisted, and wound.

The essence of the invention is the *drawing-rollers;* and if the effectiveness of the machine is to determine the paternity, to Arkwright belongs the greater honor.

The idea, however, did not originate with Arkwright, though to him more than any other man are we indebted for the effective machine. Arkwright was but two years old when Lewis Paul patented an improved spinning-machine.

Dyer, in his poem of "The Fleece" (1757), celebrates Paul's machine, as follows: —

"But patient art,
That on experience works, from hour to hour,
Sagacious, has a spiral engine formed,
Which, on a hundred spoles, a hundred threads,
With one huge wheel, by lapse of water, twines,
Few hands requiring; easy-tended work,
That copiously supplies the greedy loom.
Nor hence, ye nymphs, let anger cloud your brows;
The more is wrought, the more is still required;
Blithe o'er your toils, with wonted song, proceed:
Fear not surcharge; your hands will ever find
Ample employment. In the strife of trade,
These curious instruments of speed obtain
Various advantage, and the diligent
Supply with exercise, as fountains sure,
Which, ever gliding, feed the flow'ry lawn."

The preacher was ahead of his times in his perception of the true uses and effects of machinery. This was before Arkwright.

The glory of Lewis Paul's inventions in spinning is obscured by the success of Arkwright. Paul adopted the plan of spinning by the aid of rollers. His first patent is dated June 24, 1738, and the specification states that when the cotton or wool is prepared "one end of the sliver is put between a pair of rollers or cylinders, or some such movement, which, being turned around by their motion, draws in the raw mass of cotton to be spun, in proportion to the velocity given to the rollers. As the cotton passes regularly through or betwixt these rollers, a succession of other rollers, moving proportionally faster than the first, draw the fiber into any degree of fineness that may be desired. Paul acknowledges the receipt of £20,000 from his patents. He died 1759. See SPINNING-HEAD.

Arkwright, the great inventor of spinning-frames, was born December 23, 1736, and began business life as a barber. His improvements followed on the track of those previously patented by Lewis Paul, but their greater success indicates better construction or attention to detail, as well as the advancing demand for labor-saving machines.

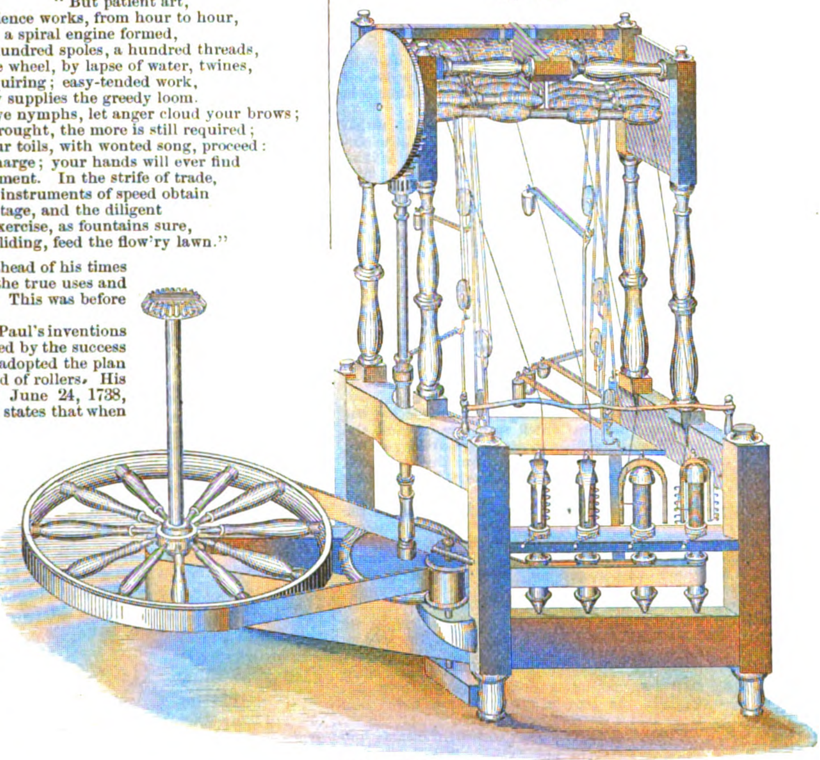
Arkwright was said to be an adept at shaving, and then, leaving the chin, devoted himself to collecting hair for wigs and to dyeing hair. He excelled in that. The perpetual motion next engaged his attention, and in the pursuit of a model maker he discovered Kay, who had some ideas on the subject of spinning cotton. They made a model together, and soon afterward Kay is lost sight of in the matter. They were miserably poor, and probably Kay became tired of the chase. Need and Strutt, of Nottingham, assisted Arkwright, who took out several patents, the most important one in 1769.

It may be mentioned that Kay turned up again in after years to assist in invalidating Arkwright's patent. Kay's wife also helped, and they claimed that a man named High had employed Kay to make what he afterward suggested to Arkwright, and the latter appropriated. Lewis Paul was also there to oppose Arkwright.

Arkwright was the first to introduce the factory system, in which the various operations on fiber are carried on under one roof by operatives managing machinery. Perhaps a single exception may be made in favor of the silk-mills of Italy.

Before Arkwright, the various operations of carding, spinning, and weaving were carried on by cottagers residing within a few miles of the place where the work was given out. Things are very much changed now, work being carried on in immense buildings, forming the nuclei of towns occupied by the operatives. The change from the cotter system, where the workmen and workwomen had the fresh air and garden employment, to the confined and fetid atmosphere of towns, has changed the physical condition of millions, and has not been accomplished without serious riots.

Fig. 5404.



Arkwright's Water-Frame.

In 1789, Samuel Slater, who had been employed by Arkwright, built the first machinery on the Arkwright model ever used in the United States, and ran it in Pawtucket, R. I., by water-power. In 1793, the "Slater Mill," the pioneer factory, was built at that place, and, we are informed, is still standing and used as a manufactory.

· The machinery for which Arkwright took out his patent consisted of various parts, his second specification enumerating no fewer than ten different contrivances, but of these the one that was by far of greatest importance was the device for drawing out the cotton from a coarse to a finer and harder twisted thread, and so rendering it fit to be used for warp as well as weft. This was most ingeniously managed by the application of a principle which had not yet been successfully

introduced in any mechanical operation. The cotton was in the first place drawn off from the skewer on which it was fixed by one pair of rollers, which were made to move at a comparatively slow rate, and which formed it into thread of the first and coarser quality; but at a little distance below the first was placed a second pair of rollers, revolving three, four, or five times as fast, which took it up when it had passed through the others, the effect of which would be to reduce the thread to a degree of fineness so many times greater than that which it originally had. The first pair of rollers might be regarded as the feeders of the second, which could receive no more than these others themselves took up from the skewers. As the second pair of rollers, therefore, revolved, we will say, five times for every one revolution of the first pair, or, which is the same thing, required for their consumption in a given time five times the length of thread that the first did, they could obviously only obtain so much length by drawing out the common portion of thread into five times the original fineness. Nothing could be more beautiful or effective than this contrivance, which, with an additional provision for giving the proper twist to the thread, constitutes what is called the *water-frame* or *throstle*.

Arkwright became very wealthy, built a fine castellated mansion, became high sheriff, was knighted, on two occasions gave £10,000 to each of his ten children, died in 1792, aged 60 years, leaving £500,000, was buried amidst the scenes of his history, a fine monument by Chantrey being placed over his tomb. See THROSTLE; BOBBIN AND FLY FRAME.

It would be a tedious tale to tell of the various suits brought to support the claims of the Arkwright patents, — the one for the drawing-rollers, 1769; and the other for the combination of carding, drawing, and roving machines, 1775.

The case of Arkwright *vs.* Nightingale, and others in which he appears as plaintiff, occupy a prominent position in the records of patent-law decisions. The cases almost rival that of Jarndyce *vs.* Jarndyce, on whose "numerous difficulties, contingencies, masterly fictions, and forms of procedure there had been expended study, ability, eloquence, knowledge, high intellect, the power of the bar, and the matured autumnal fruits of the woolsack." Such is the opinion (paid for) of Counsellor Kenge, as reported by a distinguished writer, a good judge of such matters. Singular that the said author should have summed up the result as "Words, Wigs, Rags, Sheepskin, Plunder, Precedent, Jargon, Gammon, and Spinach."

Next in the list of public benefactors, who devoted himself to the art of cheapening fabrics and elevating labor, appears the name of Samuel Crompton, the inventor of the *mule-spinner*.

The mode of spinning by the drawing-frame subjects the thread to so great tension that it is not possible to draw it as fine as is required for many purposes. It became necessary, therefore, to make machinery more nearly approximating the action of the spinning-wheel, in which the human hand, the finger and thumb, allowed the fiber to escape gradually, giving a moderate twist to the roving as it issues from the hand, and giving the whole length a final twist after it has been sufficiently compacted to bear it.

Samuel Crompton, a youth of 16, worked upon one of the Hargreave jennies in 1769, and five years afterward constructed his spinning-machine, which was called a *mule*, as it was a kind of cross between Arkwright's machine and the Hargreave jenny. It cost him five years of labor, generally after his day's work at weaving was done.

Crompton's first mule was completed in 1779.

He took his machine to pieces to avoid its destruction by the mob, but soon after he fitted the pieces together again, and its success was established, but not his own. Robert Peele and Arkwright used them in their manufactories, making large fortunes by their use. In 1812 the British government awarded him £5,000 as a mark of approbation.

Crompton's first essays were in the same line as Arkwright's, and consisted in sets of drawing-rollers. Mr. Kennedy states: —

"Crompton's first machine contained only about 20 or 30 spindles. He put dents of brass reed-wire into his under rollers, and thus obtained a fluted roller. But the great and important invention of Crompton was his spindle-carriage, and the principle of the thread having no strain upon it till it was completed. The carriage with the spindles could, by the movement of the hand and knee, recede just as the rollers delivered out the elongated thread in a soft state, so that it would allow of a considerable stretch before the thread had to encounter the stress of winding on the spindle. This was the corner-stone of the merits of his invention."

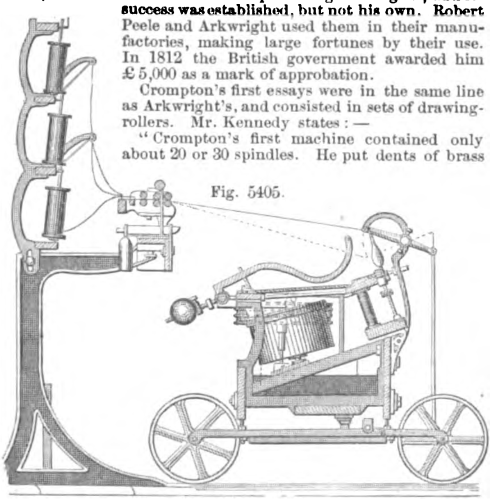


Fig. 5405.

Crompton's Mule.

Crompton worked at home in his residence, "Hall in the Wood," and made such fine yarns that competitors resorted to all mean artifices to ascertain the secret of his success. Finding it could not be kept secret, he concluded to abandon it to the public for a small consideration, subscribed by parties interested. This did not exceed $300. Some of these parties even refused this when the time came to pay.

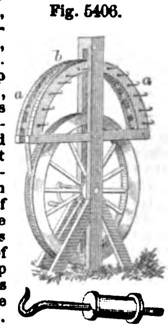
Crompton died June 26, 1827, aged 74. See MULE.

(*Flax.*) The spinning of flax resembles the throstle-spinning of cotton, but the filaments do not adhere together so readily, and, for fine qualities, it is necessary to keep the fiber damp. Water at 120° Fah. is used in preference to cold. The water is contained in a trough the whole length of the spinning-frame, and is thrown off in a dewy spray by the rapid motion of the spindles.

(*Hemp.*) Fig. 5406 is the machine used for spinning hemp into rope-yarns.

It consists of two upright posts with a wheel between them, the band of which passes over a number of rollers or wheels *a*, turning on pivots, with hooked ends, journaled in the semicircular frame *b*. By turning the wheel, these hooks are caused to revolve rapidly. The spinner wraps a bundle of hemp around his body sufficient to finish a yarn, draws out as many fibers as the thickness of the yarn demands, and twists them, attaches the bight to one of the hooks, and walks backward, gradually drawing out the proper supply of fibers from the bundle with his left hand, and allowing them to pass through the two middle fingers of his right hand, so as to regulate the amount delivered to the wheel, which is turned by an assistant. The thickness of the yarn depends on the quantity of hemp which passes through the spinner's hands in a given time and the velocity of the wheel, which governs the degree of twist.

Fig. 5406.

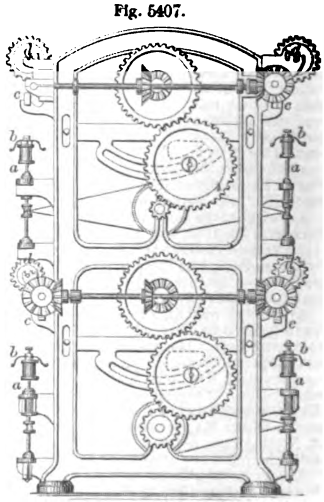


Spinning-Machine.

(*Silk.*) The twisting of silk into a thread is accomplished by machinery substantially similar to that employed for cotton, but the thread of silk being continuous, the *drawing* devices, which gradually attenuate the sliver of cotton, are not called for in the silk-spinner. The bobbins of cleaned silk are mounted on a horizontal rail, and the silk filaments are passed to other bobbins rotating on vertical axes and furnished with flyers, through the eyes of which the filaments are passed. See SILK; SILK-MILL, etc., pages 2179-82.

The silk-spinner is a machine for twisting silk threads, either single or double. An end elevation is shown in Fig. 5407. There are two rows of bobbins and spools on each side, one above the other, driven by two

Fig. 5407.



Silk-Spinning Mill.

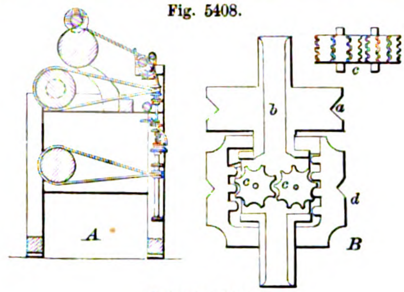
pulleys and belts operating through bevel gearing and spur wheels, one set of which rotates the bobbin-spindles and another the spools. *a a* are the bobbins on which the silk to be twisted is wound; these have flyers *b b* whose rotary motion imparts the twist. Each thread passes through one of a series of guides on guide-bars *c c*, to which a limited traversing motion is imparted, so as to wind it evenly and uniformly upon the spools arranged on the shafts *d d*.

Spin'ning-head. A form of spinner in which the drawing and twisting mechanism are united in one head. This was the first form of spinning-machine, if we except the spinning-wheel. It was invented by Lewis Paul, and patented by him in 1738. His machine had successive pairs of shaving-rolls for elongating the roving, the speed of the consecutive pairs increasing, so that each pulled upon the roving between itself and the succeeding pair, the eventual extension depending upon the relative rates of increase of speed of the successive pairs. He also gave to one or more of the pairs of rollers a revolution at right angles to the plane of their rotation, so as to give a twist to the yarn.

It is not exactly certain why this invention was unsuccessful; it was due primarily to coarse workmanship doubtless, but also to a congenital defect, possibly. Fig. 5408 is a view of an apparatus on a similar principle, patented in the United States 110 years afterward. *A* is an elevation, partly in section, of the machine. *B* is an enlarged view of the drawing and twisting head, and shows a pair of rollers. *a* is the groove for the band which rotates the tube *b* through which the roving passes, and also the wheels *c c*, which, besides their proper motion on their spindle, have rotation on their axes by contact of their cogs with the interior worm of the rotating-case *d*.

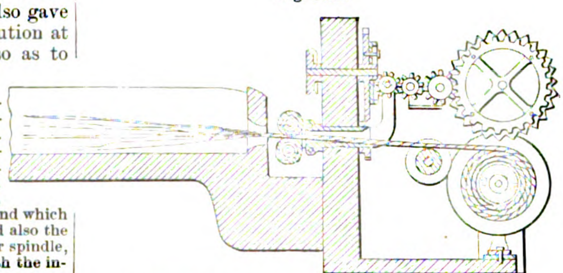
Fig. 5409 is a machine on this principle, for twisting single strands of flax, hemp, etc. The material lies loosely in a trough, from which it enters between the twisting-rollers. The receiving spool is rotated by the positive revolution and weight of the toothed guide-wheels, the strand being guided between them. The bearings of this spool are automatically shifted, that its axis may incline a little, to insure the better laying of the coil; the coil as laid gradually slides the spool upon its axis, first in one, and then in the opposite direction. The barrel of the spool is hollow and compressible, to allow the putting on and off of the heads and removing the material when wound.

Fig. 5408.



Spinning-Head.

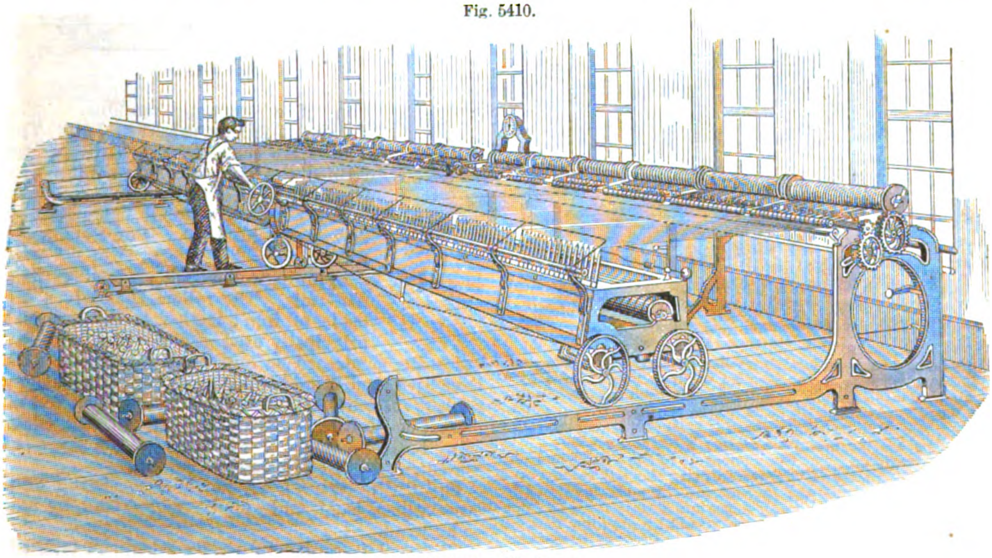
Fig. 5409.



Machine for Twisting and Winding Fibers.

Spin'ning-jack. (*Cotton-manufacture.*) A device for twisting and winding a *sliver* as it comes from the drawing-rollers. It is placed and rotated in the can, the sliver being wound on a bobbin therein. See JACK-FRAME.

Fig. 5410.



Spinning Machinery.

Spin'ning-jen'ny. James Hargreaves' invention, 1767. Up to the time of the invention of the *jenny*, all the yarn and thread of the cotton, flax, and woolen manufactures were made by hand, each thread requiring the attention of one person. The cotton was given out from the card, and occupied the time of a multitude of women and children in the towns, villages, and rural districts in the vicinity of

the looms. The cotton spun by the wheel was of so soft a character that it was only fit for weft, all the English-made cotton goods, at this time, having a linen warp. The cotton goods of the East Indies, imported under the name of *calicoes*, were all of cotton, both *warp* and *weft*, but the machinery at hand in England was yet insufficient for giving the required hard twist to the cotton thread to make it suitable for *warp*.

This was accomplished by Arkwright, a little later, in the invention of the *spinning-frame*.

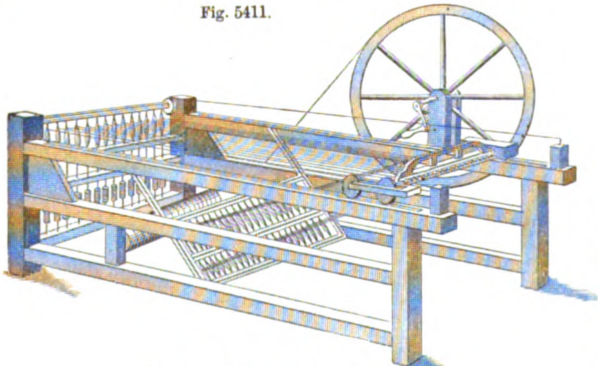
It appears that Hargreaves had long experienced the difficulty of getting a supply of weft-yarn for his loom, he being a weaver by trade. The idea of making a machine by which, under the care of one person, a number of threads might be spun at once, was a favorite project of his, and his success in this particular is what marks his place in the history of the cotton-manufacture.

He at first tried a number of horizontal spindles driven by bands from the same wheel, the rovings being held between the fingers of the left hand. The threads became entangled, and the attempt was unsuccessful. A tradition of the family records that while he was one day spinning, one or more of his twelve children upset the wheel, but continuing to hold the roving in his hand, he observed that it worked equally well, and he took a new start in his projected machine, placing eight vertical spindles in a row, each having a roving attached to it proceeding from a separate spool in another part of the frame.

The next thing was to contrive an apparatus which should simulate the action of as many hands in managing the rovings. This he accomplished with a fluted wooden clasp, which opened and shut like a parallel ruler, and, when pressed together, held the threads fast. The clasp traveled on wheels on the top of the frame, and was managed by the left hand, while the right hand turned the wheel whereby the spindles were rotated. The clasp being withdrawn a short distance from the spindles, the rovings between the two were twisted, and then the clasp was opened and retreated farther. This was repeated until the clasp reached the rear of the frame, when the threads were wound on to the spindles, and the clasp was returned to its recommencing position.

This may be called the first spinning-machine. Its name *jenny* was a modified contraction of the word *engine*, the term *gin* being a common local expression for a machine. The coal-hoisting machine is there called a *gin;* a pump moved by a windmill is called a *gin;* and the famous machine for separating the cotton fiber from the seeds is generally known as a *cotton-gin*. The machine being a *gin*, this mode of spinning was called *ginning*, and the machine a *ginny;* hence *jenny*.

Fig. 5411.



Hargreaves' Spinning-Jenny.

Hargreaves increased the number of spindles to 80, and met with the usual fate of improvers during the last century and the first quarter of the present one. A mob, instigated by jealous rivals, broke into his house and destroyed his machine. He then removed to Nottingham, rebuilt his machine, took out a patent, and lived comfortably on the proceeds of his machine, though his patent was infringed and he made nothing by an exclusive right in it. He died in 1778, leaving but a small estate, having failed entirely in obtaining a proper remuneration for a work of such great national importance.

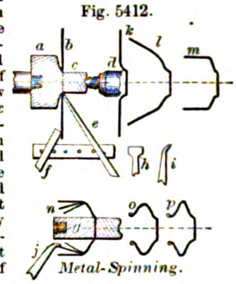
Spin'ning-ma-chine'. See SPINNING; SPINNING-JENNY; THROSTLE; MULE; DRAW-HEAD; BOBBIN AND FLY FRAME, etc., etc. See list under COTTON.

Spin'ning-mill. A name applied to a machine for spinning silk (see Fig. 5129), or to a factory where spinning is carried on.

Spin'ning Met'al. A process of forming circular articles of sheet-metal by pressure applied to the circumference while they are rotated in the lathe. It is analogous to forming pottery on the lathe, and depends for its success on the malleability of the material.

Fig. 5412 illustrates the method commonly employed for producing a teapot from a disk of Britannia metal. The wooden mold or chuck *a* is turned to the form of the lower part of the teapot, and the disk *b* is pinched tight between the flat surfaces of *a* and *c* by the fixed center screw *d* of the lathe, so that *a b* and *c* revolve with the mandrel; a burnisher *e* is held against a pin in the lathe-rest as a fulcrum, and applied near the center of the metal and a wooden stick *f*, held on the opposite side to support the edge. The metal is rapidly bent or swaged through the successive forms *k l m*, so as to fit close against the curved face of the block and its cylindrical part. The mold *a* is then replaced by *g*, and a burnisher — various forms of which, as *h i*, are used — is applied, being first slightly greased, together with a hooked stick or rubber *j*, first to force the metal inward, as shown at *n o p*, and then to curl up the hollow bead, which stiffens the mouth of the finished vessel.

Fig. 5412.



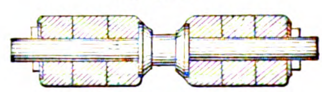
Metal-Spinning.

Sometimes the molds are made of the exact form of the inside of the work, but in several pieces, each smaller than the mouth, so that when the central block is first removed, the others may be successively taken out of the finished vessel, like the parts of a hat-block or of a boot-tree.

Plated candlesticks, the covers of cups and vessels, the bell-mouths of musical instruments, and numerous other articles of thin metal, which are required in great numbers, are produced in a similar manner.

Spin'ning-roll'er. A wheel in the drawing portion of a spinning-machine. (See DRAWING-FRAME, pages 743, 744.) The wheels are made to run in pairs, and formed the basis of the machine first invented by Lewis Paul in 1738, and brought into successful operation by Arkwright in 1769. See SPINNING-HEAD.

Fig. 5413.



Spinning-Roller.

Spinning-rollers are made of various materials. The rollers themselves are made of iron; leather is the material principally used as a covering; rubber, vulcanite, condensed cotton, wood, paper, and cork have been used, also combinations of felt and leather, rubber, vulcanite, or gutta-percha and leather, felt or flannel and leather, cork and leather, felt and cork, as well as compounds of which glue is the principal ingredient; also bichromatized gelatine.

Spin'ning-wheel. A machine consisting of a large wheel, band, and spindle, and driven by foot or by hand.

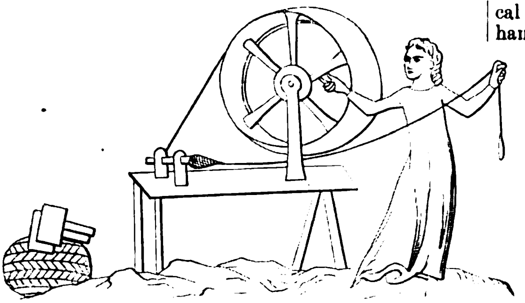
The wool is carded into rolls, which are twisted, drawn, and wound a length at a time, the wheel being turned periodically to twist the yarn. It was the first great improvement upon spinning by a distaff and spindle.

It appears to have been in use for many ages in Hindustan, but did not reach Europe before the sixteenth century. One account states that it was invented at Nuremberg about 1530: the statement is improbable.

The accompanying cut is taken from an illuminated manuscript of the fourteenth century, in the British Museum (M. S. Reg. 10 E. IV.), and represents a lady spinning at her wheel.

The spindle is rotated in horizontal bearings, having a spool, over which the band from the larger wheel passes. A roving,

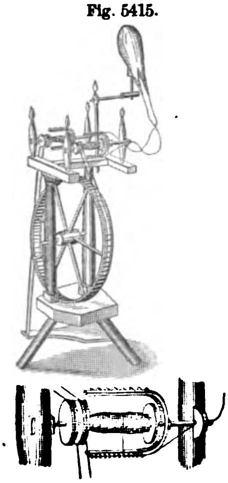
Fig. 5414.



Spinning-Wheel.

being attached to the end of the spindle, is twisted as the latter revolves, the roving being allowed to slip between the finger and thumb of the spinster, who also extends the roving by retracting the hand, or by retiring from the wheel, which continues its motion by the impetus acquired. The required length and hardness of twist being obtained by this combined drawing and twisting operation, the yarn is disengaged from the point of the spindle and wound into a *cop*, the end of the yarn being attached to the end of the spindle, so as to project and allow another roving to be connected thereto.

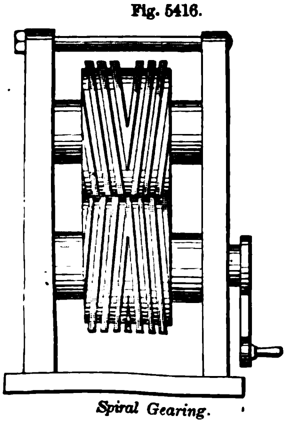
Fig. 5415.



Spinning-Wheel.

Fig. 5415 is an improved form of the old-fashioned hand-spinning wheel. It is set in motion by a treadle, which turns the large wheel, around which are bands passing over two pulleys near the ends of two horizontal spindles, which also carry flyers. The roll of fiber is placed on an upright pin, and the spinster, drawing out two thin slivers, attaches them to the two spindles, passes them between two of the teeth on each spindle, and imparts a rotary motion to the wheel, at the same time drawing out the slivers, which are thus elongated and twisted by the flyers to a degree proportionate to the velocity of the rotation. When the drawn-out sliver has been twisted sufficiently, the yarn is removed from between the teeth of the flyers and wound upon the spindles by reversing their motion, two other slivers are drawn out, and the operation proceeded with as before, and so, forming two continuous threads, until all the fiber in the roll is exhausted.

Fig. 5416.



Spiral Gearing.

Spi'ra. (*Architecture.*) The base of a column. This member did not exist in the Doric order of architecture, but is always present in the Ionic and Corinthian.

Spi'ral Bit. A wood-boring tool adapted to be used in a brace. It is made of a twisted bar of metal, and has a hollow axis. See Bit, *m, s, n*, Fig. 695.

Spi'ral Gear'ing. A gear-wheel having meshing spiral ribs and grooves. The teeth run around the periphery of the gear-wheel, and meet in an angle on a line midway from either edge of the wheel.

Spi'rals, In'stru-ment for Draw'ing. (*Drafting.*) An instrument for drawing scrolls or spirals, either on paper, in the ordinary course of mechanical or architectural drawing, or to lay out scrolls for hand-rails of winding stairs, etc.

Instruments for drawing Spirals and Scrolls.

No. 97,571.	Truesdell	Dec. 7, 1869.
No. 99,853.	Crandell	Feb. 15, 1870.
No. 138,053.	Stebbins	April 22, 1873.

Instruments for laying out Stair Curves.

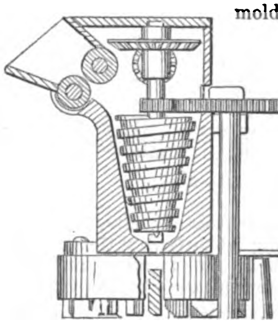
No. 5,380.	Wooster	Dec. 4, 1847.
No. 18,110.	Stewart	Sept. 1, 1857.
No. 24,763.	Shaeffer	July 12, 1859.
No. 66,796.	Clow	July 16, 1867.
No. 75,423.	Hoover	Mar. 10, 1868.
No. 97,707.	Schollar	Dec. 7, 1869.

Spi'ral Pump. A form of the Archimedean screw water-elevator, consisting of a pipe coiled spirally round an inclined axis. It is said to have been invented about 1750 by Andrew Wirz, a pewterer of Zurich, and was employed in Florence with some improvements by Bernoulli, in 1779. See Screw.

Spi'ral-rib Bit. A wood-boring tool adapted to be used in a brace. It has a spiral flange twisted around a cylindrical shaft. See Bit, *o*, Fig. 695.

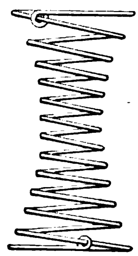
Spi'ral Screw. A screw formed upon a conical or conoidal core. In the example, it serves as a driving-screw to force clay from the hopper into the molds beneath.

Fig. 5417.



Brick-Machine.

Fig. 5418.



Double Helical Spring.

Spi'ral Spring. A coil whose rounds have the same diameter, and which is generally utilized by compression or extension in the line of its axis. The balance-spring of a chronometer hence is spiral, and is utilized by an expanding and contracting action in a plane at right angles to the axis. See Fig. 532.

A helical spring has coils of decreasing diameter as they approach the center, like the mainspring of a watch. (See Movement, Fig. 3246.) The spiral spring is used in Salter's balance and in *dynamometers;* also in bedstead-springs, as in Fig. 623, page 261.

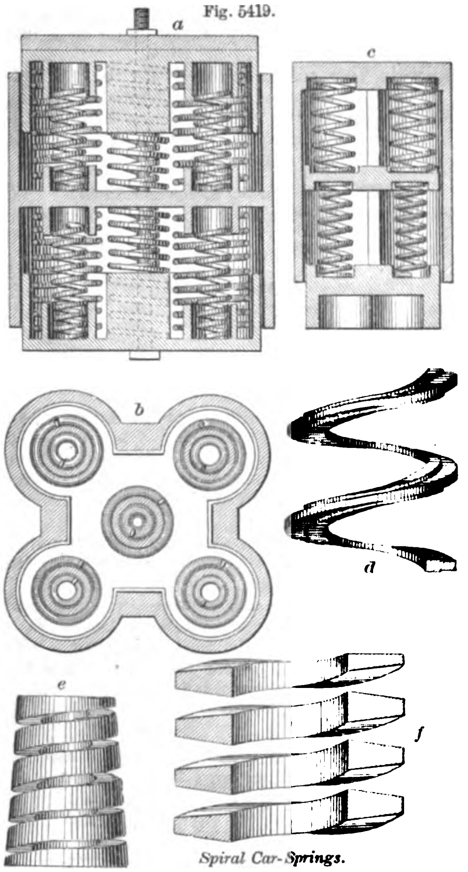
Fig. 5418 shows a double helical bedstead-spring, the coils increasing upward and downward from the point of smallest diameter at the mid-hight.

Fig. 5419 shows some applications of the spiral form to car-springs. A number more are shown at Fig. 1143, page 483.

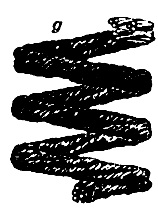
a b are respectively a vertical section and a horizontal section of Godley's car-spring. The case is open at top and bottom, and has a central fixed diaphragm, against which the concentric spirals abut.

c is Godley's spring, with an open end and a sliding partition.

Fig. 5419.



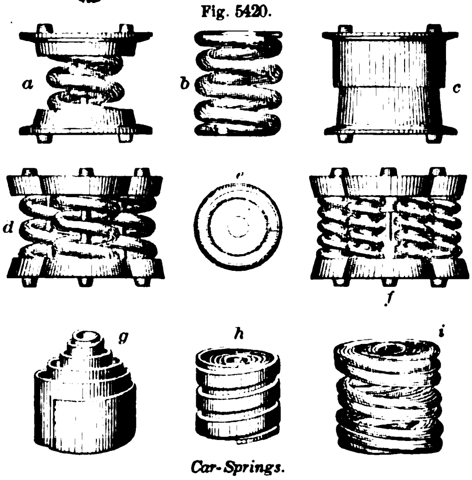
Spiral Car-Springs.



d is another of Godley's springs, having flat surfaces at the portions liable to come together, and webs of lesser thickness beyond the contacting surfaces.

e is Allen's conical spring with spiral coils of upwardly decreasing diameter.

Fig. 5420.



Car-Springs.

f, a spring having an inner edge of greater vertical thickness.

g, a spring made of metallic strands or strips, twisted or braided and then coiled.

In Fig. 5420, *a b c d e f* are springs of the Culmer Spring Company.

g h, Nichols, Pickering, & Co., spiral spring.

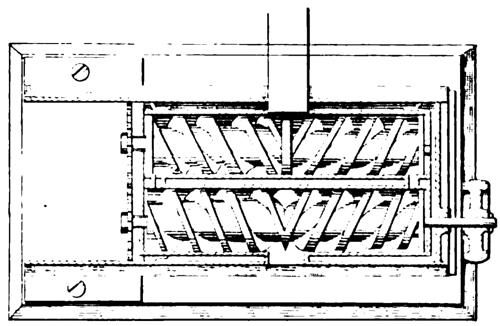
i, the Vose spring.

Spi′ral-spring Coup′ling. A coupling for a pair of shafts meeting at an angle. The ends of the spiral connect to the respective shafts and make a bent coupling. See Fig. 2021.

Spi′ral-vane Steam-en′gine. A form of rotary steam-engine in which the steam acts against a screw which winds around a cylindrical core.

The example shows two such screw-cylinders, having each a right and left hand screw, so arranged that the threads meet in the center, at which point the steam is admitted, and from which point it passes to either end of the cylinder, where it exhausts

Fig. 5421.

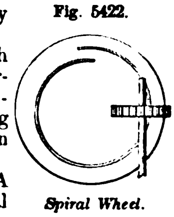


Spiral-Vane Steam-Engine.

into the other cylinder, in which it returns to the center, where an aperture is provided for its escape to the atmosphere. The screws are geared, and upon the shaft of one a pulley is placed for the purpose of transmitting power to any machinery to be driven.

Spi′ral Wheel. The spiral-thread of the disk drives the spur-gear, moving it the distance of one tooth at every revolution.

Fig. 5422.



Spiral Wheel.

Spiral gears are those in which the teeth form an angle to the surface, so that the teeth slip insensibly into engagement, avoiding jar. Each tooth is a small section of a screw. See also Fig. 5416.

Spire. 1. (*Architecture.*) A structure of pyramidal or conical form surmounting a church or cathedral. For hights of spires, see Tower.

2. (*Mining.*) The tube carrying the train to the charge in the blast-hole. Also called the *reed* or *rush*, as the *spires* of grass or rushes are used for the purpose.

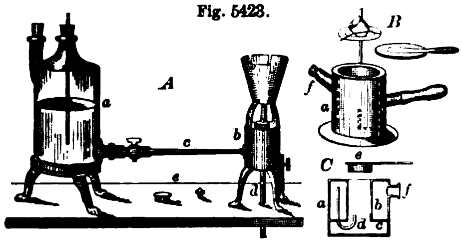
Spir′it-col′ors. A style of calico-printing produced by a mixture of dye-extracts and solution of tin, commonly called *spirit* by dyers. The colors are brilliant but fugitive.

Spir′it-lamp. A lamp burning alcohol. Used for many purposes in the arts where heat rather than light is required.

The blast spirit-lamp (*A*, Fig. 5423) consists of a vessel *a* for containing a mixture of alcohol and turpentine, and a cylinder *b* containing an argand wick supplied with the mixture through the pipe *c*, and subjected to a blast of air from a pipe *d*, which comes up through the table *e*. The blast-pipe can be fixed at different hights, and is supplied with jets of different sizes, to suit the regulated supply of spirit and the hight of the exposed portion of the wick.

The Russian spirit-lamp (B C) consists of an exterior cylinder a, containing a shorter interior annular cylinder b, having a bottom c, through which passes the pipe d, which constitutes the only communication between the interiors of the two cylinders. The outer end of this pipe terminates in a fine orifice. The cup e is then filled with alcohol or pyroxilic spirit, which

Fig. 5423.

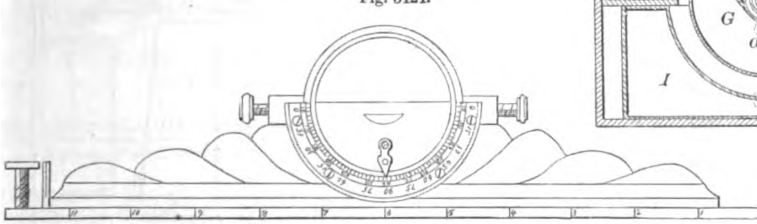


Spirit-Lamps.

is poured into the chamber b through the nozzle f, afterward stopped with a cork. An equal amount is then poured into the outer cylinder a and ignited; this soon causes the spirit in the chamber to boil, the vapor is forced through the tube d, and, being set on fire by the flame, produces a continuous column of burning vapor 6 inches high, which will last from 12 to 16 minutes. The cup e also serves as a cover to the lamp, and is used as an extinguisher.

Spir′it-lev′el. A level consisting of a glass tube nearly filled with alcohol, preferably colored. The remaining space in the tube is a bubble of air, and this occupies a position exactly in the middle of the tube when the latter is perfectly horizontal. The

Fig. 5424.



Davis's Level and Inclinometer.

tube is mounted on a wooden bar, which is laid on a beam or other object to be tested; or it is mounted on a telescope or theodolite, and forms the means of bringing the said instruments to a level position. See LEVEL.

Fig. 5425.

Alcohol-meter.

Nearly in its present form it is supposed to have been invented by Dr. Hooke, some time in the latter part of the seventeenth century.

Another tube is placed in a mortise transversely of the bar, to enable the instrument to be used as a *plumb*.

Fig. 5424 is a level which may also be used as an *inclinometer*, the reading being in degrees or linear measurements. The ring is adjusted for plumbing vertical surfaces, or leveling surfaces, by the movable ring and its set-screw. Inclination from these positions is indicated by a circular scale and index.

Spir′it-lev′el Quad′rant. An instrument furnished with a spirit-level and used for taking altitudes.

Spir′it-me′ter. An instrument for measuring the amount of spirits passing through a pipe or from a still. The ordinary *alcohol-meter* is but an adaptation of the hydrometer, having a special scale in combination with a system of tables to be used by the inspector to test the gravity of the wort and mash, so as, in connection with the known capacity of the vessel and correction for temperature, to ascertain the amount of spirits produced. See HYDROMETER; ALCOHOLMETER.

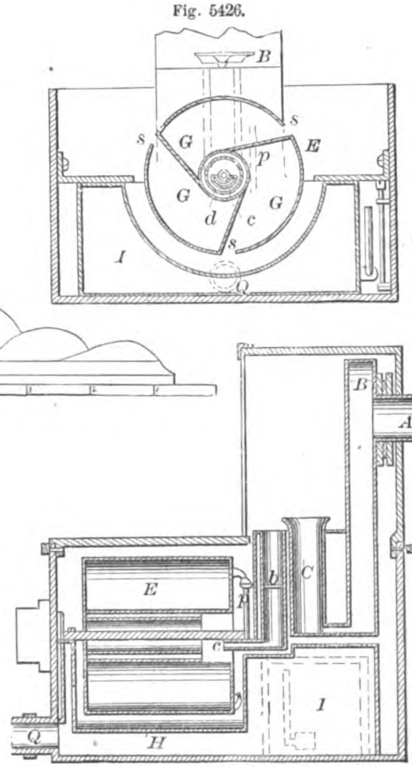
The term spirit-meter is more properly applied to a measuring device; and, for internal revenue purposes, the *high* or *low wines* or spirits are occasionally tested by the hydrometer, to find the specific gravity, the quantity of the spirit at proof being deduced from the two factors.

Spirit-meters are of several kinds: —

1. The rotating drum or tympanum of known capacity, usually divided into chambers, like a gas-meter.
2. The piston vibrating in a cylinder of known capacity, and registering its pulsations.
3. Various applications of the device known as the rotary pump.
4. Vessels of known capacity, alternately filled and discharged; usually suspended from a beam whose oscillations as the lighter one rises and the heavier descends are made to actuate an index mechanism. See also LIQUID-METER; WATER-METER.

(1.) In Augenstein's meter (Fig. 5426), the spirit passes from

Fig. 5426.



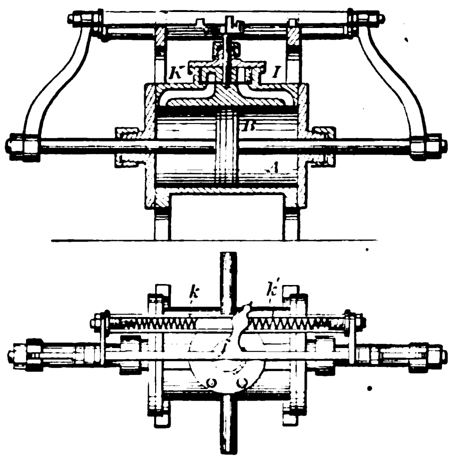
Augenstein's Spirit-Meter.

the worm of the still through the pipe A into the chamber B, and fills the upright cylinder C, whence it overflows into a second upright cylinder containing a straining diaphragm b. It thence flows through the pipe c, and is discharged into the hollow axis of the revolving cylinder E, whence it escapes into that one of its compartments G G G which is at the time in communication with the pipe c. As these become filled, they descend by gravity and discharge their contents through the peripheral openings s s s into the reservoir H, whence the liquor is conducted off by a pipe Q. On the exterior of the cylinder E are a series of brushes, or dippers, which take up a small quantity of the spirit from the chamber H and convey it to a cup, from whence it is conducted by the pipe p to a reservoir I. At suitable intervals the liquor in this reservoir is tested, serving as a sample of all that has passed through the meter. Each of the

compartments G measures a given uniform amount, and the flow of spirit into one or the other of them is continuous. Suitable clock-work mechanism is provided for registering the amount which passes through the apparatus.

(2.) Weaver's meter (Fig. 5427) has a piston B, which is caused to oscillate in the cylinder A, to each end of which the liquid to be measured is alternately admitted through ports K I, opened and closed by a circular valve provided with an arm f,

Fig. 5427.



Weaver's Spirit-Meter.

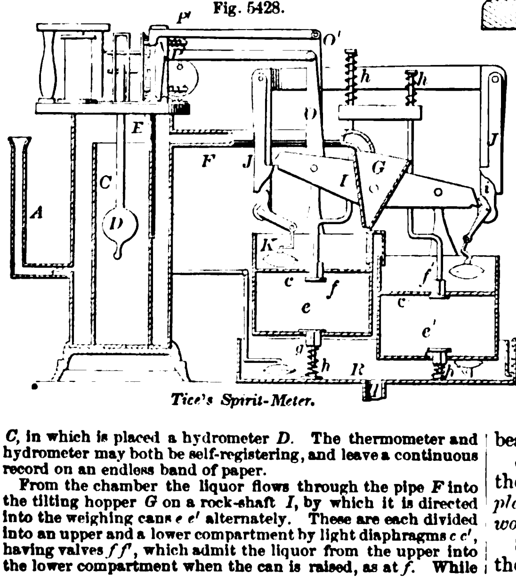
which is moved to and fro by springs k k', one of which is brought into action as the other is released at the end of each stroke.

The valve is circular, and oscillates in a horizontal plane to change the relation of its ports with the inlet and outlet ports. As the piston moves toward the left, the spring in the right-hand end of the tube is compressed in consequence of the resistance opposed thereto by the arm projecting from the valve stem, but when the piston has nearly completed its stroke, said arm is freed and actuated by the compressed spring so as to suddenly reverse the valve. The springs being duplicated, the operation is the same under the opposite movement of the piston.

(3.) The rotary-pump principle is sufficiently illustrated in Figs. 4465, 4466. See also the devices under ROTARY STEAM-ENGINE, Plate LIII. page 1991.

(4.) Tice's meter is shown in Fig. 5428. The spirit coming from the still through the pipe A is received in an exterior chamber containing a thermometer E and an upright cylinder

Fig. 5428.



Tice's Spirit-Meter.

C, in which is placed a hydrometer D. The thermometer and hydrometer may both be self-registering, and leave a continuous record on an endless band of paper.

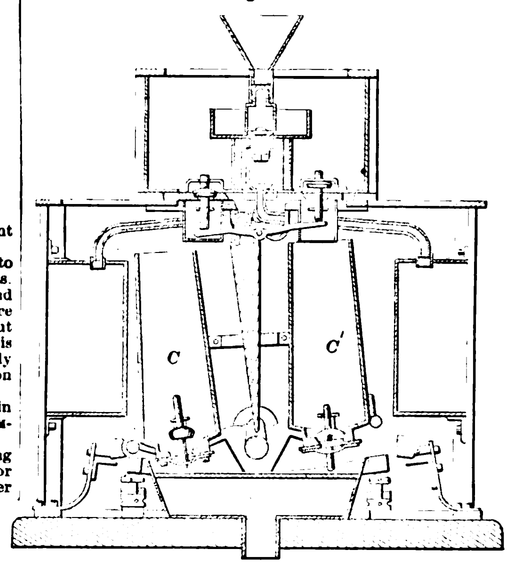
From the chamber the liquor flows through the pipe F into the tilting hopper G on a rock-shaft I, by which it is directed into the weighing cans e e' alternately. These are each divided into an upper and a lower compartment by light diaphragms c c', having valves f f', which admit the liquor from the upper into the lower compartment when the can is raised, as at f. While in this position the elevated arm of the rock-shaft I is engaged by one of the swinging latches J J, which prevents the can from descending until enough liquor has accumulated above the diaphragm f to raise the float K, causing a bent pivoted arm i, to which it is connected, to act against the latch J and release the shaft I, permitting the can to descend. The valve f then closes by the action of the spring h on its stem, while the valve g, provided with a similar spring, opens, and the liquor flows into the trough R, and is conducted away by a pipe q. This operation alternately takes place with each can, the number of times each is filled and emptied being automatically recorded by suitable registering mechanism operated through the medium of the levers O O' P P'. The amount measured each time is that contained in the lower compartment only.

Devices are attached to the meter to indicate if any attempt has been made to tamper with the meter or pass liquor through it without being properly measured in the cans.

In another form of this meter, siphons are employed to discharge the cans, which may be connected to a weigh-beam in order that the strength of the spirit may be ascertained directly from its weight.

Payne's meter (Fig. 5429) consists of a frame containing the tanks C C', which are placed on a vibrating yoke. The distilled spirit passes first into one of the tanks, and when it has filled the tank causes it to overbalance the empty one, which is in turn filled, the first one being emptied automatically at the

Fig. 5429.



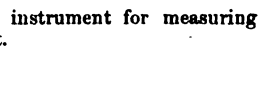
Payne's Spiritometer.

same time by a valve beneath. The tanks are thus filled and emptied alternately; the number of times each is filled and emptied being recorded upon dials by means of suitable mechanism. As the spirit passes through the tunnel into the tank, a small quantity is retained in the sampling device, and caused to flow into the receivers. The sampling device consists of a tube, provided with valves, supported by a suitable mechanism, the valves being so arranged that at each oscillation of the tanks they will allow the sample contained in the tube to pass into the chamber, and from thence into the receiver.

Spir'ket. (*Shipbuilding.*) A space fore and aft between floor-timbers or futtocks of a ship's frame. Distance between *rungs.*

Spir'ket-ing. (*Shipbuilding.*) *a.* The strake of inside planking between the water-ways, which rest upon the deck-beams and the port-sills.

Fig. 5430.



Spirketing, etc.

b. The strake between the upper deck and the *plank-shear.* The *quick-work.*

Spi-rom'e-ter. An instrument for measuring the capacity of the chest.

Fig. 5431.

Brown's Spirometer.

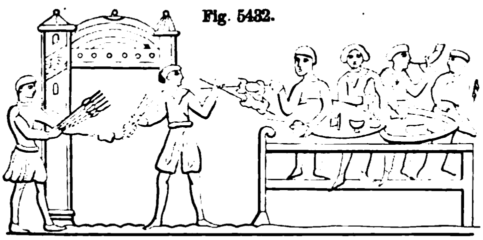
The breath-holder is an inverted chamber submerged in a water-bath. The breath is conducted by a flexible pipe and internal tube, so as to collect in the chamber, which rises in the water. An index is attached to the chamber, and is graduated on its face, so as to indicate against the edge of the index-case the cubic inches of air expired. A *chest-measurer*.

The extreme hight of a column of water which can be supported by the muscular act of expiration, transmitted by the lips, is about six feet. With the majority of wind-instruments, the pressure required for the high notes is considerably greater than that required for the low notes, each instrument having a pressure ratio of its own. The clarinet is an exception to the rule.

Spit. 1. An iron rod, on which meat is impaled for cooking.

Fig. 5432 is a representation from the Bayeux tapestry of a Norman dinner-table. The pieces of meat were handed to the guests on skewers, and fowls upon the spits on which they were roasted.

Fig. 5432.



Norman Waiters serving at Table (Bayeux Tapestry).

One guest is drinking from a horn, another is raising a tankard; wooden platters and a box of salt are probably intended by the other table furnishing.

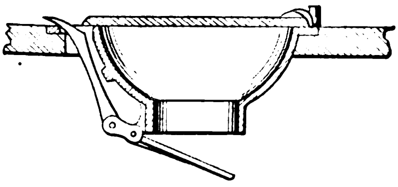
2. (*Weaving.*) A horizontal pin in the chamber of a weaver's shuttle, for receiving the spool or pirn.

Spit-box. A spittoon. A *cuspadore.*

Spit-stick'er. (*Engraving.*) A graver or sculper, with convex faces.

Spit-toon'. A box or crock for saliva. Spittoons for railway-cars are arranged with covers and automatic discharge. Fig. 5433 has a valve at the bottom, which is closed when the lid is lifted, preventing the draft of air through the opening. When the lid is closed, the valve opens and discharges the contents.

Fig. 5433.



Railway-Car Spittoon.

Splash-board. (*Vehicle.*) The leathern or wooden board in front of the driver. A *dash.*

Splash'ers. 1. (*Locomotive.*) Guard-plates placed over the wheels of locomotives to prevent any person coming in contact with them, and also to protect the machinery from wet and dirt projected by the wheels when running.

2. (*Vehicle.*) *a.* A guard over a wheel, to keep dirt from reaching the occupants of the carriage.

b. A guard near the door, to keep the dress from rubbing against the wheel in entering or alighting.

Splay. (*Architecture.*) The inward or outward expansion of an opening; the difference between its greatest and least cross-sections. Instances are found in the slanting or beveled expansion *groin*, in Gothic and Domestic architecture, to doors and windows.

The *splayed* sides of the chimney-jambs are called *covings.*

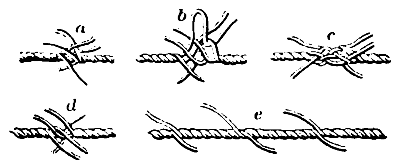
The term *fluing* is applied to the slanting jambs of a Gothic window.

Splay'er. (*Tile-making.*) A segment of a cylinder on which a molded tile is pressed to give it a curved shape, for a pantile, ridge or hip tile, gutter or drain tile.

Splice. 1. (*Nautical.*) The joint by which two ropes are united so as to make one continuous length, or the two ends of a single rope are united, to form a grommet or eye.

In the *short* splice, used for ropes which are not to be rove through blocks, the strands are unlaid for a convenient length, and each passed over one and under another of its correspond-

Fig. 5434.

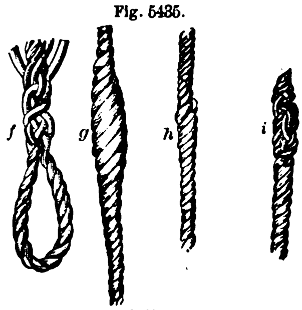


Splices.

ing strands on the opposite rope for a sufficient distance, as shown at *a b c*, Fig. 5434. The ends are then drawn taut, usually trimmed off close, and frequently the splice is covered by serving.

The *long* splice *d e* for ropes which are to pass through blocks is formed by unlaying the strands for a longer distance and laying two belonging to each rope in the scores formed by unlaying the opposite strands of the other. The third strands are split and united after the manner of the short splice, while the ends of the two others are united by splitting and interlacing in the same manner. This distributes the joining over a considerable length, rendering the enlargement scarcely perceptible.

Fig. 5435.



Splices.

f, *ring*-splice.
g, *pudding*-splice.
h, *long* splice.
i, *short* splice.

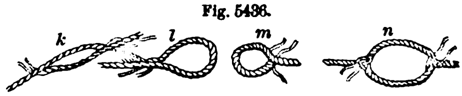
The *long-rolling* splice is used for lead-lines, fishing-lines, etc.

The *cut* or *cant* splice (*k n*, Fig. 5436) is made by cutting a piece from a rope and laying open the ends of the strands. The strands of the piece to which it is to be attached are laid open with the marlinspike, and the ends of the cut-off piece are passed in between the strands of the first.

The *eye*-splice *l m* is made in a precisely similar way, the end of the rope being worked into the standing part.

A *drawing*-splice — principally used for cables — is made by unlaying several fathoms of the two ropes to be joined, making

Fig. 5436.



Splices.

a short splice, tapering the ends of the strands and laying them along in the spaces between the strands of the other cable, where they are secured by seizings. So called, because it is readily taken apart.

A *tapered* splice is formed by gradually tapering the strands of each rope after making a short splice and passing them in between the strands of the other, again tapering and passing through, and so on until the unlaid strands are expended.

2. (*Machinery.*) To unite adjacent pieces by means of overlapping or scarfing the parts together, secured by bolts or fish-plates. See FISHING.

3. (*Carpentry.*) A scarf-joint by which timbers are united. See SCARF.

Spliced Eye. (*Nautical.*) The rope is bent around a thimble, and the end spliced into the standing part.

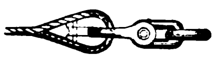
Splice-piece. (*Railway.*) A fish-plate or break-joint piece at the junction of two rails. See Fig. 2001.

Splic'ing-fid. (*Nautical.*) A tapered wooden pin or marlinspike, used in opening the strands of a rope in splicing. It is sometimes driven by a mallet called a *commander.*

Splic'ing-ham'mer. A hammer having a face at one end and a point at the other, used in splicing.

Splic'ing-shack'le. (*Nautical.*) A device for enabling a hempen cable to be bent to a chain-cable. The shackle at the end of the latter has a thimble like a dead-eye, around which the hempen cable is passed, and the *end* spliced to the standing part.

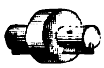
Fig. 5437.



Splicing-Shackle.

Spline. (*Machinery.*) A rectangular key fitting into a seat on a shaft and occupying a groove in the hub of a wheel, which slips thereon longitudinally, but rotates therewith. A *feather.*

Fig. 5438.



Spline.

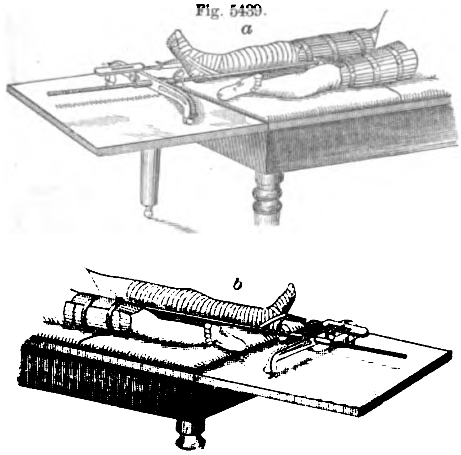
Splin'ing-ma-chine'. (*Metal-working.*) One for cutting key-seats and grooves. See SLOTTING-MACHINE; KEY-SEAT CUTTER.

Splint. 1. (*Surgical.*) A flexible and resisting lamina of wood, metal, bark, leather, or pasteboard, to keep the parts of fractures in apposition and prevent displacement. They are usually padded, and fixed by rollers or tapes.

Splints for fractured limbs are shown in Plates XVIII., XXII., XXVI., XXIX.; extension and counter-extension apparatus in Plates XXII., XXV., of "Magazyn oste Wapen Huys der Chirurgyns door Johannes Scultetus," Doordrecht, 1658.

Fig. 5439 shows an apparatus for the reduction and retention of fractures. The extension of the wounded leg is by means of bandaging tapes and a spring-balance. The counter-extension is by a rod attached to a cross-bar and connected to a splint on the thigh of the sound limb.

Fig. 5439.

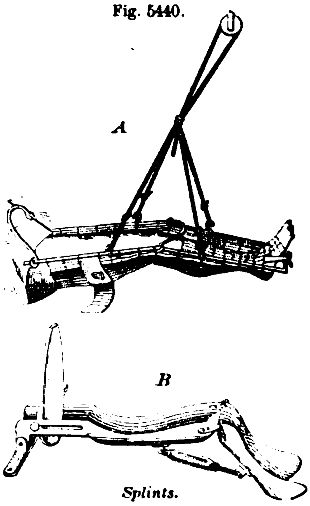


Latta's Splint.

In Fig. 5440, *A* illustrates Hodgen's suspending apparatus, used in treating fractures of the leg and thigh. The splint is a frame of stout wire, and is supported at a point nearly over the seat of the fracture, and a little above the middle of the leg, which is raised and held at the required hight by means of the tackle.

B, Liston's splint; particularly adapted for treatment of fractures of the condyles of the femur and of the upper part of this bone. It is applied to the limb by attaching the foot to the foot-board and the limb to the splint by a roller bandage. The angle of flexion is regulated by the screw.

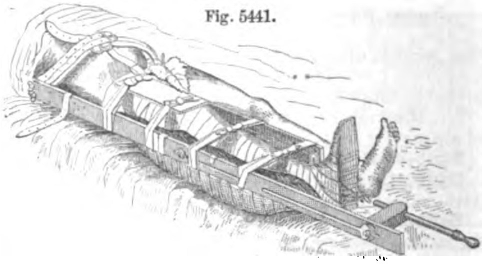
Fig. 5440.



Splints.

Fig. 5441 represents, as applied, Dr. Lente's modification of the New York Hospital apparatus, for treatment of fractures of the thigh. This is based upon the splint originally invented by Desault, and subsequently modified by Drs. Physic and Buck. The outer splint is made in two pieces, one of which slides upon the other, so as to be adjustable to the length of the limb, is retained when adjusted by a set-screw, and is provided with a cushion applied to the outer side of the leg. It has a steel brace passing half-way over the abdomen, and connected to a belt surrounding the pelvic region, and also a perineal band connected to an adjustable plate sliding on the brace before mentioned. Cushioned splints placed beneath the upper part of the thigh and on the inside of the leg are also employed. A broad strip of adhesive plaster is applied on each side of the leg, from a little below the knee, the free ends extending to below the sole of the foot, and are secured to a thin block of wood, having holes at each side for receiving a cord, to which the hook or ring at the end of the screw is attached. The perineal band is adjusted so as to grasp the tuberosity of the ischium, which serves as the point of resistance; and when the splints have been properly adjusted to the leg, and secured together by bandages, the fractured limb is extended as far as the patient can conveniently bear, by means of the screws, after which the bands, being elastic, continue the extension, gradually overcoming the resistance of the contracted muscles, and complete the extension. The hook of the screw is also connected to a spiral spring.

Fig. 5441.



New York Hospital Splint for Fracture of the Thigh.

A removable foot-piece attached by a slide and thumb-screw to a mortise in the external splint is also provided in order to prevent the usual tendency to eversion of the foot, and also by projecting a little beyond the toes to take off the pressure of the bedclothes.

2. A thin strip of wood prepared for use in manufactures, as for making baskets, brooms, matches, etc.

3. A wooden strip for splicing and stiffening a fractured bar or beam.

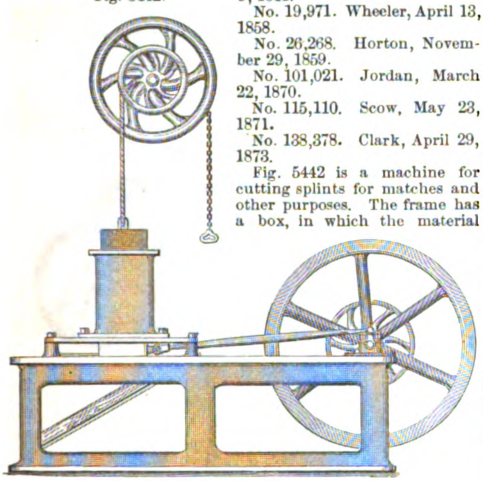
4. (*Ordnance.*) A tapering strip of wood, used to adjust a shell centrally in the bore of a mortar.

Splin′ter-bar. (*Vehicle.*) *a.* A cross-bar in front of a vehicle, to which the traces of the horses are attached, as in coaches and artillery carriages, in which *double* and *single trees* are not used.

b. A cross-bar which supports the spring.

Splint-ma-chine′. A machine for riving or planing small slats or splints for use in making woven-slat blinds, baskets, box-stuff for millinery or fruit, etc. See SLIVERING-MACHINE.

Fig. 5442.



Splint-Machine.

See patents, Gleason, October 9, 1841.

No. 19,971. Wheeler, April 13, 1858.

No. 26,268. Horton, November 29, 1859.

No. 101,021. Jordan, March 22, 1870.

No. 115,110. Scow, May 23, 1871.

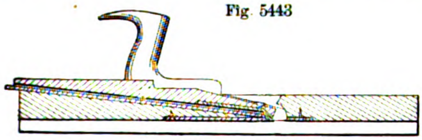
No. 138,378. Clark, April 29, 1873.

Fig. 5442 is a machine for cutting splints for matches and other purposes. The frame has a box, in which the material to be worked up is placed. The cutters are attached to a slide, worked by a connecting rod from the crank-shaft, and the material is pressed down by a weight. The machine cuts 3,500 splints per minute. See also EXCELSIOR-MACHINE, page 815.

Splint-plane. One for riving splints from a block or board, for blind-slats, small boxes, etc. A *scale-board plane.* Patent No. 143,737.

In Fig. 5443, the thickness of the slat is regulated by the spring tongue at the end of the wedge, the tongue being adjusted by a set-screw at the point. The plane is intended for making blind-slats, each one pushing the preceding one out.

Fig. 5443.



Splint-Plane.

See patents No. 52,473, Welsh, February 6, 1866; No. 50,947, Ogborn, November 14, 1865; No. 51,153, Dempsey, November 28, 1865.

Patent No. 52,173, Kleinschmidt and Schlater, January 23, 1866, has a very oblique setting-knife or cutting-bit. Just forward of it is a channel, having the same angle in respect to the plane that the bit has, so that as the shaving is cut by the bit, it is forced out through the channel, which causes it to be twisted around in the form that paper-lighters are made by hand.

Split. 1. (*Weaving.*) One of the flat strips which are arranged in parallel vertical order and form the *reed* of a loom. The *warp*-threads pass between the *splits* or *dents.* The reed is placed in a swinging frame, called the *lay*, *lathe*, or *batten*, and its office is to beat the *weft*-thread up to the *web* to compact the fabric.

2. (*Leather.*) A thin kind of leather made by splitting a hide into two thicknesses.

3. *a.* One of the pieces of an osier after quarternary division through the pith by two knives placed at right angles to each other. These splits are shaved, and the flat strip is then a *skain.*

b. A ribbon of wood rived from a tough piece of green timber, such as hickory, white oak, or black ash. Used in making baskets, hurdles, chair-bottoms, and for many other purposes for which osiers are commonly used in places where they are plentiful. See also SPLINT.

Split-draft. (*Furnace.*) In steam-boilers, when the current of smoke and hot air is divided into two or more flues. In contradistinction to a *direct*, a *reverting*, or a *wheel draft.*

Split-ful. (*Weaving.*) The number of yarns, usually two, which is passed between each *split* or opening in the *reed* of the *batten* or *lathe.* A rod lying athwart the warp divides the yarn-threads into split-fuls, two threads passing alternately over and under it.

Split-leath′er. Leather split by machinery, to economize it or to reduce it to a suitable thickness for a given purpose.

It appears to have been introduced by Nossiter, England, who found the cut surface, when polished by a slicker, to take varnish better than either the flesh or grain side of the hide.

Split-leather is an inferior article, and is used for light boots and shoes, inner soles, linings, carriage upholstery; trunk, portmanteau, and cushion covering. Splits of the smaller skins, such as goat and sheep, are made into wash or glove leather.

Split-pin. A pin or cotter with a head at one end and a split at the other. The ends diverging after passing through an object prevent the accidental retraction of the pin. See also FOX-BOLT and Fig. 2092.

Fig. 5444.

Split-Rings.

Split-ring. A split-ring has an opening by which keys may be introduced to be strung upon it. The metal of the ring is pliable, and the opening closes of itself.

Split′ting-board. (*Mining.*) Said of a dividing board used in mine ventilation to divide the incoming air and direct it to separate districts of the mine.

Split′ting-chis′el. A blacksmith's chisel having a sharper cutting edge than is usually found in chisels for cutting iron. It is intended for dividing the metal longitudinally.

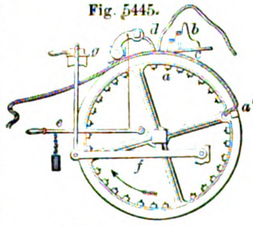
Split′ting-knife. A knife used in a machine for splitting leather. It is sometimes stationary, and is gaged to a distance from a roller over which the *grain-side split* is wound as the hide passes through.

In the more common form of leather-splitting, the knife is six feet in length, the length of the drum, and has a rapid longitudinal vibration in a plane parallel to the axis of the drum. See LEATHER-SPLITTING MACHINE, and next article.

Split′ting-ma-chine′. A machine for dividing a skin of leather parallel with one of its surfaces.

The leather-splitting machine (Fig. 5445) consists of a drum *a*, having an opening *a′* running its whole length; the end of a hide is wedged into this opening, and as the drum is rotated, an endwise traversing motion being at the same time imparted to the knife-carriage *b* by means of a crank, the leather is drawn against the knife *c*, which divides it into two thicknesses, one part passing above and the other below the knife. The hide is held down and wrinkles smoothed out by a plate *d*, extending the whole

Fig. 5445.



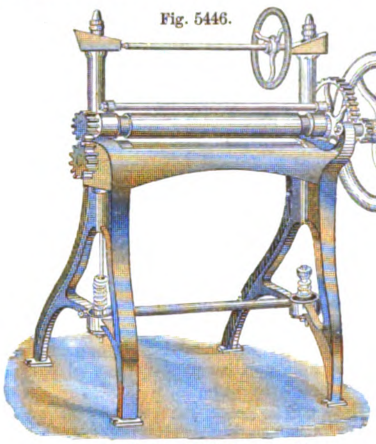
Splitting-Machine.

length of the drum, and connected by a cord to a weighted lever *e*. The bearings of the drum rest upon a lever *f* at each end; this is raised or lowered to vary the thickness of cut by means of a screw *g*.

The knife-carriage *b* is provided with set-screws for setting the edge of the knife straight.

In Fig 5446, the leather is passed between the rolls and against a knife, the depth of the split being regulated by the upper or gage roller, the bearings of which are adjusted vertically by the hand-wheel shaft, right and left screw-threaded at its ends, and playing in wedges.

Fig. 5446.



Leather-Splitting Machine.

Split'ting-saw. (*Wood-working.*) One for resawing thick stuff. See RESAWING-MACHINE.

A circular saw for ripping up thick stuff.

Spoil. (*Civil Engineering.*) Earth dumped by the side of an excavation, to get rid of it when it is in excess of the quantity required for embankments.

Spoke. 1. (*Vehicle.*) *a.* One of the radial arms which connect the *hub* with the *rim* of a wheel. The parts are: the *foot*, which is inserted into the hub; the *shoulder* of the foot; the *tongue* or *tenon*, which is inserted into the felly; the *body*, or part between the hub and felly; the *throat*, a contracted part of the body near the *hub*.

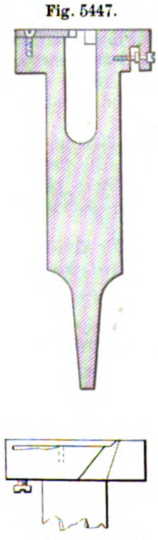
b. A fastening for a wheel to lock it in descending a hill.

2. (*Nautical.*) One of the handles projecting beyond the rim of the steering-wheel by which it is turned.

3. A *round* or *rung* of a ladder.

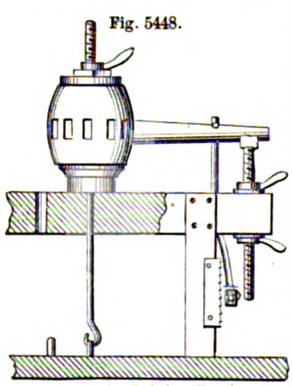
Spoke-au'ger. (*Vehicle.*) A hollow auger employed to make the round tenons on the outer ends of spokes. See AUGER, Figs. 428 – 432.

Fig. 5447.



Spoke-Auger.

Fig. 5448.



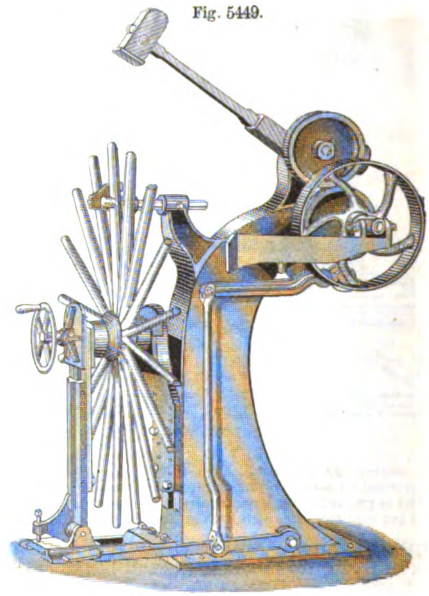
Spoke-Driving Bench.

In the example, the adjustable slide limits the diameter of the opening to form tenons of different sizes. The rankness of cut is adjusted by a screw inserted from the rear of the cutter-head, to act upon the inner surface of the cutter-plate.

Spoke-driv'ing Bench. The hub is clamped on the bench and the spokes supported in turn by a vertically adjustable post; an upper clamp prevents the bouncing of each spoke while being driven by a hand-mallet.

Spoke-driv'ing Ma-chine'. A machine for driving spokes into their mortises in the hub. The swinging mallet is brought into action by depressing the treadle, bringing a friction-wheel on the pulley-shaft against a wheel on the mallet-shaft. The rapidity and force of the blow are proportioned to the pressure on the treadle. The machine is adapted for wheels of from 2 feet to 6 feet in diameter.

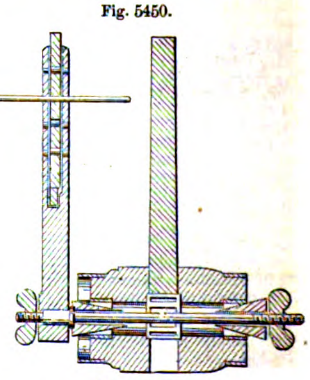
Fig. 5449.



Hosler's Spoke-Driver.

Spoke-gage. An instrument for testing the *set* of spokes in the hub. The mandrel has conical sleeves which abut upon the ends of the boxing, and hold the hub true while the gage-pin in the staff tests the distance of the spokes.

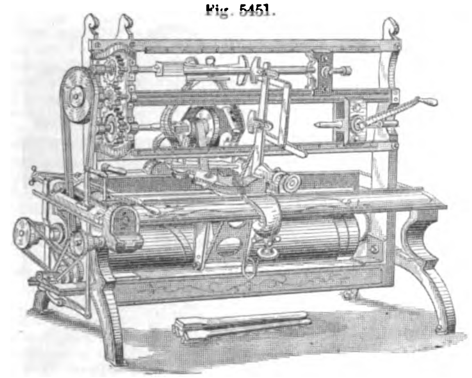
Fig. 5450.



Spoke-Gage.

Spoke-lathe. A lathe for turning irregular forms. The foundation of the machine is the Thomas Blanchard patented machine of 1828, shown at *A*, Fig. 2836, page 1264. Many improvements have been added. See

Fig. 5451.



Spoke-Lathe.

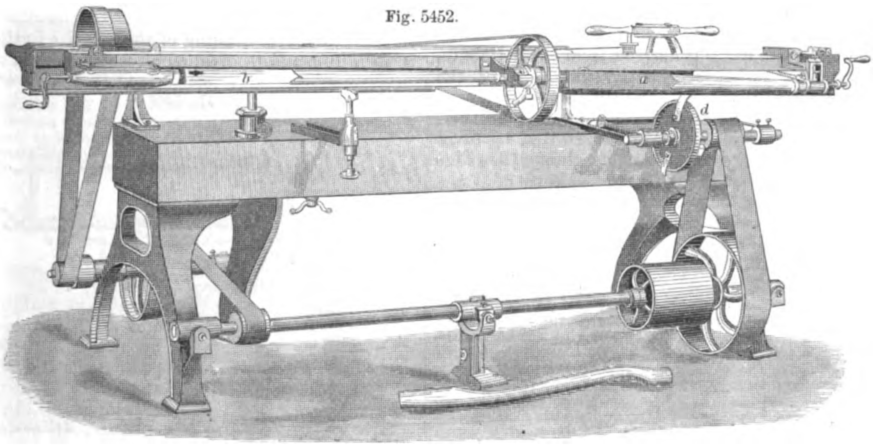
LATHE FOR TURNING IRREGULAR FORMS, pages 1263, 1264.

The spoke is placed between centers in a lathe-head, and is approached to or drawn away from a cutter, in accordance with the shape of a pattern which governs the proximity of the tool to the work. Fig. 5451 shows one modern form. The pattern spoke is in the upper part of the machine, and the guide-pieces on each side govern the position of the revolving cutter, which acts upon the material placed between the lower centers.

The lathe (Fig. 5452) is adapted for turning handles for axes and other implements, as well as spokes. The work *a* and pattern *b* are fixed between centers and revolved upon a carriage, which is automatically traversed in a longitudinal direction, and at the same time swung by the upright guide, bearing against the pattern, so as to present the work to the action of a set of cutters fixed in the rotary head *d*; the amount of this swing and consequent penetration of the cutters is dependent upon the shape of the pattern, of which the work is thus caused to present an exact copy. Adjustments are provided for forming several sizes of work from the same pattern.

Among these may be cited the patent of A. D. Waymouth, of Fitchburg, Mass., July 29, 1856. The improved lathe is so nearly automatic that the necessity for skill is obviated, except in keeping the knives in order and setting them. The headstock has a hollow center, which receives the stick which is to be wrought. A sliding hollow gage *roughs* the stick, leaving it round, and ready to be cut into small pieces. This roughing-gage is pushed upon the stick the length of one of the pieces which is to be made, a lever attached to the tail-stock furnishing the means of applying the force. When the roughing is completed, a knife, operated by a lever worked by the knee, cuts the material to the shape desired, the tool falling back out of the way when its work is done, while another thin knife runs up from the under side, cutting off the finished piece, the gage and the center of the headstock supporting the two ends of the stick until another length is roughed and the operation is repeated. A stick can thus be worked entirely up, cutting off one piece after another until the whole is used.

Fig. 5452.



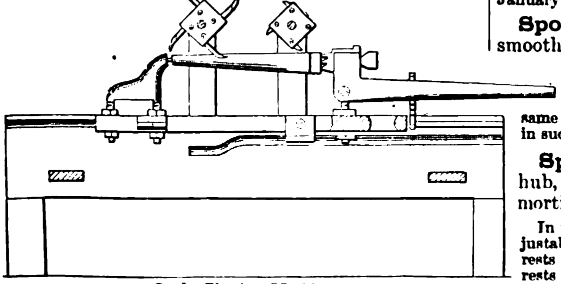
Spoke-Turning Machine.

Spoke-plan'ing Ma-chine'. One for dressing a spoke lengthwise of the stuff, the spoke or the cutter being so moved, the one relatively to the other, that the required shape is produced.

In the example, the piece is clamped between the dog in the bent lever and the opposite center; the clamp lever is held in position by a support placed under it and upon the bench. The carriage is reciprocated on the ways, beneath the roughing and the finishing cutter, a guide-bar determining the presentation to the cutter, so as to confer the proper shape.

See also Benton's patent, March 21, 1854; Olney and Kellogg, January 4, 1859; and Boynton, January 23, 1866.

Fig. 5453.



Spoke-Planing Machine.

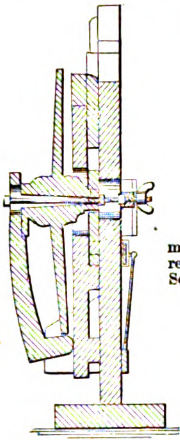
Spoke-pol'ish-ing Ma-chine'. A machine for smoothing spokes after turning and before painting.

Rouse's machine, July 8, 1873, has a continuous sand-belt moving in a direction contrary to the rotation of the spoke. Several articles are placed in the same frame, which are automatically moved to the sand-belt in succession. See also Woolsey's patent, August 24, 1869.

Spoke-set'ter. A machine for centering a hub, so that it may be bored truly for the spoke-mortises.

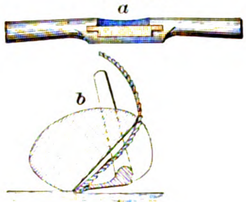
In the example, the standard forms a support for the adjustable portions of the apparatus. The point of the hub rests on a block keyed up by wedges. The butt of the hub rests on a pivoted bar, whose carriage is vertically adjustable on the standard by a lever and rod in the rear. The

Fig. 5454.



Spoke-Setter.

Fig. 5455.



Spokeshave.

mandrel bolt clamps the pivoted hub-rest to a bar on the back of the standard. See also SPOKE-DRIVING MACHINE.

Fig. 5456.

Spokeshave.

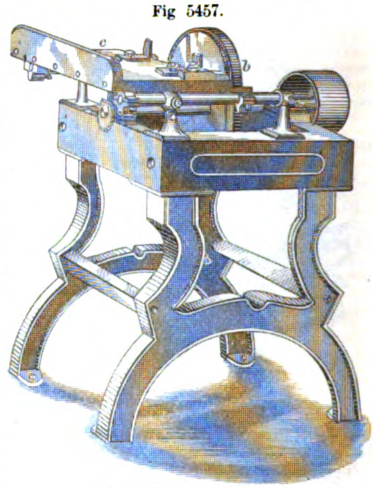
Spoke'shave. A form of plane with a handle at each end. Its name is derived from the article on which it was, perhaps, primarily used. At *a* the sole is presented ; *b* shows the principle of action.

Fig. 5456 has two iron wedges pivoted at their outer and upper angles to the stock, so that by turning them down into their sockets they will wedge and hold the bit fast in its place.

Spoke-siz'ing Ma-chine'. (*Wheelwrighting.*) A machine for planing the sides of spokes and bringing them to a uniform shape ; the edge of the tenon may be tapered at the same operation if desired.

The spoke is placed upon the table *c*, where it is held against a stop, adjustable to different sized spokes ; the table is pushed forward to an amount determined by the previous adjustment of a collar on the stop, bringing the side on the spoke in contact with the cutters on the rapidly rotating cutter-head *b*, which at once dress that side of the spoke and tenon ; it is then turned over, and the other side similarly dressed. On drawing the spoke forward and releasing it from the stop, the desired bevel is given to the edge of the tenon by means of the cutters, the particular inclination being determined by an adjustable angle-gage.

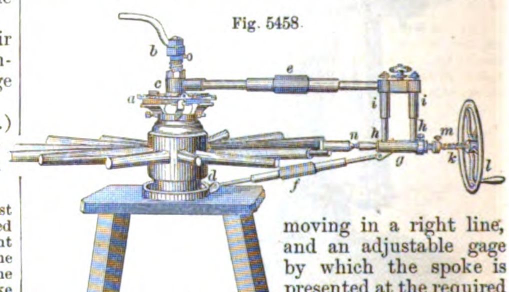
Fig 5457.



Spoke-Sizing Machine.

Spoke-ta'per-ing Ma-chine'. One to taper the edge of the spoke-tenon to fit the bevel heading of the mortise in the hub. It usually consists of a reciprocating chisel-cutter, moving in a right line, and an adjustable gage by which the spoke is presented at the required angle. See Foster's patent, August 8, 1865.

Fig. 5458.

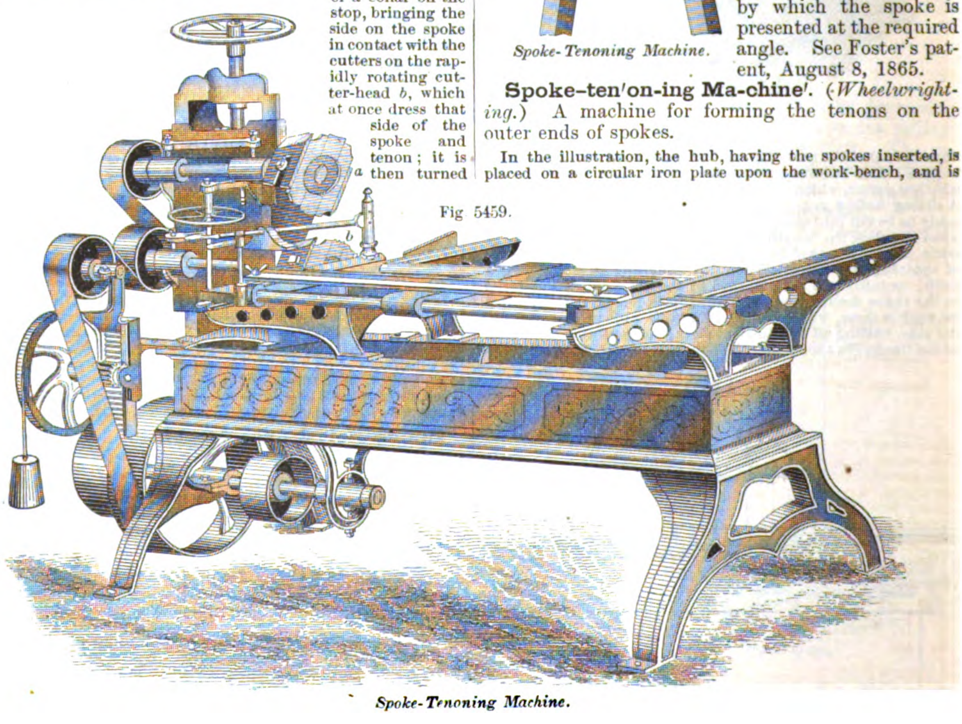


Spoke-Tenoning Machine.

Spoke-ten'on-ing Ma-chine'. (*Wheelwrighting.*) A machine for forming the tenons on the outer ends of spokes.

In the illustration, the hub, having the spokes inserted, is placed on a circular iron plate upon the work-bench, and is

Fig 5459.



Spoke-Tenoning Machine.

held fast by adjustable clutches upon the head-piece *a*. The whole apparatus is secured to the bench by a screw and nut and lever *b*. Surrounding the screw is a collar *c*, and in like manner the bottom plate is surrounded by a collar *d*. From these collars extend jointed adjustable arms *e f*, the middle part of each of which is a right and left hand nut corresponding to screws on the ends of the other joints. These arms carry at their ends the brace-guide *g*, which has vertical adjustment to suit different-sized hubs by means of two screws simultaneously operated by a hand-wheel, and working in the tubes *h h*, which slide in the tubes *i i*. In the end of the brace-guide is a nut, which is not threaded on its outer side, and turns freely in the guide unless held by a set-screw; when this is made fast the screw-shaft *k* feeds in either direction, according as the hand-wheel *l* is turned to the right or left.

The depth of tenon is gaged by a collar *m*, adjustable at any point on this shaft. The tenons are formed by a hollow auger held by the brace *n*, the apparatus being rotated around the fixed hub as a center.

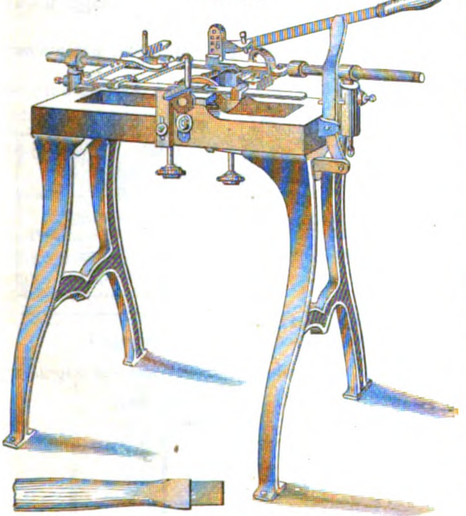
That shown in Fig. 5459 is adapted for tenoning cabinet work as well as spokes. The two cutter-heads *a b* are raised or lowered by means of a screw and hand-wheel to each, and are adjustable to vary the thickness of the tenon or the depth of the shoulder as required, the carriage always remaining stationary.

For spoke-tenoning it is provided with a light adjustable attachment on the carriage for grasping the spoke, and a saw for cutting it off to the proper length, at the same time that the tenon is cut.

Spoke-throat′ing Ma-chine′. The *throat* of a spoke is the portion of diminished thickness a short distance from the hub, to give a certain degree of flexibility to the spoke. See the lower figure in the illustration, where it is purposely slightly exaggerated, to show it the more clearly.

The machine (Fig. 5460) is intended for shaping and smoothing the throats or necks of spokes, preparatory to insertion in the hubs. It has an iron frame. The cutter-head revolves on a steel shaft, running in self-oiling boxes, and can be so constructed as to make the throat of any desired shape. The frame

Fig. 5460.



Spoke-Throating Machine.

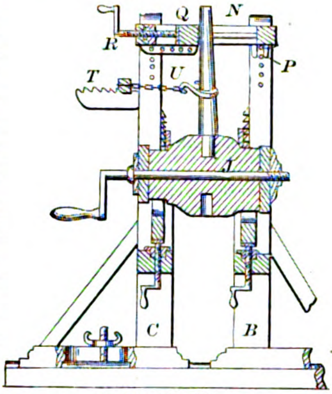
upon which the spoke to be throated rests is hinged on a slide-bar which passes back and forth over a guide, which, in connection with the knives on the cutter-head, regulates the shape of the throat. The spoke is placed under a lever, and held firmly while passing back and forth; ordinary spokes can be throated on both sides by simply changing the guard, which is accomplished by the hand-lever on the end of the machine.

Spoke-turn′ing Ma-chine′. See SPOKE-LATHE.

Spok′ing-ma-chine′. One for setting spokes in the hub with a uniform *dish*. See GATHER; SWING.

It has a fixed standard *A* and a movable standard *C*, carrying pillow-blocks adjustable as to hight by means of screws, and a head *N*, which may, to vary its elevation, be hinged in either one of a series of notches *P*. The hub is laid with its ends resting in the pillow-blocks, and clamped by the rod *J*, which works into a nut, and the spoke is adjusted to the required dish, and firmly held, while being driven, by means of a gage-block *Q*, operated by a cranked screw *R*, while a hook and chain *U*, attached to a beveled-edged lever engaging one of the notches in the rack *T*, holds it to the gage and prevents its moving too far in the opposite direction. Each *spoke* is successively driven and the wheel removed, the head *N* being turned on its hinge.

Fig. 5461.



Spoking-Machine.

Spole-frame. (*Rope-making.*) One of the parts of a rope-making machine. Each *spole-frame* has apparatus for determining the torsion and tension of each strand, and a cluster of three *spole-frames* combines the three strands into a rope. See ROPE-MAKING MACHINE.

Spon′cion. See SPONSON.

Sponge. 1. A compound radiate protozoan having a reticulated horny tissue, forming a skeleton for the gelatinous creatures which have silicious secretions.

Or, it may be defined as a soft gelatinous mass, mostly supported by an internal skeleton composed of reticularly anastomosing horny fibers, in or among which are usually imbedded silicious or calcareous spicula.

The best sponges for toilet use come from the Ægean, and are found in about eight fathoms of water. As in the time of Aristotle, they are gathered by a brotherhood of divers, who inhabit the islands off the Carian coast, and those between Rhodes and Calymnos. A coarse quality of sponge is found on the coasts of Florida and the West Indies. These are gathered with long-hafted forks. To remove the sarcode, the sponge is buried for some days in the sand, until the animal matter rots, and then the horny keratose is soaked and washed.

"Some have proposed even to stuff the sofas and chairs with sponge, on the idea that that will make the occupiers more amorous." — ATHENÆUS, Epil. B. I. 32 (A. D. 220)

For the purpose of stuffing mattresses, it is dipped in glycerine to give it the required resiliency.

See United States patents, —

No. 38,813, Davis, June 9, 1863. Sponge is pressed into a mold of any desired shape, dried therein, and, after removal, covered with water-proof material.

No. 41,589, Alden, February 16, 1864. All calcareous substances are removed by means of muriatic acid. It is then subjected to the action of a picker or *stuff* engine, by which it is cut into small particles and afterward baked or heated in an oven.

No. 48,970, Moith, July 25, 1865. The impurities are removed from the sponge, by means of weak acid, and then saturating it with a composition of equal parts of glycerine and water, the sponge being afterward subjected to moderate pressure to remove the surplus composition.

No. 59,714, Doremus, November 13, 1866. Sponge is cut in small pieces, and is moistened with solution of chloride of magnesium, or other deliquescent salt.

No. 72,322, Paraf, December 17, 1867. The sponge, when purified, if too hard, is soaked in water containing from 10 to 20 per cent of glycerine, after which it is cut into small pieces and carded. It is then felted or spun.

No. 102,760, Braun and Schmidt, describes a process for bleaching sponges, by treating them in a solution in water of permanganate of soda or potash and sulphate, or of other alkalies, and subsequently washing them in a solution of hyposulphite of soda or a bath of liquid or gaseous sulphurous acid.

No. 101,776, Smith. A multiple sponge, composed of a series of small pieces of sponge, which are connected by concealed thread.

No. 106,076, Ohlsen. A coach-cleaning sponge, consisting of

a net filled with pieces of sponge and held by jaws, one of which has a socket to contain a handle.

No. 136,310, Devlan, February 25, 1873. Car and window washer. A head with a stationary and a movable jaw, between which is a sponge, from which water is ejected.

No. 132,333. Sweeny, October 15, 1872. A carpet lining of sponge and cotton.

Bleached Sponge (*Spongia dealbata*). Ordinary sponge soaked in dilute hydrochloric acid to remove calcareous matter, then in water repeatedly, squeezing it out; then in water with chlorine or sulphuric acid in solution; wash in clean water, scented with rose or orange-flower water, and dry.

Many varieties of sponge are found in warm seas, but that of commerce is almost exclusively derived from the Grecian Archipelago, Syria, Barbary, and the West Indies. The Syrian or Turkish, also known as toilet sponge, is most esteemed. Next in value, and closely resembling it, is that from the Grecian Archipelago. Coarser varieties, valuable on account of their firmness and tenacity, come from Greece and Barbary. That from the West Indies is harsher, coarser, and less durable than the Mediterranean kinds.

On the Barbary coast sponge-fishing is most actively prosecuted during the months of December, January, and February; at other seasons the places where the sponges grow are overgrown with sea-weeds, which are swept away by the storms occurring in November and December.

The summer fisheries are conducted in shallower water by divers or by wading; the produce is less and the quality inferior. Three methods — spearing, diving, and dredging — are employed. The Greeks, who are the most skillful and successful sponge-fishers, employ small boats, carrying a rower and a spearman, the latter of whom views the bottom through a tin tube, furnished with a sheet of glass at the lower end, which is held beneath the surface of the water. He manages to transfix sponges at a depth of sixty feet by using three or four spears, thrown with such quickness and accuracy that the end of the first is struck by the second before it disappears beneath the surface, imparting an additional impetus and enabling it to reach the sponge. The Sicilians also employ small row-boats; they do not use the eye-tube, have not acquired the knack of using three or four spears, and are less successful than the Greeks. The Arabs employ sail-boats, carrying from four to seven men, one of whom acts as spearman, while the others manage the boat; they are less skillful and successful than either the Greeks or Sicilians.

2. Artificial sponge is made of caoutchouc by imbedding intimately and evenly throughout the plastic magma of gum some sugar or other granulated material, which may be subsequently dissolved, leaving the gum porous.

No. 97,880, Chesterman, Nov. 19, 1861, uses golden sulphuret of antimony, and *sets* the rubber by vulcanizing it in its extended form. The ingredients are incorporated into a homogeneous mass on hot rollers and are afterward expanded and vulcanized.

See also 94,631, Moulton, Sept. 7, 1869, for inking-rollers.

Goodyear, No. 25,110, August 16, 1859, has a woven fabric with a thin, porous covering of caoutchouc; and No. 25,192, a porous fabric of woven cloth covered with gum and faced with flock.

3. (*Ordnance.*) A mop for cleaning the bore of a cannon after a discharge.

The sponge-head is a wooden cylinder covered with a fabric, of which the warp is hemp and the weft woolen yarn, woven in loops like a Brussels carpet.

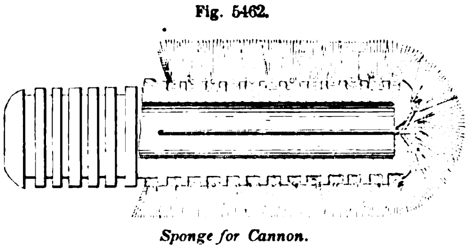
Alum-dressed sheepskin with the wool on is sometimes used.

In field-service, the *rammer* is at one end of the staff and the sponge at the other.

A rope sponge has a rope staff instead of a stiff one, and is used on shipboard in bad weather when the lower ports cannot be opened for the service of the guns except at the moments of firing.

A hair-brush is used for this service with rifled guns. In the

Fig. 5462.



Sponge for Cannon.

example, a hollow head, as usual, is made to fit the rammer or sponge staff, and a spiral groove is turned on its outside from one end to the other; a mat of horse or horned-cattle hair is then laid around the stock and lashed down by wire wound upon it, over the grooves, imbedding it in the same.

4. (*Metallurgy.*) *a.* Iron in soft or pasty condition, as delivered in a ball from the puddling-furnace, ready for the squeezer, shingling-hammer, or tilt-hammer.

b. Iron ore reduced but not melted, preserving its former shape, but porous and lighter by the removal of foreign matters.

c. Platinum in a foraminous condition, resembling sponge. See Fig. 2622, page 1152.

d. The gold remaining from the *parting* process after the silver has been dissolved by nitric acid from the alloy of gold and silver. See CUPELLATION.

e. Silver in a partly reduced condition ready for refining.

5. (*Surgical.*) Used for washing and cleansing wounds and ulcers, for absorbing acrid discharges, as a compress for hemorrhages, tent for dilating wounds, in which latter case it is immersed in wax and cooled.

Sponge is added to ordinary paper-pulp in making bibulous paper, for dressing and tents for wounds.

Burnt sponge (*Spongia usta*) calcined in a crucible, used as medicine.

Waxed sponge (*Spongia cerata*). Sponge dipped into melted wax, pressed between iron plates, and cut up into pieces to form sponge tents.

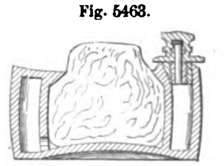
6. (*Baking.*) Raised dough, full of globules of carbonic acid and ready for baking.

Sponge–cov′er. (*Ordnance.*) A pocket of Russia duck, to cover a cannon sponge. Its interior diameter is the caliber of the piece, and it is closed by a draw-string.

Sponge–cup. A dish with a sponge to wipe pens upon.

In Fig. 5463, the sponge-cup is surrounded by an annular

Fig. 5463.



Sponge-Cup.

Fig. 5464.

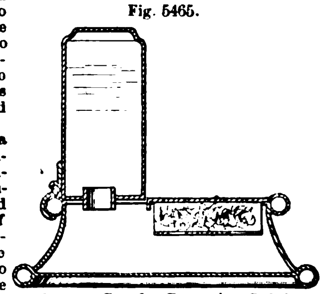
Sponge-Cup.

water-chamber, and connects therewith at an opening on a low level. Water is admitted to the sponge by allowing access of air to the water-chamber

In Fig. 5464, the novelty consists in combining a spring with the sponge, within a suitable water-cup, so that after the sponge has been pressed into the water and moistened, and allowed to rise, all superfluous water will be drained from it.

Fig. 5465 is a sponge-cup for gumming labels. The adhesive solution saturates the sponge, and minute portions of the solution penetrate through the perforated plate, so that on sliding the label over the plate the gum is applied.

Fig. 5465.

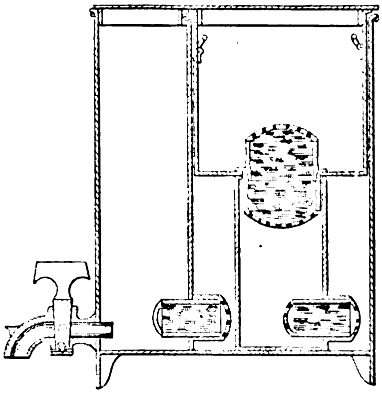


Sponge-Cup for Gumming Labels.

Sponge–fil′ter. One in which water passes through sponge to deprive it of its earthy matters held in suspension.

In the example, the water passes from the upper chamber through sponge into a chamber beneath;

Fig. 5466.



Sponge-Filter.

thence, by one or more tubes filled with sponge, into a compartment which has a discharge-faucet.

Sponge-tent. (*Surgical.*) Used for dilating wounds. It is formed by dipping sponge into hot wax plaster, and pressing it till cold between two iron plates. It is then cut into pieces.

Spon'gi-o-pi'line. (*Surgical.*) A substitute for a poultice, made of an absorbent stratum of sponge and fiber on an india-rubber backing.

Spon'son. (*Shipbuilding.*) The angular space before and abaft the paddle-box against the ship's side.

Spon'son-beam. (*Shipbuilding.*) One of the two projecting beams uniting the paddle-box beam with the ship's side.

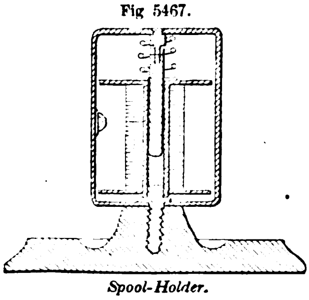
Spon'son-rim. (*Shipbuilding.*) The *wale* connecting the paddle-beam with the ship's side.

Spon-toon'. (*Weapon.*) A pike formerly carried by infantry officers.

Spool. A hollow cylinder upon which thread may be wound. It assumes various forms, — the ordinary spool for sewing-thread; the spool for winding-machines, and otherwise called a *bobbin*: the spool to hold the thread in a shuttle, and revolving on a spindle in the latter.

Spool-hold'er. 1. A stand for a spool or spools of sewing-thread.

Fig 5467.



Spool-Holder.

2. A creel on which spools or bobbins are placed on skewers for warping.

3. A skewer on a sewing-machine to hold a spool of thread.

Spool'ing. The winding of yarn or thread upon *bobbins*: either *pirns*, for netting; *shuttles*, *spools*, or *cops*, for weaving; little wooden *spools*, for sewing; small metallic *spools*, for sewing-machine shuttles, or round bobbins for the machines using the rotary hook below the cloth-plate.

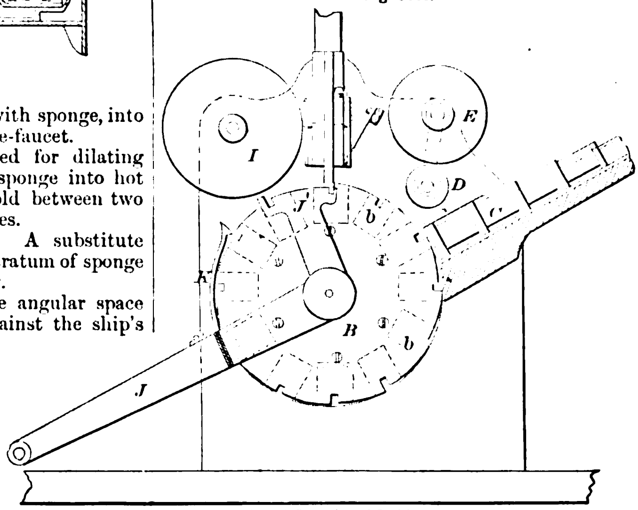
Spool'ing-ma-chine'. (*Cotton-manufacture.*) A machine on which cotton-thread is wound on to wooden spools. The spool is placed on a rotating spindle, and the thread is guided on to it by a steel finger, which delivers the thread in coils, whose layers have a gradually increasing length as the thread is built up against the conical ends of the spool. As each reel is filled, the thread is broken and the end inserted in a notch at the edge of the spool.

Weild's machine for winding sewing-thread upon spools, January 22, 1869, is an automatic machine. It takes the empty spools, winds the thread upon them, stops when they are filled, nicks the edge of the spool, inserts the thread therein, breaks the thread, discharges the filled spools, takes empty ones, starts the machine to wind the thread upon them, and so on continuously.

Spool-la'bel-ing Ma-chine'. A machine for sticking the labels on spools of cotton, etc.

In that illustrated, the spools are delivered consecutively from a trough C into the peripheral pockets $b\,b$ of a cylinder B, which is caused to rotate by the engagement of a catch K on the lever J. E is a paste delivery roller, and D a pasting-roller, which is

Fig. 5468.



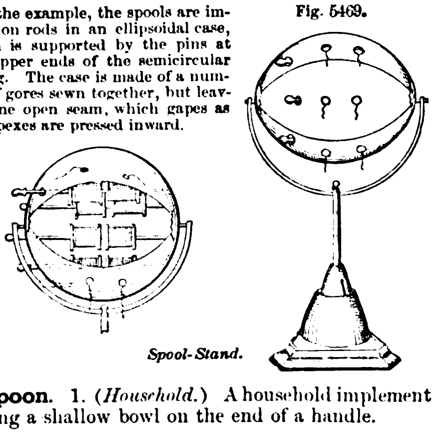
Spool-Labeling Machine.

brought in contact with the end of each spool as it passes by; G is a tube containing the labels, which are pressed downward by a weight, but held within the tube by a catch at each side; this tube drops by gravity at each backward movement of the lever J, bringing the lowermost label in contact with the pasted end of the spool, by which it is drawn between the catches and, passing under the roller I, is pressed securely against the spools. The arm J' lifts the label-carrier out of the way at each backward movement of the lever J.

Spool-stand. A frame for holding various-sized spools for work-table purposes or for exhibition in stores.

In the example, the spools are impaled on rods in an ellipsoidal case, which is supported by the pins at the upper ends of the semicircular spring. The case is made of a number of gores sewn together, but leaving one open seam, which gapes as the apexes are pressed inward.

Fig. 5469.



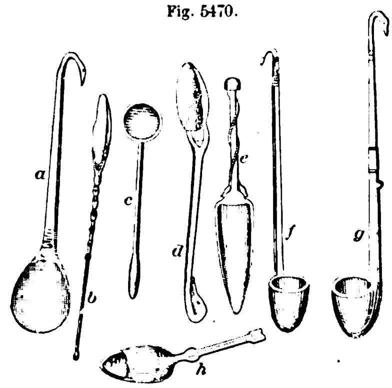
Spool-Stand.

Spoon. 1. (*Household.*) A household implement having a shallow bowl on the end of a handle.

Ancient Egyptian spoons were made shell-shaped, of glass, stone, marble, wood, shell, and ivory. They were handsomely carved. A number are in the Abbott Collection, New York, brought from a tomb at Abouseer (1430 B. C.), Sakkarah, and elsewhere.

The spoons (Fig. 5470, *a b c d e*) are from the collections of Wilkinson, Burton, and Salt. The three on the left are of bronze; the next is of wood, and the right-hand one is of ivory. Others (*f g*) are in the form of dippers or ladles, and resemble the Roman *simpulum*. They were usually of bronze, and

Fig. 5470.



Egyptian Spoons.

frequently gilt. The length of the one represented at *f* is 18 inches; the cup is 3 inches deep, 2¼ inches in diameter. Some of the handles are hinged, others have sliding collars.

The Greeks used spoons at meals. The *cochlear* had a pointed end for picking snails out of the shells, and a flatter end for eating eggs.

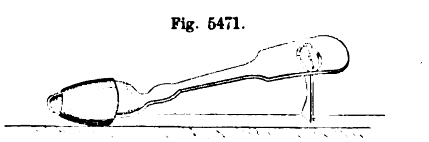
"He needs a long spoon that must eat with the devil." — SHAKESPEARE.

"Paid my silversmith £22 18 *s.* for spoons, forks, and sugar-box." — PEPYS' *Diary*, 1664.

Spoons are made of various materials, sizes, and shapes. The latter for different purposes, — for cooking, serving food, for soup, eggs, mustard, and what not.

Spoons for the use of the mustached, and for the administration of medicine to invalids in a recumbent posture, are made with a shield which converts the pointed end into a funnel. *h* is a modern mustache-spoon.

Fig. 5471.



Medicine-Spoon.

2. (*Cotton-manufacture.*) A weighted and gravitating arm in the stop-motion of a drawing-machine, which is kept in position by the tension of the sliver, and falls when the sliver breaks or the can is emptied, and thereby arrests the motion of the machine.

Spoon-bit. A wood-boring tool adapted to be used in a brace. It has a rounding end, assuming a conoidal form, terminating the grooved semicylinder which constitutes the *barrel* of the tool. See BIT, Fig. 693, *b*.

Spoon-chis'el. A bent chisel with the basil on both sides, used by sculptors.

Spoon-gouge. (*Joinery.*) A gouge with a crooked end, used in hollowing out deep parts of wood.

Sports'man's Knife. One containing a number of tools, to be used in emergencies.

Spot-lens. (*Optics.*) A condensing lens in a microscope, in which the light is confined to an annular opening, the circular middle portion being obstructed by a *spot*, which forms the dark background behind the semi-translucent illuminated object.

Spout. 1. The discharging chute, ajutage, or tubular ventage of a vessel or machine whence issues the liquid or comminuted material; as, the spout of a pitcher, the issuing nozzle for the ground meal from the mill-stones, etc. See AJUTAGE.

2. (*Mining.*) *a.* A channel of the same size as the air-head, driven from the air-head into the gate-road at intervals of about fifteen yards, so as always to keep the communication as forward as possible.

b. The chute which carries the coal or ore from the wagon and dumps it into a car or ship.

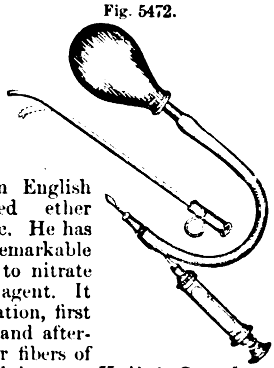
Spout-plane. (*Carpentry.*) A round-soled plane used in hollowing out stuff for spouting and troughs.

Spray. 1. (*Founding.*) A set of castings attached by their individual *sprues* to the main stem, which occupy the runner and its branches by which the metal entered the mold and was led to the various places it was required to fill.

2. The vapor from an atomizer.

Spray-in'stru-ment. (*Surgical.*) One for the administration of an anæsthetic or refrigerant in a finely divided liquid form. See ATOMIZER, page 183; ANÆSTHETIC APPARATUS, pages 92, 93; FOOT-BELLOWS, Fig. 2062.

Fig. 5472.



Huckley's Spray-Instrument for the Eustachian Canal.

Fig. 5472 is an instrument for the eustachian canal.

Dr. Richardson, an English physician, introduced ether spray as an anæsthetic. He has lately made some remarkable statements in regard to nitrate of amyl as a remedial agent. It causes extreme relaxation, first of the blood-vessels, and afterward of the muscular fibers of the body, being useful in cases of spasmodic diseases, including tetanus and spasms produced by strychnia and in *angina pectoris*. It is deemed possible that hydrophobia may be brought under the range of successful treatment. See also Fig. 1814.

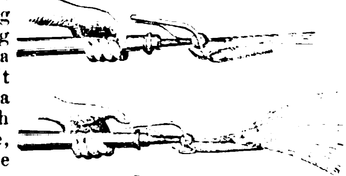
Spread'er. 1. (*Flax-manufacture.*) A machine in which the *stricks* of *line*, fresh from the *heckle*, are drawn out and combined so as to make a *sliver*, and eventually a *roving*, to be operated upon by the spinning machinery.

A first, second, and third drawing gradually attenuate the material, which, in the first place, is fed upon a feeding apron, but in the subsequent operations is fed as a sliver. A number of slivers are doubled and drawn, and the operation in this respect resembles the drawing-frame of the cotton-manufacture, but the flax-machine has a series of combs or *gills*, through which the slivers are drawn. This feature — of pins to imitate the action of the fingers in holding or retaining the flax with regularity as it is drawn out by the rollers — has given a name to the machine, which is called the *gill-frame* or *gill-head*, probably from the French word *aiguille* (needle).

The machine for which the *gill-frame* was substituted was one with a succession of rollers, over and under which the *line* was passed.

2. A device for flattening and spreading the jet from a hose-pipe. It consists of a flat blade with thumb-piece, pivoted at the end of the noz-

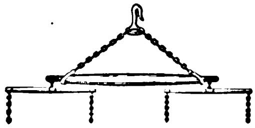
Fig. 5473.



Jet-Spreader.

zle, and thrown up to receive the impact of the stream and spread it into a sheet by pressing on the thumb-piece; in its normal position it is kept down by a spring.

Fig. 5474.



Spreader.

3. (*Vehicle.*) A stick which stretches apart the ends of a chain to which the single-trees are attached. It is a substitute for a double-tree, the hook at the midlength of the chain being attached to the pole-iron, to a log-chain, or what not.

Spread'ing-frame. (*Flax-manufacture.*) A machine in which a number of *stricks* or slivers of flax are spread and conducted to a system of drawing-rollers, whereby they are united and drawn into one. See DRAWING.

Spread'ing-fur'nace. (*Glass.*) A heated chamber in which cracked cylinders of sheet-glass are laid, in order to spread out into sheets. The glass is blown into *pears;* elongated into *cylinders;* cracked longitudinally by a cold iron or cut by shears; flattened in the spreading-furnace; and annealed in the *leer*, which is immediately adjacent and in communication with the furnace. See SHEET-GLASS.

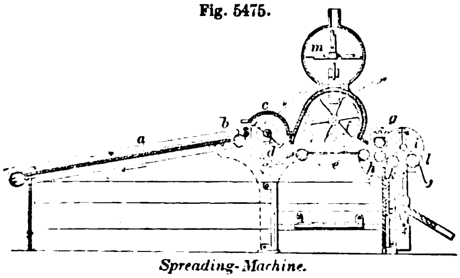
Spread'ing-ham'mer. The second hammer of the gold-beater, used after the *quartiers* are packaged with interleaves of vellum (Fr. *marteau à chasser*).

It is more convex than its predecessor, the *commencing-hammer*, has a face 2 inches in diameter, and weighs 4 or 5 pounds. See GOLD-BEATER'S HAMMER, page 993.

Spread'ing-ma-chine'. (*Cotton-manufacture.*) A machine in which cotton is subjected to the batting process and formed into a continuous band ready for carding.

The cotton is laid upon the endless feed-cloth *a* and fed between the nipping-rollers *b*, whence it is drawn into the drum *c* and subjected to the action of the revolving batting arms *d*, by which the dirt is beaten out of it. It is then received upon a second feed-cloth *e*, and being compressed between this and the roller *f* is carried between the two rollers *g h*, pressed together

Fig. 5475.



Spreading-Machine.

by weights, and is finally wound upon the roller *i*, which is held down upon two other rollers *k l*, so that the band of fiber is compacted as it winds upon the first-named roller. The feed-cloth *a* is divided into equal parts by transverse lines, so that by increasing or diminishing the equal weighed amounts of cotton laid upon each division different thicknesses of batting may be produced. The dust arising during the process is carried off by the fan-blower *m*. See SCUTCHER.

Spread'ing-ov'en. (*Glass-making.*) The FLATTENING-FURNACE (which see).

Spread'ing-plate. (*Glass-making.*) A flat hearth-stone or plate on which a split cylinder of glass is placed, to be opened into a flat plate. See FLATTING-FURNACE; CYLINDER-GLASS.

Spread Win'dow-glass. See SHEET-GLASS.

Spren'gel-pump. An air-pump or aspirator (see Fig. 393, page 170). It is considered in a paper by W. Crookes on the Atomic Weight of Thallium, Phil. Trans. 1873, Vol. CLXIII. p. 295.

Sprig. 1. *a.* A small square-bodied nail whose head consists of a slightly projecting lip on one side only. A small brad. See NAIL.

b. A brad or triangular piece of tin plate, to confine a pane of glass in a sash until the putty dries.

2. (*Nautical.*) An eyebolt with a barbed shank.

3. (*Fabric.*) A small, isolated ornament of the nature of a branch, woven or printed on textile fabrics.

For the formation of woven sprigs, there are often as many shuttles as colors, or a number of little swivel-looms, such as are used for the weaving of tapes, are introduced occasionally.

Spring. 1. An elastic substance of any kind, interposed between two objects, in order to impart or check motion, or permit them to yield relatively to each other.

The ancients made springs of bronze, which contained only from 3 to 4 per cent of tin. It was, as is supposed, carefully tempered and hammered.

No carriage-springs are found among the nations of antiquity, including the Romans. Carriages were not a general mode of transit until roads were made good. In England, till one hundred years since, the riding-horse and the pack-horse were the principal dependence for travelers and merchants.

The suspension of carriage-bodies by straps was in use about the middle of the seventeenth century. The date of its invention is not known.

Springs of coiled wire are much used for balances, for chair and sofa cushions and backs, mattresses, and in various other domestic applications where no great amount of strength is required. See WIRE SPRING; SPIRAL SPRING; CAR-SPRING, Fig. 1143. See under the following heads: —

Accumulator.	Spring-bar.
Atmospheric spring.	Spring-beam.
Bolster-spring.	Spring-blade knife.
Carriage-spring.	Spring-block.
Car-spring.	Spring-coupling.
Coiled spring.	Spring-draft.
C-spring.	Spring-faucet.
Door-spring.	Spring-head.
Draft-spring.	Spring-hinge.
Draw-spring.	Springing.
Driving-spring.	Spring-lock.
Elliptic spring.	Spring-mattress.
Furniture-spring.	Spring-polisher.
Hair-spring.	Spring-proof.
Half-elliptic spring.	Spring-punch.
Hammer-tail spring.	Spring-seat.
Helical spring.	Spring-tool.
India-rubber spring.	Spring-wagon.
Leading-spring.	Strut-spring.
Main-spring.	Tempering springs.
Pneumatic spring.	Tug-spring.
Proving-machine.	Volute spring.
Spiral spring.	Wagon-spring.
Spring (nautical).	Watch-spring.
Spring-balance.	Wire spring.

2. (*Nautical.*) *a.* A rope or hawser passed from the stern of a ship and made fast to the cable on the anchor from the bow, by which she is riding. The object is to bring the broadside to bear in any direction.

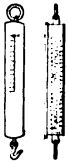
b. A check on a cable while unshackling it.

Spring'al. (*Weapon.*) An ancient form of military engine for throwing stones and darts.

Spring-back. (*Bookbinding.*) A mode of binding in which a spring in the back throws up the folded edge so as to make the leaves lie flatly.

Spring-bal'ance. A balance in which the weight of an object is determined from the tension or compression of a spring provided with an index and scale.

Fig. 5476



Salter's Spring-Balance.

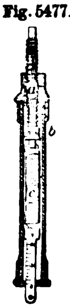
In Salter's spring-balance, the spring is spiral and inclosed in a cylindrical box, at whose upper end is a suspending ring. The hook from which the object to be weighed is suspended is connected by a rod to a piston above the spring, so that the weight has the effect of condensing the spring, a finger on the rod projecting through a long slot in the case and indicating the weight upon a graduated and numbered scale.

In Martin's modification, the interior rod is furnished with a rack moving a pinion on the arbor of an

index-finger, which traverses a circular dial on the outer case. This permits a much more minute reading.

In Fig. 5477, the supporting screw *a* of the spring *b* is connected to the latter by a swivel-joint, to allow of the rotation of the screw, in order to adjust the zero of the scale to the bottom of the case *c*. The highest graduation visible indicates the weight of a body suspended from the scale.

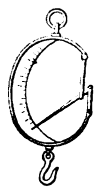
Fig. 5477.



Spring-Balance.

Another spring-balance is made in the form of a letter C, the upper end being suspended by a ring, and the lower end affording attachment for the hook whereby the object is suspended. As the *bow* opens a finger traverses a graduated arc and registers the weight.

Fig. 5478.



Spring-Balance.

Harris' spring-balance has a semicircular spring in a case, the straightening of the spring moving a rack, pinion, and index-finger, which traverses a dial-plate having in concentric circles the various systems of weights of different countries within the range of its compass.

Marriott's has an elliptical spring somewhat similarly placed.

Regnier's dynamometer has an elliptic spring. See DYNAMOMETER for this and several other spring-balances.

Spring-bal'ance Valve. (*Steam.*) A spiral spring weighing-balance, with an index and pointer attached to the end of the lever, by which the pressure upon the safety-valve is adjusted.

Spring-bar. 1. (*Saddlery.*) A stirrup-loop with a spring side which opens to release the stirrup-leather if a rider be thrown from the saddle, but remains closed under ordinary circumstances.

2. (*Vehicle.*) A bar parallel with the axle and resting upon the middle of the elliptic spring. The *body* rests by loops upon the ends of the spring-bar.

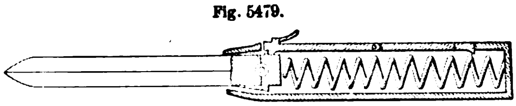
Spring-beam. 1. (*Shipbuilding.*) The fore-and-aft timber uniting the outer ends of the paddle-box beams. The *sponsons* are curved timbers uniting the spring-beam to the sides, fore and aft of the paddle-box.

2. An elastic bar at the top of a tilt-hammer, mortising-machine, or jig-saw, to accelerate the fall or give the return motion, as the case may be.

3. (*Carpentry.*) A beam stretching across a barn without a central support, so as to leave the two bents of the barn floor free for various uses.

Spring-blade Knife. A pocket-knife whose

Fig. 5479.



Spring Dirk-Knife.

blade is thrown out or held out by a spring. In the ordinary pocket-knife, the blade is held by the spring in open or closed position.

In the example, the blade is projected longitudinally from the handle by a spiral spring; catches on the handle maintain it in either its projected or retracted position.

Fig. 5480.

Spring-Block.

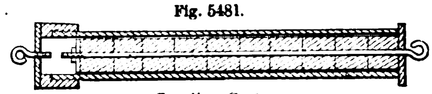
Spring-block. (*Nautical.*) A common block or dead-eye connected to a ring-bolt by a spiral spring. It is attached to the sheets, so as to give a certain amount of elasticity and assist the vessel in sailing. Invented by Hopkinson.

Spring-board. (*Gymnastics.*) An elastic board used in vaulting.

Spring-box. The barrel containing the spring in a watch or other mechanism. The *barrel.*

Spring-coup'ling. A connecting device between cars, for attaching the draft-team to street-cars, etc. The example is a series of india-rubber cylinders inclosed in a frame of rods, and with two end disks to which

Fig. 5481.



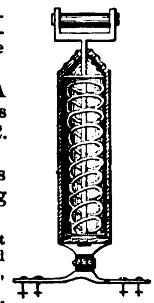
Coupling-Spring.

the coupling-ring and hook are respectively connected, so as to condense the caoutchouc when a strain is brought upon it.

Springs have been used for tugs in attaching draft animals to loads. They present an elastic resistance when the animal pulls, and tend to save him from the strain incident to sudden jerks.

The clip at the end of the spring is attached to the vehicle, and the roller is attached either behind the single-tree of the horse or at the end of his trace-tug.

Fig. 5482.



Draft-Spring.

Spring'er. (*Architecture.*) *a.* A lower voussoir of an arch. One rests on each *skewback*, *abutment*, or *impost*.

b. The rib of a groined roof.

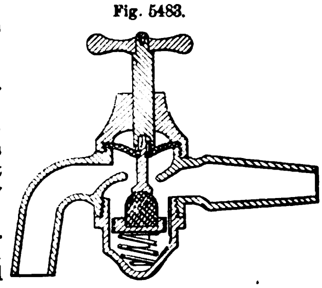
Spring-fau'cet. One which is closed by a spring when the opening force is withdrawn.

In Fig. 5483, the valve is depressed against the force of the spring by a key entered above. When the pressure is withdrawn, the spring forces the valve against its seat.

In Fig. 5484, the ball-valve is kept to its seat by a spring-plunger, excepting when the plunger is withdrawn.

In Fig. 5485, the tube has a flexible lining, which is compressed by a spring-stopper at one point; pressing down this spring permits the flow of the liquid.

Fig. 5483.

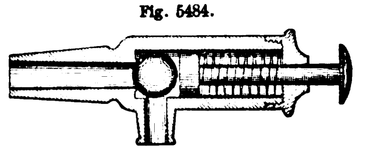


Self-Closing Faucet.

Spring-fore'-lock. A cotter-key whose entering end springs apart to keep it from accidentally withdrawing.

Spring-gun. (*Weapon.*) A gun which is fired by the stumbling of a trespasser upon it or against a wire connected with the trigger.

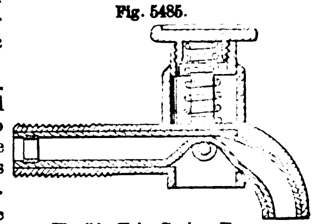
Fig. 5484.



Spring-Faucet.

Spring-head. A box, clutch, or connection at the point of contact of the outer ends of an elliptic spring.

Fig. 5485.



Flexible-Tube Spring-Faucet.

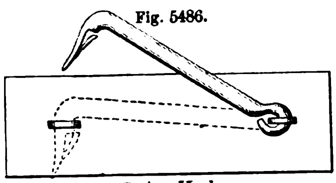
Spring-hinge. A hinge provided with a spring to shut it after the door to which it is attached is opened.

A beautiful elastic spring-hinge is attached by the mason-spider of the Tropics and Southern Europe to the earth-kneaded door of his cell. The cell is subterranean and tapestried with silk; the door closes of itself after each entrance and exit of the

cavern's occupant, and so neat is the fit that it is almost impossible to distinguish the line of junction of the door and the cellar-way even when the observer has just witnessed the closure of the lid.

Spring-hook. 1. A hook having a spring-latch to prevent disengagement.

Fig. 5486.



Spring-Hook.

2. (*Steam-engine.*) In the English practice, one of the hooks fixing the driving-wheel spring to the frame of a locomotive-engine. A screw on the end of the hook regulates the weight on the driving-wheels.

Spring'ing. (*Architecture.*) The bottom stone of an arch which lies on the impost. A *springer.*

Spring'ing-line. (*Architecture.*) The line from which an arch rises. The line of the *springers* on the *imposts*, and from which the *versed sine* or *rise* is calculated.

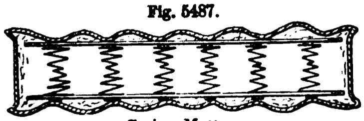
Spring-latch. One that snaps into the keeper after yielding to the pressure against it.

Spring-line. In a ponton-bridge, a line passing diagonally from one ponton to another.

Spring-lock. (*Locksmithing.*) A lock in which the bolt slips back when the catch or hasp is applied and returns by a spring to engage the *hasp, catch,* or *staple.* It is thus *self-locking.*

Spring-mat'tress. One having metallic springs beneath the hair or moss filling.

Fig. 5487.



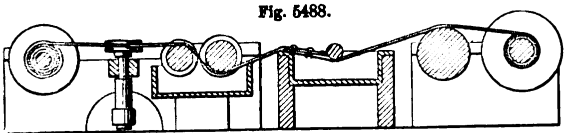
Spring-Mattress.

Spring-pin. (*Locomotive.*) In the English practice, a rod between the springs and axle-boxes, to regulate the pressure on the axles.

Spring-pol'ish-er. A machine for polishing wire or flat metallic ribbon-steel for springs.

In the example, from the burring-rollers the spring is conducted between the burnishing-rollers, which act on the opposite surfaces of the spring simultaneously. It then passes

Fig. 5488.



Machine for Polishing Metal Springs.

through the bath of molten lead, into which it is depressed by a roller. The bath has a bluing heat, and the spring after leaving it is wound on a reel.

Spring-proof. The strength and temper of springs is tested by suspending from them a weight or causing them to be subjected to a strain equivalent to a certain weight adapted to their capacity.

The main-spring of United States small-arms is proved (1) by a weight of 70 to 75 pounds, which should cause the spring to bend to a given mark without breaking or setting; (2) by being required to stand at the position of full cock for 12 hours in a spring-proof containing 35 main-springs.

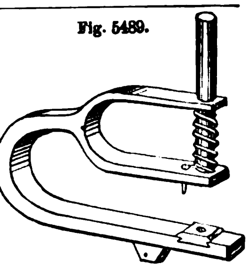
The sear-spring is required to sustain a strain of about 20 pounds.

Spring-punch. One which has a spring to retract the plunger after the blow or the pressure, as the case may be.

Fig. 5489 is designed to be used by blacksmiths in punching bar-iron, and held in place upon the anvil by the lug, which enters a hole in the face of the anvil.

Fig. 5490 is a hand-punch which has a spring to open the handles, and so withdraw the plunger from the ticket which has been punched.

Fig. 5489.

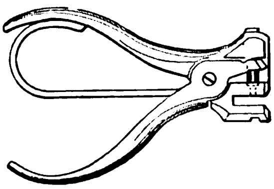


Spring-Punch

Spring Safe'ty-valve. (*Steam-engine.*) One arranged to resist a definite amount of steam pressure, through the medium of a spring or springs.

Spring-search'-er. A steel-pronged tool to search for defects in the bore of a cannon.

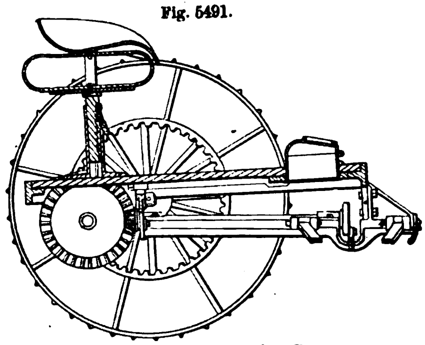
Fig. 5490.



Hand-Punch.

Spring-seat. (*Vehicle.*) A seat having a spring or springs beneath it, and placed in a wagon, on a sulky plow, rake, or harvester. These vehicles not having springs between the bed or frame and the axle, the seat itself is made to rest on springs.

Fig. 5491.



Mowing-Machine Spring-Seat.

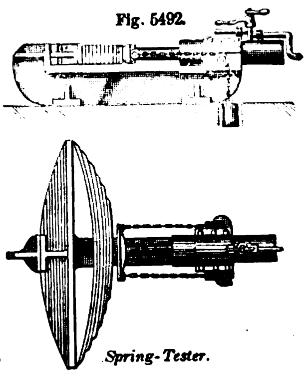
Fig. 5491 shows a spring-seat applied to a mowing-machine.

Elliptic, half-elliptic, S-shaped, spiral, and caoutchouc springs are used for this purpose.

Spring-spike. A spike with a spring, used for temporarily spiking a gun.

Spring-stay. (*Nautical.*) A preventer stay, used to assist a principal stay.

Fig. 5492.



Spring-Tester.

Spring Take-up. (*Knitting-machine.*) An elastic finger fixed to the needle-carrier, to take up the slack yarn at the end of each stroke. The spring take-up has an eye formed in its end, through which the yarn is passed. The yarn passes

around pins or guides to and from the spring take-up.

Spring-test'er. A form of hydrostatic press adapted to the compression of railway-car and locomotive springs, to test their integrity and strength.

In using the machine, the accumulator is charged with air at a pressure of about 300 pounds per square inch, the power-pumps are started, and water is pumped into the accumulator until the requisite pressure is attained, which is indicated by the rising of the safety-valve. On opening the stop-valve, the accumulated pressure acts suddenly on the ram and compresses the spring.

Spring-tool. (*Glass-making.*) The light tongs of the glass-blower whereby handles and light objects are grasped.

Fig. 5493.

Spring-Tool.

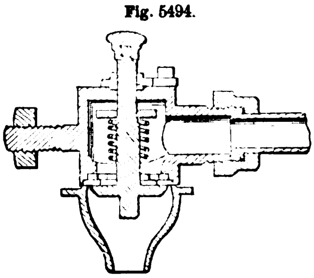
Spring-trap. 1. One whose falling bar or door is operated by a spring as soon as the detent is released by the tampering with the bait by the animal. See TRAP; ANIMAL TRAP.

2. A form of steam-trap.

Spring-valve. One in which the valve is held to its seat by a spring, except as temporarily depressed by the hand to allow the flow of water.

The valve-stem has a fixed and a removable disk. The former constitutes the valve, and the latter forms a bearing for one end of a spiral spring, the other end of which rests against a perforated disk fixed in the case. The valve-seat is of rubber. The water is admitted by depression of the stem.

Fig. 5494.



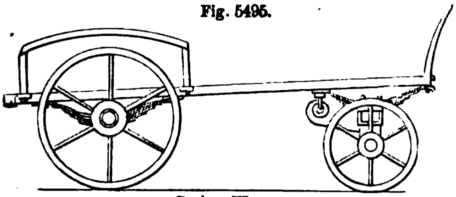
Spring-Valve.

Spring-vise. 1. One whose jaws have an appreciable amount of grip by the force resident in a compressing spring.

2. A small vise used for confining the main-spring of a gun-lock when the lock is to be taken apart. They are issued to the troops in the proportion of one to each ten muskets.

Spring-wag'on. One whose bed rests by springs on the axles. In the example, the bed rests by springs on the hind axle, and the front is supported by springs on the bolster of the fore axle; volute spring-braces attach the bed to the bolster.

Fig. 5495.



Spring-Wagon.

Sprink'ler. A form of watering-pot as old as the Greek and Roman times. It had a bottom with fine perforations and a single hole at top. It was filled by submerging it in water; then, being held vertically, the water would not run out so long as the upper hole was closed by the pressure of the finger.

a in the figure is from Fludd's work, "De Naturæ," 1618. *b* is a glass sprinkler found in Pompeii. The part shown in outline had been broken off before the discovery. It is on the same principle as the wine-taster or *velinche*. *c* is also of glass, and is supposed to have been a wine-taster, the liquid having been drawn by suction at the small end, or, as Ewbank conjectures, by simply immersing the larger end in a vessel and stopping the small end with the finger, as is practiced at the present day. See THIEF-TUBE.

Fig. 5496.

Sprinklers.

(*a*, Fludd, 1618.) (*b*, *c*, Pompeii.)

The clothes-sprinkler *à la Chinoise* is the mouth, which discharges the water in a splutter of spray.

Sprit. (*Nautical.*) A diagonal spar which raises the peak of a boat's sail, the lower end resting in a becket called the *snotter*. It serves instead of a *gaff*.

Sprit'sail. (*Nautical.*) *a.* A four-cornered sail, bent to the mast at its weather-leech, and having its peak extended by a raking spar called a *sprit*. The *heel* of the *sprit* rests in a *grommet* (*snotter*), which may be slipped on the mast. It is a common form of sail for boats.

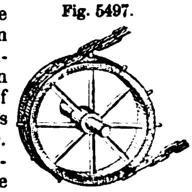
b. A sail set on the bowsprit.

Sprit'sail-yard. (*Nautical.*) A spar, occasionally used, crossing below the bowsprit a little abaft of the dolphin-striker, and used for securing the rigging of the jib-boom and flying jib-boom.

A pair of spars pointing obliquely downward at opposite sides of the bowsprit are sometimes used instead of the *spritsail-yard*. These spars are known as *spritsail-gaffs*.

Sprock'et-wheel. A wheel whose projecting pins are adapted to receive the links of a chain. The latter may communicate motion to the wheel, or conversely. The relative distance of the links on the chain is equal to the peripheral distance apart of the pins on the wheel, and the engagement of the links with the pins prevents slipping. See Fig. 1230, page 520.

Fig. 5497.



Sprocket-Wheel.

By a modification, the sprockets may be forked, and thus made to partially embrace the links of the chain, instead of being pointed and entering into the links. Such are seen on some forms of water-elevators.

Spruce. (*Leather.*) Prussia leather; *pruce.*

Sprue. (*Founding.*) *a.* The *ingate* of a mold, through which the metal is poured.

b. The piece of metal attached to a casting, occupying the *gate* through which the metal was poured. As the metal rises in the *gate* it indicates that the mold is filled, and when cooled the *sprue* is knocked off.

Fig. 5498.

Molders' Sprue.

The *sprue* of a type is called a *jet*.

c. A piece of metal or wood used by a molder in making the *ingate* through the sand.

Spud. 1. (*Husbandry.*) A sharp, straight, narrow spade, with a long handle. It is used for digging post-holes, and digging out heavy-rooted weeds, such as burdock, wild parsnip, elecampane, thistles, iron-weed, etc.

2. (*Well-boring.*) A spade-shaped implement, used in fishing for broken tools in a well.

Spun-gold. A flatted silver-gilt wire, wound on a thread of yellow silk. GOLD-THREAD.

Spun-silk. A cheap article produced from short-fibered and waste silk, in contradistinction to the long fibers wound from the cocoon and *thrown*. See SILK. It is frequently mixed with cotton.

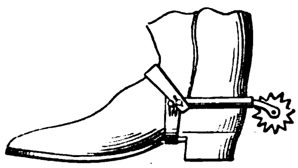
Spun-sil'ver. Thread of coarse silk, or *singles*, wound with flattened silver wire.

Spun-yarn. (*Nautical.*) A line formed of a number of yarns twisted together, but not *laid up*. Used for seizings, serving, etc.

Spur. 1. (*Manege.*) An instrument attached to the heel, and having a rowel or wheel of points to prick a horse's side.

Spurs were used by the Greeks and Romans. They are referred to by Plautus (died B. C. 184) and by other Latin authors.

Fig. 5499.



Spur.

The *rim* is the part inclosing the heel of the boot; the *neck*, the part between the *rowel* and the *rim*; the *rowel*, a wheel with sharp radial points.

Spurs are represented on seals of the eleventh century. They were common among the Saxons, being made of brass or iron, and fastened to the shoe by a leathern thong. Instead of a rowel, the rear had a single fixed, sharp point. The rowel is noticed in the reign of Henry III. Anciently the knight wore golden spurs, and his squire spurs of silver.

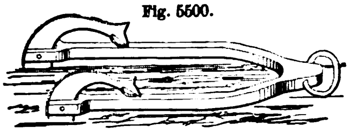
2. (*Shipbuilding.*) *a.* A shore extending from the bilgeway, and fayed and bolted to the bottom of the ship on the stocks.

b. A curved piece of timber, serving as a half-beam to support a deck where a hatchway occurs.

c. A compass timber or knee, having one arm bolted to the deck-beams and a vertical arm bolted to the bitts, which are additionally secured thereby.

3. (*Nautical.*) *a.* A sole with spikes, to enable a seaman to stand on a whale while flensing.

Fig. 5500.



Anchor.

b. A prong on the arm of some forms of anchor, to assist in turning the lower arm from the shank.

4. (*Hydraulic Engineering.*) A projection carried out from the bank of a river to deflect the current and protect the bank. It is made of masonry, of piles, or of earth revetted by gabions or fascines. See GROIN; CROY.

5. (*Carpentry.*) A strut or brace strengthening a rafter, or stiffening a post.

6. (*Architecture.*) A buttress.

7. (*Fortification.*) *a.* A tower or blockhouse in the outworks before the port.

b. A wall that crosses part of a rampart and connects to the interior work.

Spur-gear'ing. One with radial cogs. See SPUR-WHEEL.

Spur'ling-line. (*Nautical.*) *a.* A line from the steering-wheel to the *tell-tale* in the cabin, by which the position of the tiller may be observed without going on deck.

b. A line with *fair-leaders*, for running ropes.

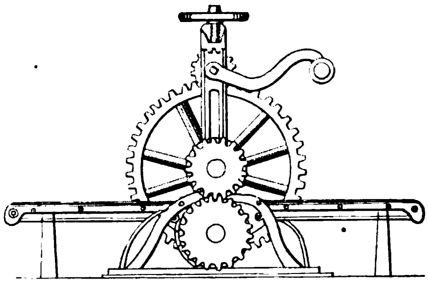
Spurn. (*Mining.*) *Spurns* are small ties or connections left between the coals hanging and the ribs and pillars, to insure safety to the miner during the operation of cutting.

Spurn-wa'ter. (*Nautical.*) A channel at the end of a deck, to restrain the water.

Spur-wheel. The ordinary form of cog-wheel. The cogs are radial and peripheral, and are adapted to engage counterpart cogs on another wheel. See list under GEARING.

The pitch-lines of the *driving* and the *driven* wheel are in one plane.

Fig. 5501.



Spur-Gearing.

Proportions of wheels. Spur and bevel gear: —

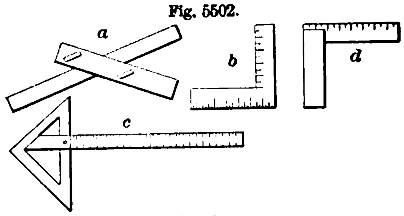
Height of tooth	= $^{12}/_{15}$ths of pitch.
Height below pitch line	= $^{13}/_{30}$ths "
Height above pitch line	= $^{11}/_{30}$ths "
Thickness of tooth	= $^{19}/_{40}$ths "
Breadth of wheel	= $2\frac{1}{2}$ times the pitch.
Edge of rim	= space.
Feather under rim	= "
Thickness of feathers	= thickness of tooth.
Breadth of arms	= pitch × 2.
Thickness round eye	= pitch.
Feather round boss	= length of tooth.

Sputch'eon. The inner part of the mouthpiece of a sword scabbard, which retains the lining in place.

Spy-glass. A telescope. The term is rather maritime.

Square. 1. An implement used by artificers for laying off lines to which work is to be sawed or cut. It consists essentially of two pieces at right angles to each other, one of which is sometimes pivoted, so

Fig. 5502.



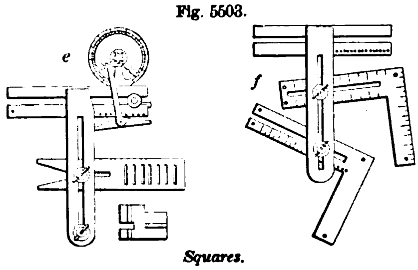
a, *T-square* and *Bevel*.
b, *Machinists'* flat, steel square.
c, Ames's *Universal* square.
d, *Steel* square; *try*-square; *trial*-square.

that other angles than a right angle may be scribed or measured.

The *miter*-square is a bevel-square, set to an angle of 45°. See also BEVEL-SQUARE, Fig. 670, page 279.

e, *f*, are squares for laying off complex joints. The first is provided with a short straight-edge attached to an arm with a segment-rack meshing with a pinion carrying an index and

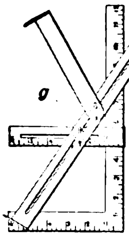
Fig. 5503.



Squares.

graduated circle or arc, enabling small angles to be laid off and measured; also, a supplementary arm, having longitudinal transverse and angular adjustments on the principal arm. The

Fig. 5504.



Square.

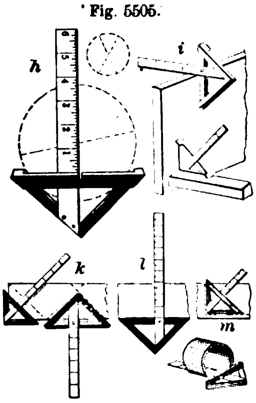
second has two supplemental graduated squares having all three of these adjustments.

In *g*, the sliding bar moves along one arm of the graduated square. The straight-edge is clamped to the bar by a set-screw. The relative positions are adjusted by the set-screws in the elongated slots of the bar and straight-edge.

The square, Fig. 5505, combines *five different instruments*, viz. the try-square, the miter, the T-square, the graduated rule, and the center-square, for finding the center of a circle.

h shows its application as a center-square. Put the instrument over the circle, as the end of a bolt or shaft, with the arms resting against the circumference, in which position one edge of the rule will cross the center. Mark a straight line in this position; apply the instrument again to another part of the circumference, and mark another line crossing the first. The point where the two lines cross each other will be the center of the circle. *i* shows the application of the instrument as a carpenter's try-square and an outside-square, *k* as a miter, *l* as a T-square and a graduated rule, *m* as an outside-square for drawing and a T-square for machinists.

Fig. 5505.

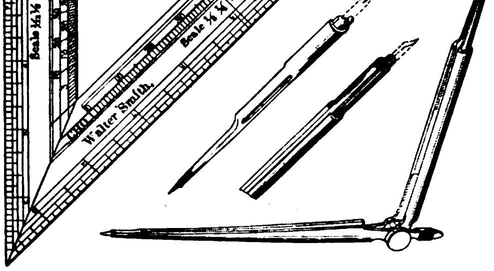


Ames' Universal Square.

The school-square of Walter Smith is a drawing-implement formed of two sides of a square connected by a diagonal, the outer edges provided with various scales, and the inner with a scale of angles, forming in one implement a square, triangle, and protractor. It stands in the place of a number of separate instruments, — the rule, set-square, scale, and protractor.

The other figures represent a pocket instrument, containing a circle-pen, a writing-pen, dividers, and pencil-holder. The instrument has a reversible extension leg, which has a fixed point, a pencil-holder, and a pen-holder slide.

Fig. 5506.

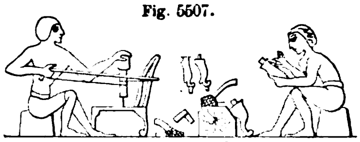


Smith's School-Square and Dividers.

Theodorus of Samos was probably a very successful architect, but it is not likely that he was, as Pliny states, the inventor of the square and the level. The builders of Athens, Thebes, and Sparta, and the early cities of the plains of the Euphrates and Tigris, we may reasonably suppose, had squares, levels, and plumbs, as well as the hammer and lever credited by the same Pliny to Cinyra of Cyprus.

It will surprise no one who knows what *good work*, *square work*, was made by the ancient Egyptians to be informed that they used a square, but the association of the tools in the accompanying cut brings to our view the state of the art in the year 1490 B. C. The chair-legs were "got out" by the adze and tested by the square in the days when the lathe was not.

Fig. 5507.



Carpenter's Square, etc. (from Thebes).

The square was regarded in ancient times as the sign of completeness. Simonides speaks of a man being "square as to his feet, his hands, and his mind." Aristotle has the same kind of comparison. We yet hear of working and acting "on the square," having accounts "all square," and of "square meals," complete and satisfying.

The square (*norma*) is represented on Roman tombs. In some cases it is a right-angled triangle; in other examples the hypothenuse is omitted, — the modern form. See CARPENTER'S TOOLS, page 473.

The Japanese have iron squares, marked with degrees. Their measures are brass, very light and fluted. On one side the inch, or what stands for the inch with us, is 1 1/16 inches, and divided into ten parts. On the other side is a different scale, measuring 1 13/16 English inches, and divided into twelve parts.

2. (*Nautical.*) *a.* That part of the shank of an anchor to which the *stock* and shackle are attached. See ANCHOR.

b. To *square away* is to square the yards by the braces and run before the wind.

3. (*Bookbinding.*) The projection of a board beyond the book-edge.

4. (*Horology.*) *a.* That portion of the *arbor* on which the winding-key is placed.

b. A similar part on the arbor of the hands of a watch, whereby they are set.

5. (*Glazing.*) A pane of glass.

6. (*Carpentry.*) 100 feet, — that is, 10 × 10; a unit of measurement used in boarding and roofing.

7. (*Printing.*) A certain number of lines in a column, of nearly equal height and width.

Square-file. A file which is square in its transverse section. It is usually taper, and has one *safe* side. It is used as an *entering* file in starting *key-ways* and grooves for *splines*, *cotters*, and *wedges*.

Square-frame. (*Shipbuilding.*) A frame square with the line of the keel, having no beveling.

Square-joint. A mode of joining wooden stuff in which the edges are brought squarely together, without rabbeting, tongue, or feather. See JOINT.

Square-rab'bet Plane. (*Joinery.*) One for making a rabbet at an angle of 90° with the working face.

Square-rig. (*Nautical.*) That rig in which the lower sails are suspended from horizontal yards, as distinguished from *fore-and-aft* rig. See FORE-AND-AFT SAIL.

Square-roof. (*Carpentry.*) One in which the principal rafters meet at a right angle. See ROOF. See Fig. 4420, 10; Fig. 4421, 17.

Square-sail. (*Nautical.*) *a.* A four-sided sail, whose middle position is athwartship. It is supported by a *yard*, *slung* at its mid-length by a *truss* or *parral*. It is distinguished from sails which are extended by stays, booms, gaffs, lateens, sprits, etc.

Of a square-sail, —
The upper edge is the *head*.
The lower edge is the *foot*.
The side edges are *leeches*.

The lower corners are *clews*; they are stretched by ropes called *sheets*, and are drawn up to the *bunt* of the yard by *clew-lines*.

The *bowline* is attached by *bowline-bridles* to the *leech* of the sail, to keep the weather-edge drawn forward when the ship is close-hauled.

Buntlines are in front of the sail, and are for hauling up the foot of the sail to the yard in furling.

Leech-lines pass to the leech, and are for hauling up the leech to the yard in furling.

The *slab-lines* are similar to the *leech-lines*, but pass abaft the sail.

Reef-tackles have a twofold purchase, and are used for hauling up the leeches of courses and topsails to the yard-arms before furling them.

Gaskets are plaited ropes for tying up the furled sail.

b. A sail set on the foremasts of schooners, and on the masts of sloops and cutters, when sailing before the wind in light weather.

Square-sail Boom. (*Nautical.*) A spar used to extend the outer lower corners of square-sails in schooners, sloops, and cutters.

Square-stern. (*Shipbuilding.*) A build in which the wing-transom is at right angles to the stern-post, in contradistinction to *round* stern.

Square-tim′ber. (*Shipbuilding.*) One standing square with, that is, perpendicular to, the keel.

Square-tucks. (*Shipbuilding.*) The flat surfaces left at the stern of a vessel when the planks of the bottom are not worked round to the wing-transom, but end in the fashion-piece.

Squat. (*Mining.*) *a.* Tin ore, mixed with spar.

b. A small separate vein of ore.

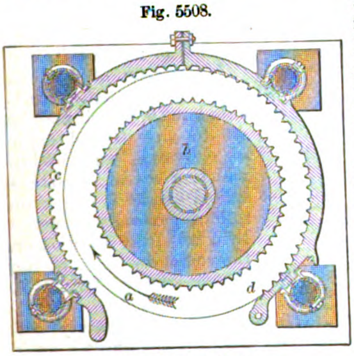
Squee′gee. 1. (*Nautical.*) A scrubber, consisting of a plate of gutta-percha at the end of a handle. *Squilgee.*

2. The same kind of tool is used in wiping superfluous moisture from plates.

Squeez′er. (*Metal-working.*) A machine which takes the ball of puddled iron and reduces it to a compact mass, ready for the rolls. In one form it is a toothed or corrugated wheel or segment, turning within an outer eccentric casing in such manner as to be rolled by the contact of the two, being squeezed between the gradually narrowing space between the surfaces of the wheel and the case.

In Ralston's rotary squeezer the ball of metal is inserted at *a*, and is carried around in the direction shown by the arrow by the ridged roller *b*, which, rotating in that direction, compresses it between itself and the ridged eccentric casing *c* as the sectional area of the space between the two diminishes; expressing the cinder and delivering the ball at the opening *d*.

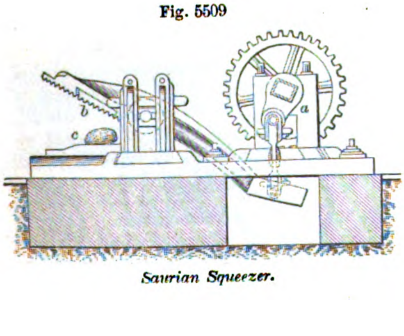
Fig. 5508.



Ralston's Rotary Squeezer.

The Saurian squeezer is so called from its similarity to the jaws of a saurian,—a crocodile, for instance. The upper jaw *b* is moved by a crank *a* on a pivot, in the manner of the movable jaw of a pair of heavy shears. The palate and lower jaw are corrugated. Its office is to compact and shape the ball *c* of puddled iron, and squeeze out the dross.

Fig. 5509



Saurian Squeezer.

Squeez′ing-box. (*Pottery.*) A metallic cylinder having a hole in the bottom, through which clay is pressed for shaping the handles, etc., of earthenware.

Squib. (*Pyrotechny.*) A paper case filled with powder.

Squid-jig′ger. A trolling-hook for catching squids for bait. See patent, Fitzgerald, January 13, 1874, No. 146,443.

Squid-throw′er. A device like a catapult for throwing a fishing-line seaward, carrying the squid-bait. Used in blue-fishing. See patent, Peck, November 10, 1874, No. 156,648.

Squil′gee. (*Nautical.*) An instrument like a hoe, covered with leather, to rub the decks after washing.

Squinch. (*Architecture.*) A small pendentive arch formed across the angle of a square tower to support the side of a superimposed octagon. Also called a *sconce.*

Squir′rel. One of the small rollers, provided with cards, and acting in conjunction with the large cylinder of a carding-machine in opening the knots and bringing the filaments into parallelism. See CARDING-MACHINE.

Squirt. A SYRINGE (which see).

Stab′ber. 1. (*Leather.*) A pegging-awl. A pricker.

2. (*Nautical.*) A marlinspike.

3. (*Domestic.*) A lady's awl for opening holes for eyelets.

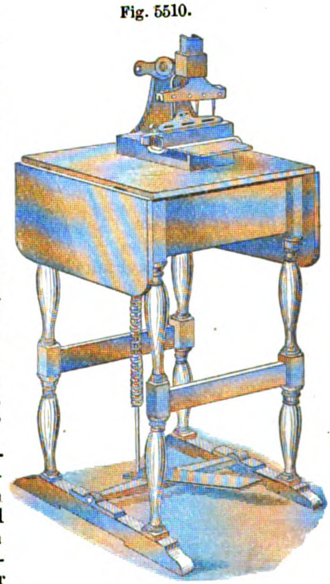
Stab′bing. 1. (*Bookbinding.*) *a.* The puncturing of the boards for the slips.

b. The perforation of a pile of folded sheets for a *stitching* twine. A cheap substitute for *sewing.*

2. (*Masonry.*) The picking or roughening of a brick wall, in order to make plaster adhere thereto.

Stab′bing-ma-chine′. (*Bookbinding.*) A machine for perforating a pile of folded and gathered signatures for the insertion of the *stitching*-thread. It is a cheap substitute for *sewing.* The thread is reeved through these holes a short distance from the folded edge of the signatures and tied.

Fig. 5510.



Stabbing-Machine.

Three awls are adjustably inserted in a vertically sliding head, depressed by means of a treadle; after puncturing the set of sheets, the head is thrown up by a spiral spring when the foot is lifted from the treadle.

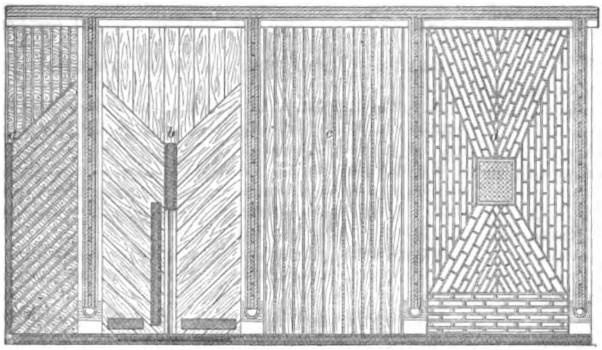
See also No. 114,286, Glass, May 2, 1871; No. 116,757, Reynolds, July 4, 1871.

Stab′bing-press. A bookbinder's press, in which pointed rods are driven through the folded sheets near the back, to stitch them together. A substitute for sewing. See STABBING-MACHINE.

Sta′ble. A house for horses or cattle.

a. A half-plan of stall with wooden block floor. The edges

Fig. 5511.



Jackson's Stable-Flooring.

of the blocks are beveled, forming gutters to prevent the horses from slipping; their surfaces are treated with coal-tar or asphaltum.

b, diagonally laid plank floor; top removed from central gutter.

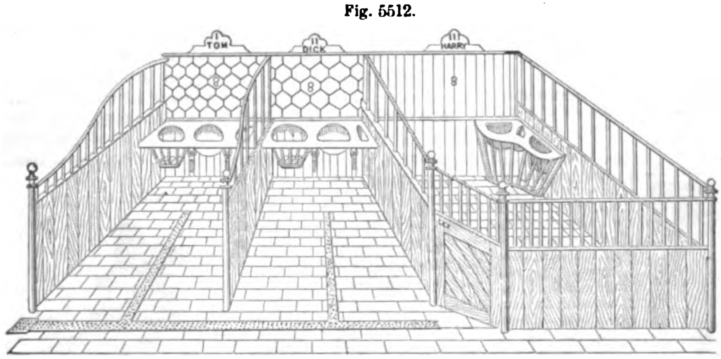
c, floor with slats and interstices, sloping two inches from rear to front.

d, brick floor, with sides sloping toward central cesspool and trap, connecting with drain-pipe.

Besides those shown, a variety of wood-block and concrete floors, and many forms of gratings, are used for stable-floors. The great requisites of a good floor are dryness, warmth, and perfect cleanliness.

Fig. 5512 shows some forms of stable-fittings.

Fig. 5512.



Jackson's Stable-Fittings.

Sta'ble-clean'er. A manure-drag for removing used litter from stables.

Stack. 1. *a.* A chimney of masonry or brick-work, usually belonging to an engine or other furnace. To term a smoke-pipe or metallic chimney a stack is but a loose use of the word, to say the least.

b. (*Architecture.*) A cluster of chimneys.

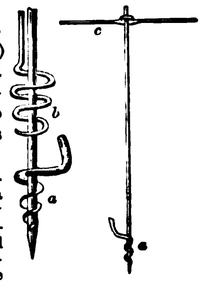
2. (*Husbandry.*) A structure of hay, or grain in sheaves, having, when of perfect shape, a conical top, and a frustum of an inverted conoid for a base.

The term *stack* is applied in the United States to those which are round in plan; *rick* to those which are elongated in plan.

3. (*Military.*) A number of small fire-arms stood up together so that their bayonets cross. See STACKING-HOOK.

Stack-bor'er. (*Husbandry.*) An implement for taking a cylindrical plug out of a stack, so as to admit air when the hay is heating to a dangerous extent.

Fig. 5513.



Stack-Borer.

It consists of two parts, — a leading screw and cutting lip *a*, and a drawing screw *b*. Each is worked by a cross-handle *c*, in the usual manner. The tool *a* is entered first, and cuts out the plug; being then withdrawn, the tool *b* is inserted in the manner of a cork-screw, and withdraws the plug of hay.

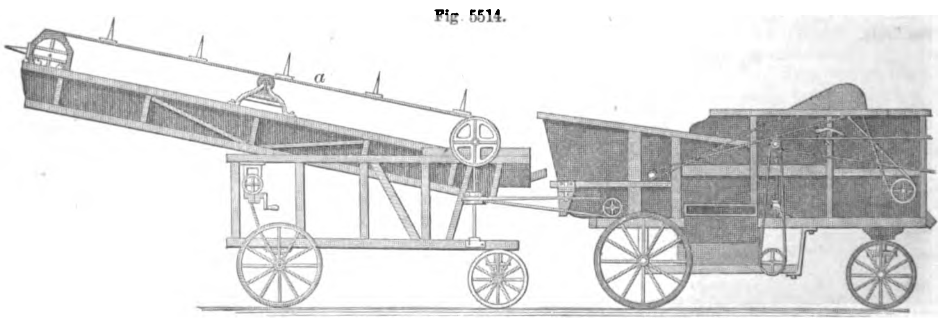
The policy of letting air to the center *after* the heating has taken place is disputed, as it admits oxygen to increase the energy of the action. This, however, does not concern us now. Such is the tool.

Stack'er. A machine adapted for delivering straw from the thrashing-machine on to the stack, or hay from a wagon on to a stack or into a loft.

It consists of a truck carrying a trough of suitable length, which may be set to any desired angle of elevation, and within which a wide, endless spiked band *a* is carried on rollers, generally operated by a belt from a pulley on the screen-cylinder of the thrashing-machine. See HORSE-POWER, Fig. 2570, page 1126.

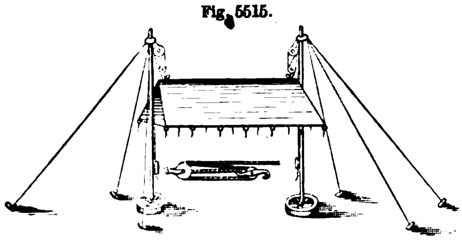
Stack-guard. (*Husbandry.*) A temporary roof capable of elevation, and designed to protect a stack or rick of hay or grain in process of formation; may be made by a couple of poles stayed by guys and

Fig. 5514.



Stacker.

Fig. 5515.



Stack-Guard.

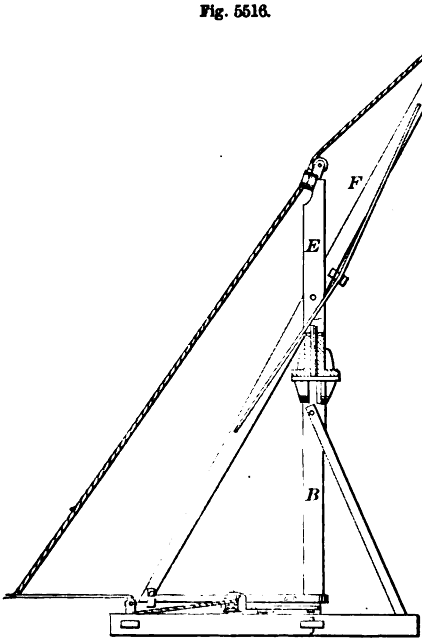
planted in wheels. The awning is stretched upon a frame, and suspended by tackle from each spar.

Stack'ing-band. (*Husbandry.*) A rope used in binding thatch upon a stack.

Stack'ing-der'rick. A form of derrick for use in the field or stack-yard for lifting hay on to the stack.

A horse hay-fork is employed, and is slung from the

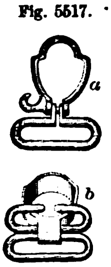
Fig. 5516.



Hay-Derrick.

yard *F*, which is secured by a parral to the topmast *E*; this is swiveled on the post *B*, so as to give circular sweep to the end of the yard. The hoisting-rope passes over pulleys on the yard, mast, and base-piece.

Fig. 5517.



Stacking-Hook, etc.

Stack'ing-hook. (*Fire-arms.*) A hook attached to the upper band of a rifle or carbine, to enable the arms to be stacked without using the wiping-rod or attaching the bayonet. Invented by Lieut.-Col. E. Rice, U. S. A., and adapted for use upon arms manufactured by the government.

a, upper band, with stacking-hook and swivel for sling.

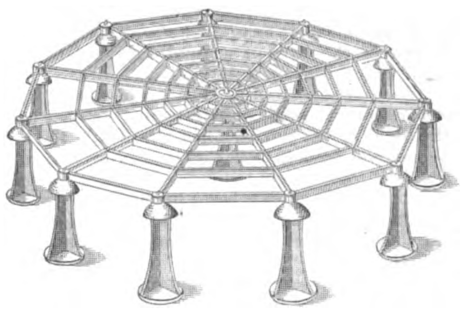
b, upper band, with stacking-swivel and sling-swivel.

Stack'ing-stage. (*Husbandry.*) A scaffold used in building stacks.

Stack'ing-swiv'el. A swivel attached to the upper band of a breech-loading rifle or carbine, to enable stacks to be formed without attaching the bayonet or using the wiper. See STACKING-HOOK.

Stack-stand. (*Agriculture.*) A device for supporting a stack of hay or grain at a sufficient distance above the ground to preserve it dry beneath and prevent the ravages of vermin. It consists of a central foot, around which are arranged a series of pillars, connected to the central one by radial bars; braces connect the pillars and radial bars with each other. The supports are of cast-iron, and the other parts of wrought-iron.

Fig. 5518.



Stack-Stand.

More care is lavished upon stack-stands in Britain than in the United States. A stack-stand in the West is a mere foundation of rails, usually a square of the length of a rail, say 11 feet, or else 11 × 22. Some carry up the sides for a round or two.

The British stack-yard, when conducted in the most approved style, has stands in rows for the reception of grain, the stacks being carefully thatched. On the foundation are erected posts, which support the floor. In the center is an open, pyramidal structure, affording an opening for access of air to the center of the stack.

Stad'da. The double-bladed saw of a comb-maker. See COMB.

Stad'dle. (*Husbandry.*) A circular platform, supported on posts, and designed for a stack-stand, to raise the grain above the reach of vermin.

For large stacks the staddle has several concentric circles, or the annular platform connects by converging-rods with a central post.

Stad'dle-stand. (*Husbandry.*) A stack-stand.

Stad'dle-roof. A protection for a stack.

Stade. 1. A landing, or wharf. A *staith*.

2. A measure of distance. A *stadium*, or furlong. See STADIUM.

Sta-dim'e-ter. An instrument invented by Messrs. Paucellier and Wagner, of the French topographical corps, for ascertaining the distance between two points. It consists of a horizontal, graduated rule, mounted on an upright staff. It is viewed through an inverting telescope provided with a micrometer. The number of divisions of the micrometer that cover a certain number of the divisions on the rule indicates the distance between it and the telescope.

Sta'di-um. 1. An instrument for approximately measuring distances by the visual angle subtended by them. It is made of sheet-metal, brass or silver, and has a tapering slit, on the edges of which are marked the distances at which a man of ordinary size would just appear to fill the aperture when the instrument is held a certain distance from the eye. This distance is regulated by a string held between the teeth.

2. An ancient measure of length, = 600 Greek feet, 625 Roman feet, or 125 Roman paces, = 606.75

feet English. This was the length of the Olympic foot-race course.

Staff. 1. The handle of a tool or implement.

2. A pillar or stake, for support; as the Jacob staff of a circumferenter. See *b*, Fig. 2710.

3. A straight-edge, for testing or truing a line or surface.

4. (*Milling.*) The *proof*-staff, *red*-staff, *tram*-staff, used in testing the face of the stone, or ascertaining whether it runs exactly horizontal.

5. (*Surveying.*) *a.* A graduated stick, used in leveling. See Fig. 2913.

b. A Jacob's staff. See Fig. 2710.

6. (*Plastering.*) A slat placed at a salient angle of an interior wall flush with the plastering on either side, to form a protection thereto. An *angle-staff.*

7. A *round*, *rung*, *rundle*, or *step* of a ladder.

8. One of the bars of a rundle; a certain open style of wagon-bed, made like a crate.

9. (*Shipbuilding.*) A measuring and spacing rule. The *cutting-down* staff is a rod, having marked upon it the hight of the *cutting-down* line above the keel at the several frames. See CUTTING-DOWN LINE.

The *half-breadth* staff is a rod, having marked upon it half the length of each beam in the ship.

The *hight*-staff is a rod having marked upon it the hight above the keel of all the frames at the beam-line of the ship.

The *room and space* staff is for regulating the distances apart of the frames.

10. (*Nautical.*) A pole for a flag. The *ensign*-staff is erected over the stern; the *jack*-staff, over the bowsprit cap.

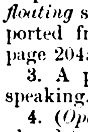
11. (*Surgical.*) A curved and grooved steel instrument introduced through the urethra into the bladder in the operation of lithotomy, and serving as a director for the gorget or knife.

12. (*Music.*) The five lines and four spaces on which notes of tunes are written.

Staff-an′gle. (*Plastering.*) A slat at a salient angle of an interior wall to protect the plastering. See STAFF-BEAD.

Staff-bead. A species of angle-staff. A beaded strip of wood placed at a vertical exterior angle in an apartment, and serving to protect the plastering, and as a guide in *floating*. It is made flush with the surface of the plaster, and is secured by nails to bond plugging or wooden bricks fixed in the walls.

Fig. 5519.



Staff-Bead.

Stage. 1. A landing at a quay or pier. It sometimes rises and subsides with the tide, or is lowered or raised to suit the varying hight of water.

2. A platform on which workmen stand in painting, pointing, calking, scraping, etc., a wall or a ship. A *hanging* stage is suspended by ropes. A *floating* stage rests on the water. A *scaffold* is supported from beneath by poles or framework. See page 2045.

3. A platform or rostrum for acting or public speaking.

4. (*Optics.*) A platform on which an object is placed to be viewed by a microscope.

Stages are of various constructions, as *lever-stage*, *magnetic stage*, *mechanical stage*, etc.

The mechanical stage has horizontal and vertical mechanical movements, sliding object-holder, and revolving fitting.

5. A vehicle traveling on a regular route for carrying passengers.

Stage-coach. A vehicle for passengers running on a regular route.

Stage-coaches appear to have been introduced into Britain by Henry Anderson, who, about 1610, brought them from Stralsund, Pomerania, and was granted a patent for the privilege of running them between Edinburgh and Leith. Some fourteen or fifteen years afterward they had become known in England. In 1659 the Coventry coach is referred to, and in 1661 the Oxford coach, which took two days to reach London (55 miles). In 1669 an Oxford coach ran from London to Oxford in thirteen hours, in summer. In 1742, however, the Oxford stage was still two days on the road. In 1662, owing perhaps to the revolution, there were but six coaches on all the roads in the country, among them one to Aylesbury, next year one to St. Albans. In 1672 they appear to have become so numerous that one John Cresset wrote against them as being mischievous to the public, destructive to trade, and prejudicial to land; they destroyed the breed of good horses, hindered the breed of good watermen, and encouraged the gentry to visit London too often.

A few years previously one of these gentry wrote: "This traval has so indisposed mee yt I am resolved never to ride up again in a coach." How the knights and ladies, of whom, according to his account, his fellow-passengers were made up, stood it, does not appear.

In 1677 there was a Chester, in 1679 a Birmingham, and in 1680 a Bedford coach. In 1682 the journey between Nottingham and London occupied four days (130 miles). The coaches had projections, called *boots*, on each side, where passengers sat with their backs to the body of the carriage. In 1678, Provost Campbell established a coach to run from Glasgow to Edinburgh, "drawn by six able horses, to leave Edinboro' ilk Monday morning and return again (God willing) ilk Saturday night." In 1706 the time between London and York, by coach, was four days, and in 1734 John Dale notified the public that a coach would set out from Edinburgh to London (400 miles) *toward the end of each week*, and perform the journey in nine days being three days less than "any coach that travels that road."

Twenty years later, however, the Edinburgh stage-coach, "a new, genteel, two-end glass machine, hung on steel springs, exceedingly light and easy," took ten days in summer and twelve in winter to perform this distance. In 1754 the prospectus of the "flying coach" set forth that, "however incredible it may appear, this coach will actually (barring accidents) arrive in London four days and a half after leaving Manchester." Three years later the Liverpool flying coach undertook to do the distance between that city and London in three days.

No great improvements in speed were made until Palmer, who, according to De Quincey, was twice as great a man as Galileo, because he not only invented mail-coaches (of more general practical utility than Jupiter's satellites), but married the daughter of a duke and succeeded in getting the post-office to use them. This revolutionized the whole business. The Manchester mail did its 187 miles in 19 hours; the Liverpool mail its 203 miles in 20 hours 50 minutes; the Devonport mail its 227 miles in 20 hours; the Holyhead mail its 261 miles in 26 hours 55 minutes; while the Edinburgh mail traveled its whole distance of 400 miles in 40 hours. Other light coaches carrying passengers only rivaled the mail-stages in speed.

To obtain these results everything was thoroughly systematized, and no expense was spared; little time was lost in changing horses, everything being ready prepared when the coach arrived at each station. The number of horses required was at the rate of each mile; thus the "Wonder" had 154 horses, 154 miles being the distance from London to Shrewsbury. The horses were fine animals, abundantly fed, and rested 23 hours out of the 24, besides remaining quiet every fourth day; their work was, however, very severe while it lasted.

The coaches were built so as to combine great strength with lightness, and were termed paper-coaches by the jehus of the slower turn-outs.

They carried no luggage on the roof, but four outside passengers, one on the box and three behind, and in addition to the coachman were provided with a guard, quite an important official, dressed in the royal livery, whose duty it was particularly to see to the safety of the mails.

Stage-for′ceps. (*Optics.*) A device for holding an object upon the stage of a compound microscope.

Stage-mi-crom′e-ter. (*Optics.*) One adapted to the stage of a microscope, to measure an object within the field of view. Invented by Joseph Jackson Lister.

It consists of a slip of glass, on which lines have been ruled by a diamond, at a certain distance apart, — $^1/_{1000}$, $^1/_{2000}$, $^1/_{5000}$, or $^1/_{10000}$ of an inch. The machine whereby this is effected may be similar to the engraver's ruling-machine, by which the fine sky-tints are ruled on steel-plates. See also NOBERT'S PLATES.

The micrometer is inserted in the eye-piece of the microscope, and so arranged that it may be moved across the field of vision by the aid of a screw.

Stage-plate. (*Optics.*) A glass plate $4 \times 1\frac{1}{2}$ inches, on the stage of a microscope, having a narrow ledge of glass cemented along one edge to hold an object when the instrument is inclined. It may form the bottom plate of a *growing-slide.*

Stage-wag'on. (*Vehicle.*) A vehicle carrying goods on a regular route.

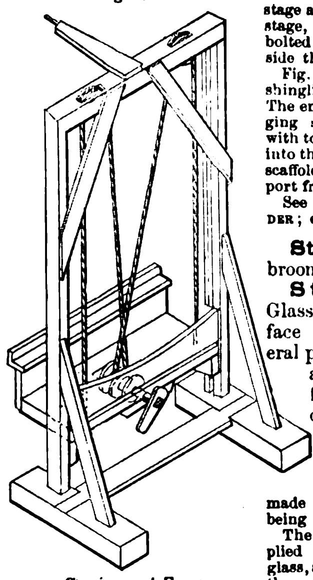
Stag'ger. (*Vehicle.*) To set spokes in a hub so that they are alternately on the respective sides of a median line, in order to give them a broader base, and a consequently greater stiffness to the wheel against lateral strain. The mortises are said to be *dodging*.

Stag'gered Wheel. (*Vehicle.*) One whose spokes are set in and out alternately where they enter the hub.

Sta'ging. A form of scaffold used by builders, painters, and others.

In Fig. 5520, the staging rises between guide-posts, the elevating power being a winch, ropes, and pulleys.

Fig. 5520.



Staging and Frame.

In Fig. 5521, the outer frame has an upper, braced stage and a lower suspended stage, and its uprights are bolted to vertical pieces inside the building.

Fig. 5522 is a staging for shingling or repairing roofs. The ends of the portable staging support are provided with toothed plates, which fit into the roof and prevent the scaffolding placed on the support from slipping.

See also SCAFFOLD; LADDER; etc.

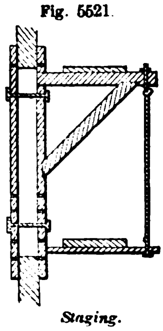
Stail. A mop or broom handle.

Stained-glass. Glass painted on the surface with various mineral pigments, which are afterward fused and fixed by the application of heat.

The glass should be colorless, uniform, and difficult of fusion; crown glass, made with but little alkali, being preferred.

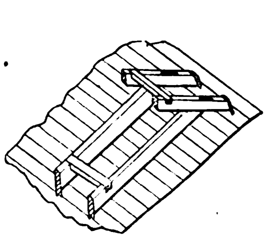
The design on paper is applied to the back of the glass, and the outlines traced through with a fine pencil in dark colors, after which the proper pigments to produce, when burnt, the various colors, are applied to the face of the glass, previously coated with gum-water. Where lights are required, the colors are partially removed by a quill pen without a split. Where two colors adjoin which are apt to run into each other during fusion, one is applied on the back of the glass.

Fig. 5521.



Staging.

Fig. 5522.



Roof-Staging.

The plates are burnt in a close muffle of fire-clay, closed by folding doors of iron having peep-holes, through which the progress of the work may be viewed, and test-strips, containing the several pigments, withdrawn. The plates are laid on a layer of dry sifted lime, sometimes in several layers, with lime interposed between each. The fire is raised very gradually, to prevent cracking the glass, and a full heat is maintained for three or four hours, after which it is gradually allowed to die out to anneal the glass. See GLASS-STAINING, page 983; GLASS-COLORING, page 977.

Stain'ing Wood.

Ebonized black, for moldings, frames, etc.: Strong vinegar, 1 gallon; extract of logwood, 2 pounds; green copperas, ½ pound; China blue, ¼ pound; nut-galls, 2 ounces. Boil in an iron pot over a slow fire; when cool, the mixture is ready for use. Add to the above ½ pint iron-rust, prepared by steeping iron filings in strong vinegar.

Stain for the sap part of black-walnut: Strong vinegar, 1 gallon; burnt umber, dry, 1 pound; rose-pink, ½ pound; Vandyke brown, burnt, ½ pound. Mix, let them stand one day, and apply with a sponge.

Walnut stain for pine and white woods: Very thin sized shellac, 1 gallon; dry burnt umber, 1 pound; dry burnt sienna, 1 pound; lamp-black, ¼ pound. Shake until well mixed. Apply one coat with a brush, sand-paper, and apply a coat of shellac varnish.

Bright rosewood stain: Alcohol, 1 gallon; cam-wood, 1½ pounds; red-saunders, ½ pound; extract of logwood, 1 pound; aquafortis, 2 ounces. When dissolved it is ready for use. Apply in three coats, sand-paper, grain with iron rust, shade with asphaltum, thinned with spirits of turpentine; when dry apply a thin coat of shellac, sand-paper when dry, and varnish.

Satin-wood stain: Alcohol, 1 quart; ground turmeric, 3 ounces; powdered gamboge, 1½ ounces. Strain through fine muslin, and apply two coats with sponge; sand-paper and varnish.

Black stain for pine or white wood: Water, 1 gallon; logwood chips, 1 pound; black copperas, ½ pound; extract of logwood, ½ pound; indigo blue, ½ pound; lamp-black, 2 ounces. Boil over a slow fire; when cool, strain and add ¼ ounce nut-galls.

Crimson stain: Alcohol, 1 quart; Brazil wood, 3 ounces; cochineal, ½ ounce; saffron, 1 ounce. Steep and strain.

Stair. (*Carpentry.*) One of a series of steps for ascending from one story to another.

The *riser* is the vertical portion of a step.

The *tread* is the flat portion on which the feet rest.

The *nosing* is the rounded front edge of a *tread* projecting beyond the face of the *riser*.

A *staircase* is the complete arrangement of supporting frame, casing, balusters, etc.

Flyers ascend in a straight line, and form a *flight*.

Winders ascend spirally, around a solid or open *newel*; or they connect *flights*.

A *well-staircase* has an open *newel*.

A *stairway* is a *staircase* bounded by walls or casing.

A comfortably proportioned staircase is a modern contrivance, unknown to Egyptian, Greek, or Roman.

The first bottom step is the *curtail* step, when its end has a round turn, on which the *newel* or baluster-post is placed. See NEWEL.

The top step is the *landing*.

A resting-place at the end of a flight, midway of the two floors, is a *half-space* or *quarter-space*, according to extent.

Stairs are known by the following names: —

Corkscrew.	Geometrical.
Dog-legged.	Open newel.
French-flight.	Solid newel.

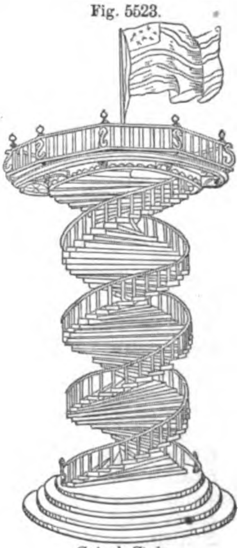
Fig. 5523 is a spiral staircase, in which the steps are perforated at the center and secured upon a central post, so that the respective ends of the steps belong to separate adjacent staircases, at opposite sides of the central post.

Fig. 5524 shows on a larger scale two stairs of a set. The iron stairs are cast hollow, and with an end portion, which forms part of the solid newel in the center. A succession of these pieces forms the stairs.

See also Close's patent, No. 111,610, February 7, 1871, in which a number of segmental plates are arranged in a space above a spiral stairway, and can be operated so as to open or close the stairway, to prevent fire from communicating from story to story of a building, and also to prevent heat from ascending from a lower to an upper story.

Instruments are made for laying out scrolls and curves for stair-work. See SPIRAL; INSTRUMENT FOR DRAWING.

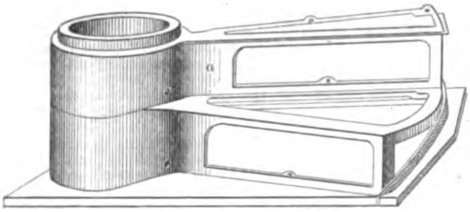
Fig. 5523.



Spiral Stair.

A stair with double risers is economical of room. Each foot

Fig. 5524.

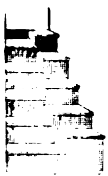


Spiral Stair.

treads its own side of the stairs, ascending a riser at each step, and only advancing at each second step.

Artificial flights of steps are among the most ancient monuments. The pyramids themselves, now that the envelope which filled the steps has worn off, form the most magnificent artificial flights of steps in the world. The stairs at the Nilometer of Elephanta, and those of Benares on the Ganges, are other notable examples; the former are mentioned by Strabo.

Fig. 5525.



Double-Riser Stairs.

Stairs are mentioned several times in the Bible, as are also steps; the *steps* of the altar, of the king's throne, etc.

Great as is the convenience of a stairs or interior flight of steps, it was a comparatively uncommon thing until a recent date, except in the form of a ladder.

The ladder is once referred to in the Bible, in the vision of Jacob, but may be presumed to have been quite a well-known contrivance. We know by the Egyptian paintings that scaling-ladders were common in the wars of the great Pharaohs. Also, that they were a regular part of the military equipment of the Romans.

Perhaps the first notice of regular stairs occurs in the description of Solomon's temple at Jerusalem. This structure was 30 cubits high, say 50 feet, and it may be inferred that the stairs had one exterior and one interior flight.

"The door for the middle chamber *was* in the right side of the house; and they went up with winding stairs into the middle *chamber*, and out of the middle into the third"

The italics are the addenda of the translators. The middle story of the three, which would be called the *first* story in England, and which we call the *second* story, appears to have had a door on the outside, "the right side" to a person facing the principal entrance; but the winding stairs led "out of the middle (2d story) into the third" (story).

If we assume the "winding stairs" to have been of the simplest form, they were made to wind around a central post, the outer edges of the *treads* being supported by a circular wall of posts. The hight of the stories may have been 20, 20, and 10, unless the dimensions given (50 feet perpendicular) include the roof; but this was probably flat, as usual in Palestine. The assumption that the building was after the Greek model is absurd, as the earliest Greek order, the *Doric*, did not commence till 350 years afterward. Persons with Masonic enthusiasm, without a Mason's knowledge, in stating that the order was Corinthian, have anticipated Callimachus 650 years. The Corinthian order was unknown until the period of the Macedonian conquest of the southern states of Greece.

The staircase of the *Scala Santa* at Rome consists of three flights. The middle one has 28 steps, which are stated to have been sent from Jerusalem to Rome by Helena, the devout and highly successful explorer. These steps are stated to have been formerly in the house of Pilate, and to have been ascended by our Saviour in his progress to the judgment-hall of the capricious Roman. The pilgrims ascend them on their knees.

"A winding stair-ladder joined on to the open chamber, leading to the secret walk, and a banqueting-room capable of containing nine couches, constructed and furnished in the Egyptian style." — Description of the ship of Ptolemy Philopator, by Callixenus, and quoted by *Athenæus* in the "Deipnosophists."

The staircase became a prominent feature in interior architecture in the reign of Elizabeth of England.

Stair'case. A set of steps in a house to ascend from one story to another.

A *geometrical staircase* is one in which the stairs have an open newel, each step being supported by the wall at one end only. See STAIR.

Stair-head. The top of a flight of stairs.

Stair-rod. A rod confining a stair-carpet at the receding angle where the riser and tread meet.

Stair'way. A flight of steps; a *staircase.*

Staith. An elevated railroad-staging, from which coal-cars discharge their loads into cars or vessels beneath. See Fig. 1357.

Stake. 1. (*Currying.*) A post on which a skin is stretched while currying or graining.

2. (*Husbandry.*) *a.* An upright bar to support a vine or tree.

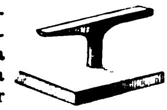
b. One of the uprights of a wattled fence or screen.

c. One of the pieces of timber leaning against the corner of a worm-fence, and serving with its fellow on the other side to hold the *rider* rail.

3. (*Railway.*) An upright bar held by staples on the edge of the bed of a platform car, to hold on the load of lumber, or the side and end boards which hold the coal, gravel, etc.

4. (*Vehicle.*) The upright or standard on the bolster of a wagon, to keep the bed, a log, or a load of lumber from shifting off sideways. See Fig. 705.

Fig. 5526.



Stake.

5. (*Metal-working.*) A small anvil used by blacksmiths and sheet-metal workers. It usually has a tang, by which it is *stuck* in a square socket of a bench, block, or anvil. It has various forms in the different trades.

a (Fig. 5527), a *hatchet* stake, from 2 to 10 inches wide, and used for bending the thin metals, as the edge of an anvil is used for bending thicker metal, by the blacksmith.

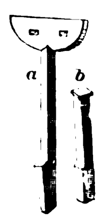
b, a stake with a rounded edge.

c, a stake with a rounded top.

d, a stake with a ridged top.

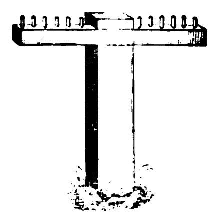
e, a stake with a conoidal top.

Fig. 5527.



Stakes.

Fig. 5528.

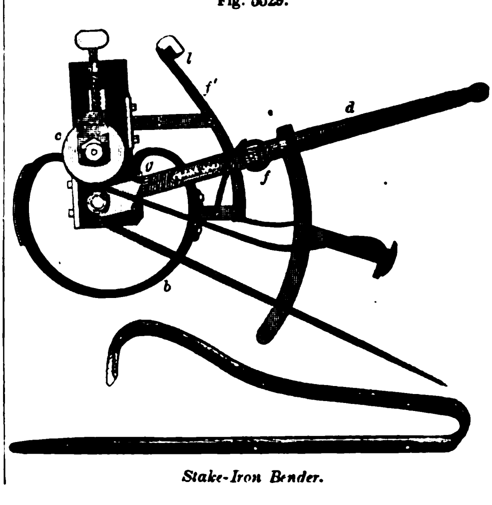


Stake-Head.

Stakes are also known by their purpose, as *chasing*, *dressing*, *planishing* stakes.

6. (*Shipwrighting.*) A regular course of planking on a ship. A *strake.*

Fig. 5529.



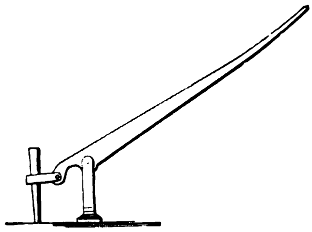
Stake-Iron Bender.

Stake-head. (*Rope-making.*) A horizontal bar supported by a post and stationed at intervals in the length of a ropewalk, to support the yarns while spinning. The upper edge of the bar has pegs to separate the yarns which are spun by the respective whirls in the spinner. Fig. 5528.

Stake-ir'on Bend'er. A machine for bending stake-irons for the bolsters of wagons.

The machine is composed of an adjustable roll *c*, a supporting bow or ring *b*, and a lever *d*. The stake-iron is bent by three operations. In the first the straight-rod is clamped at *l*, and bent by the roller *f* on the lever *d*, over the curved surface *f'*. In the second the rod is gaged in slot *g*, in lever *d*, and bent by the lever between it and the main roll *c*. In the third operation the middle of the rod is gaged as in the second, and bent by the same agencies into the finished form shown in the figure. The lower portion of the figure shows a finished stake-iron.

Fig. 5530.



Stake-Puller.

Stake-pull'er. A lever rigged to lift stakes, poles, or posts from the ground. See also POST-PULLER.

Stak-tom'e-ter. A drop measurer. A *pipette* or *burette*.

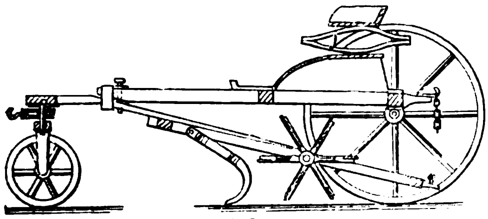
Stal'der. A trestle for casks.

Stalk. 1. (*Founding.*) An iron rod armed with spikes, forming the nucleus of a core.

2. A tall chimney, usually of a furnace. A *stack*.

Stalk-cut'ter. (*Husbandry.*) An implement for cutting old corn-stalks in the field in order that

Fig. 5531.



Stalk-Cutter.

they may be readily plowed in. The frame with the rotating knives is dragged beneath the main frame, which rests on wheels. Shares precede the cutter-wheel and draw the stalks into lines, so that they are cut across by the knives.

The "Eureka" stalk-cutter is capable of being turned into a roller by placing shells over the cutting-cylinders.

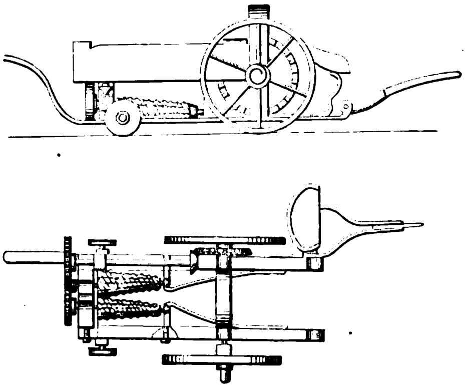
Stalk-pull'er. (*Husbandry.*) An implement for pulling cotton and hemp stalks from the ground, in order that they may be raked into windrow and burnt.

In the example, the arch straddles the stalks, the plates form a throat to direct them to the rollers, which tear them up and cast them on one side of the machine.

Stall. 1. (*Mining.*) An opening made between pillars in the direction that the work is progressing, or transversely. A *room*. See POST AND STALL.

2. A compartment in a cathedral, a market, a stable.

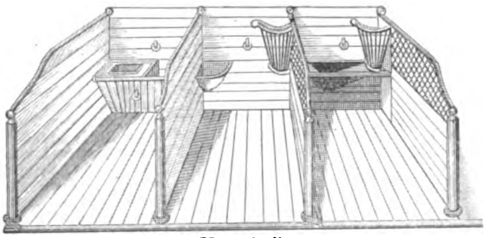
Fig. 5532.



Stalk-Puller.

Stalls for horses and oxen, for fatting cattle and calves, were common among the Hebrews. The references to stalled oxen and calves of the stall are sufficient to show that the people knew well what it meant. The daily provision of meat for Solomon's household was 10 fat oxen and 20 oxen from the pasture; the distinction is well understood. David had 40,000 stalls for horses.

Fig. 5533.



Horse-Stalls.

Fig. 5533 is a range of open stalls. The hay-racks are of cast-iron, with wrought-iron bars. The mangers for grain, of which three different patterns are shown, have iron flanges, to prevent the horse from cribbing. See also STABLE.

"And Duncan's horses,
Beauteous and swift, the minions of their race,
Turned wild in nature, broke their stalls, flung out."

Stall-boards. A series of floors on to which soil or ore is pitched successively in excavating.

Used in digging sewers, etc., in which the soil is pitched from floor to floor until it reaches the surface.

Sta'min. (*Fabric.*) A slight woolen cloth; *linsey-woolsey*.

Stam'mel. (*Fabric.*) A fine woolen cloth.

Stamp. 1. An engraved block by which a mark may be delivered by pressure.

The stamps and seals of ancient Egypt were cameo and intaglio. They generally had a royal name, and were of the shape of a cartouche. Dr. Abbott's collection in New York has old Egyptian stamps in porcelain, wood, gold, and stone.

The Romans used stamps, and the Babylonian signet-rings and brick show that the impressional art is very ancient.

A Roman signet-ring, now in a British collection, is 2 inches long by 1 inch broad, is made of bronze, and covered with the *ærugo*, or peculiar oxidation, which gives the character to the antique medals. It has the inscription in raised letters: —

CAIUS JULIVS
CÆCILIVS HERMIAS

The letters rise flush to the level of the border, and at the back is a ring for the finger. It was evidently inked on the face, and then impressed on the letter or document.

Hand-stamps are made of several kinds for various purposes: —

Canceling.	Address.	Embroidering.
Dating.	Official.	Eyeleting.
Post-office.	Embossing.	Monograms.

See Figs. 1055, 1056, 2389.

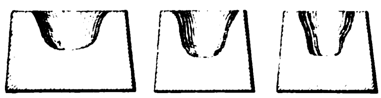
2. (*Bookbinding.*) A brass tool for embossing or gilding. Some are hand-stamps, others are arranged on a foundation plate and used in a press.

3. An instrument for cutting out objects, such as wads, planchets, blanks for making various objects.

4. (*Metal-working.*) A tool or machine by which sheet-metal is molded into form by a blow or simple pressure. See STAMPING-MACHINE; STAMPING-PRESS.

Deep vessels are stamped by a series of successive molds, from sheets of metal, whose width is equal to that of the width and depth of the finished article. The first mold is comparatively

Fig. 5534.

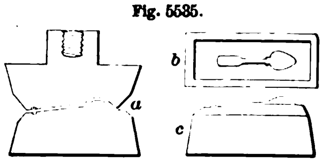


Sections Showing Progression.

shallow, the succeeding ones are deeper and narrower. The metal is forced into the molds by corresponding dies, and burnished after each stamping upon a revolving tool with a frusto-conical head. Only three molds are shown, but a larger number is frequently employed, the object being to gradually bring the metal to the required shape without rupturing or wrinkling it.

In making spoons, forks, etc., with the fly-press, it was formerly customary to stamp the handles and the bowls at two different operations. The dies (Fig. 5535), having curved surfaces and beveled edges, produce the spoon at a single impression, leaving only a slight fin at its edges. *a* represents a section of the counterpart dies; *b* is the face of the upper die, and *c* an elevation of the lower one.

Fig. 5535.

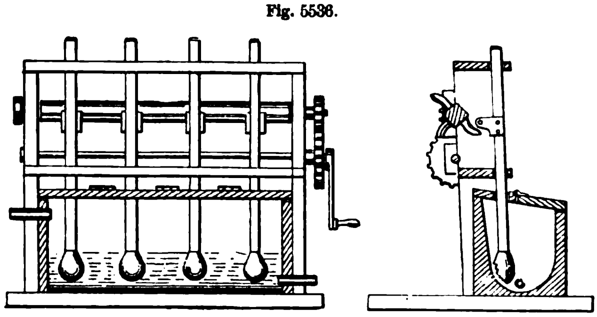


Stamp.

5. (*Mining.*) *a.* One of the pestles or vertically moving bars in an ORE-STAMPING MILL (which see).

b. A mark cut in the roof or side of the mine, as a point of reference to show the amount of work done.

Fig. 5536.



Stamping-Machine for Treating Hides, Skins, and Leather.

6. (*Leather.*) A machine for softening hides, etc., by pounding them in a vat.

7. A label to attach to a letter to prepay postage, signify the payment of a duty, or for other purposes.

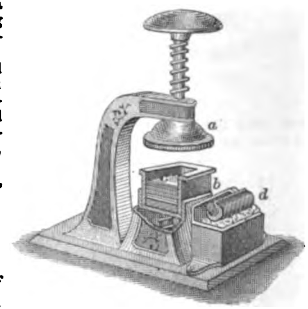
Postage-stamps, after being printed under the hydraulic press, in sheets each containing 200, are gummed by placing each sheet separately, back upward, on a flat board, its edges being protected by a metallic frame, and a paste composed of dextrine is applied with a whitewash-brush. They are again pressed, and each sheet cut in half.

The perforation is effected by passing the sheets between two cylinders, one above the other, and provided with a series of raised bands, which are adjusted to a distance apart equal to that required between the rows of perforations. Each ring on the upper cylinder has a series of cylindrical projections, which fit corresponding depressions in the bands of the lower cylinder; by these the perforations are punched out, and by a simple contrivance the sheet is detached from the cylinders to which it has been conducted by an endless band; the rows running longitudinally of the paper are first made and then, by a similar machine, the transverse rows. The sheets are then pressed to remove the roughness caused by the punching operation.

Stamp-af-fix'er. A device for attaching stamps to letters, etc.

It consists of a stand having an arm carrying the spring-presser head *a*; a box *b* having an interior spiral spring pressing against the movable bottom of the stamp receptacle *c*, and a trough *d*, containing sponge or other absorbent.

Fig. 5537.



Stamp-Affixer.

The stamps, gummed side upward, are placed in the receptacle, successively moistened with a roller, and attached to the object, placed between them and the presser-head, by forcing the latter down.

Stamp-bat'-ter-y. (*Metallurgy.*) A series of stamps in a machine for comminuting ores. See Fig. 596. See also STAMP-MILL.

Stamp-book. One whose pages are arranged with little squares, with the names of countries and the various values of the stamps of each country appended thereto.

Collectors of postage-stamps might read "Cornelius O'Dowd upon Men and Women and other Things in General," "Blackwood's Magazine," Vol. XCVII. pp. 67–69.

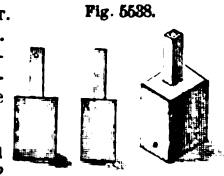
Stamp-can'cel-er. A hand-stamp for defacing postage or internal-revenue stamps. It is said that the double hand-stamps for canceling stamps and post-marking letters by the same stroke of one hand saved the government in 1866 the salaries of two hundred and fifty-four clerks at from $700 to $900 each, or more than two hundred thousand dollars per annum.

Stamp'er. (*Porcelain.*) A mill with heavy, iron-shod stamps, which comminute calcined flints for porcelain. From the *stamper* the dust is removed to the GRINDING-VAT (which see). See STAMP-MILL.

Stamp'er-press. A press for stamping sheet-metal. See STAMPING-PRESS.

Stamp-head. The iron block at the end of a vertical stamping-bar.

Fig. 5538.

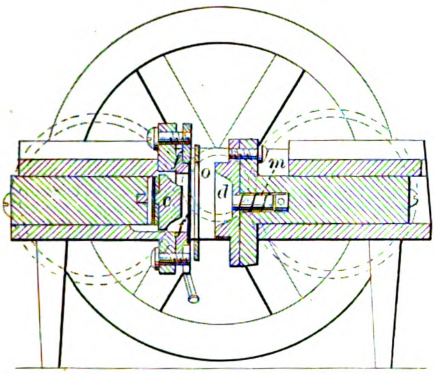


Stamp-Heads.

Stamp'ing-ma-chine'. (*Metal-working.*) A machine for swaging sheet-metal between dies to the requisite form.

In Fig. 5539, a sheet of metal is inserted between the ring *o* and the fixed annular die *f f'*,

Fig. 5539.

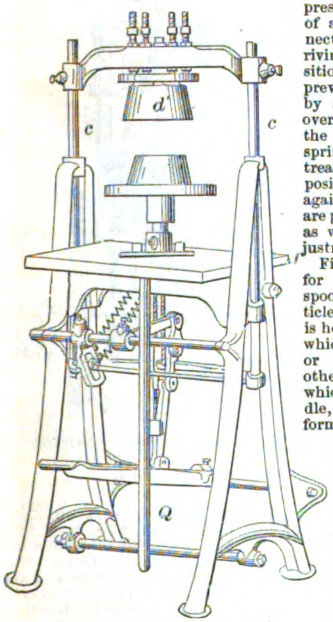


Machine for Forming Sheet-Metal Basins, etc.

the intaglio die d then advances, and its edge acting against $f f'$ cuts out a blank, which is then struck into the die d by a forward movement of the cameo die c; as d recedes the article is forced out by a follower m.

In Fig. 5540, the intaglio die d' is attached to a yoke connected with the two rods c c, through which it is depressed by the operation of a treadle and connecting devices; on arriving at its lowest position it is temporarily prevented from rising by a rod Q engaging over the treadle; when the rod is pushed aside springs restore the treadle to its normal position, and the die again rises. The dies are provided with lateral as well as vertical adjustment.

Fig. 5540.



Stamping-Machine.

Fig. 5541 is designed for stamping forks, spoons, and similar articles. One die, as B, is hollowed at the part which forms the bowl or prongs, and the other, A, at the part which forms the handle, the object being to form as small a burr as possible, and that at the angles instead of centrally.

The lower die is vertically adjusted upon wedges operated by set-screws. The die-holder is used in connection with an ordinary fly or other press. See also STAMPING-PRESS.

2. (*Shoemaking.*) For stamping finished goods. The shoe is readily jacked upon the post, and, being guided by the hand, is forced up against the stamp by the depression of the treadle.

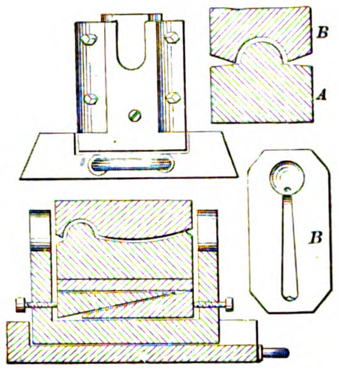
Stamp′ing-mill. A machine for breaking ore. See STAMP-MILL.

Stamp′ing-press. Another name for the STAMPING-MACHINE (which see also).

Machinery for making seamless articles from sheet-metal by stamping was devised in France as early as 1840. The first attempts, which were partially successful, were made with the drop-press. This, however, it was thought, did not allow sufficient time for the metal to assume the required form without tearing, and the screw-press was substituted for it, giving better results. The cam-press has also been generally used in France, which has long maintained a pre-eminence in wares of this kind.

Vessels are manufactured from sheet-iron, the depth being

Fig. 5541.



Machine for Stamping Forks, Spoons, etc.

given at several successive pressings, depending on the depth of the article. The metal is annealed after each pressing, and is finally turned.

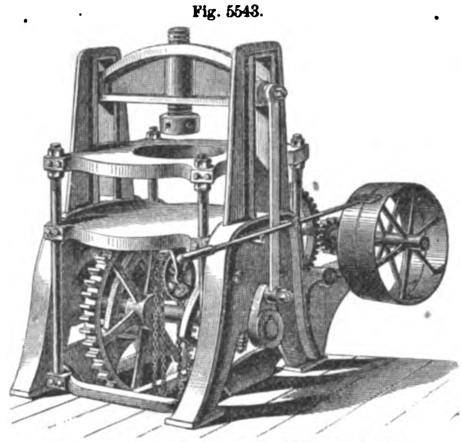
Such articles are now manufactured in this country from tin-plate, annealing being dispensed with, and the goods are prepared ready for market without re-dipping.

Fig. 5542.

Stamping-Machine (Shoe Machinery Manufacturing Co.).

Fig. 5543 illustrates a machine for forming pans or kettles from blanks. There are several molds for each pan, the operation being a progressive one; deeper and deeper molds being used successively so as to stretch the blank more and more, to avoid the tearing which would result from the attempt to stretch the thin sheet-metal at a single impulse, even though very moderately and gradually performed. The hollow mold is placed on the flat table, shown in the view, and upon it is laid a blank of sheet-metal, or a pile of blanks when several are to be stamped at once. The under side of the blank rests upon the flat upper surface of the hollow die, and the holder (shown with a round opening through it) is brought down upon the blank so firmly that, when the upper die descends, the metal has to expand into the hollow die, stretching out into a smooth seamless pan or kettle, without buckling or corrugating the margin. The upper

Fig. 5543.



Howard's Stamping-Press for Sheet-Metal Ware.

or salient die is fastened to the headed screw (which is shown above), and is operated when the cross-head descends by means of the pitmen and cranks on the sides of the machine, forcing the blanks into the hollow die as far as the ductility of the metal will permit. The holder is clamped down upon the blanks by means of cams beneath the table.

Metallic cartridge-cases are made in the same way.

Fig. 5544 is a machine for shaping sheet-metal. The plate to be shaped or stamped is placed upon the die, and the attendant depresses the treadle connected with the valve-rod of the chest *c*, whereupon, the water being admitted above the pistons of the four cylinders, the clamp *b* is forced downward and fastens the circumferential portion of the plate between its own lower surface and the flat upper surface around the die. The other treadle is then depressed, and causes the central piston to descend and force the follower or stamp downward, so that the

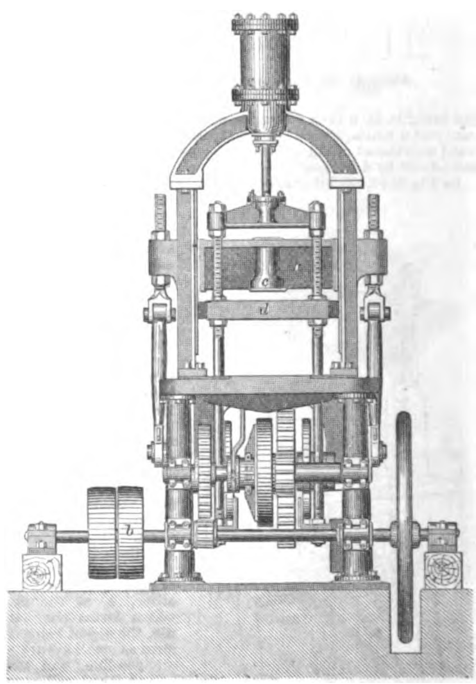
Fig. 5544.

Grimshaw's Machine for Shaping Sheet-Metal.

sheet-metal is pressed into the die and made to receive a corresponding form. As the sheet-metal is thus forced into the die by the pressure of the follower or stamp, its circumferential portions are drawn out from under the clamp, and the strain or tension thus exerted upon the metal effectually insures smoothness in the completed article, and also enables a deeper dish or similar piece of ware to be produced at a single operation. *a* is a casting with four cylinders, and *e* the top plate on which the receiving-chests are placed.

The press (Fig. 5545) for stamping hollow articles for sheet metal has a cross-head *a* reciprocated by connecting-rods from crank-arms on a horizontal shaft rotated by gearing driven from the fast-pulley *b*. The cross-head receives a convex die *c*, which works into a counterpart concave die held by the table *d*, which is suspended by a yoke and rod from a piston in the cylinder above. The latter has a cushion of air in its lower part, so as to give a certain degree of elasticity to the blow, the table and lower die receding slightly before the pressure of the upper die.

Fig. 5545.



Stamping-Press for Hollow Ware.

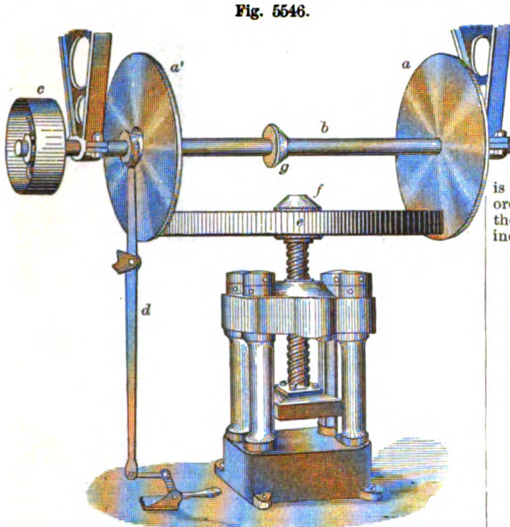
Debeauvais' press (Fig. 5546) is operated by two friction-wheels *a a'* attached to opposite ends of a shaft *b*, rotated by a belt turning the pulley *c*. When it is desired to depress the platen or stamp, the shaft *b* is, by means of a treadle operating a connecting-rod *d*, thrown to the left, bringing the face of the wheel *a* in contact with the periphery of the horizontal wheel *e* keyed on the head of the screw. On releasing the treadle a spring, which throws the shaft *b* to the right, is permitted to act, bringing the wheel *a'* in contact with *e* and causing a reverse movement of it and the screw, lifting the platen until the cone *f* at top of the screw strikes a cone *g* on the shaft *b*, throwing the two wheels out of contact. The rapidity of movement of the platen progressively increases, as the wheel *e* recedes from the centers of the wheels *a a'* either in the ascending or descending movement of the screw.

Fig. 5547 is for striking ornaments on metal or leather, or for cutting disks or planchets from sheet-metal. The punch or upper die is brought down by pressure of the foot on the treadle, the plunger being actuated by a lever which is vibrated by toggle motion set in operation by the treadle. The lower and upper dies bear the relation required by the work, whether for mere impression of a raised ornament or the severance of pieces of metal.

Fig. 5548 is a stamping-press for cutting wads, washers, or planchets from sheet-metal strips.

A swivel-step is seated in the annular base, and a swivel die-chuck connected with the lower end of the slide, or to the stem thereof. A spring-dog is applied to the chuck by means of a screw to engage with the stem of the slide, the hook end entering a socket made in each side of the stem to prevent the slide

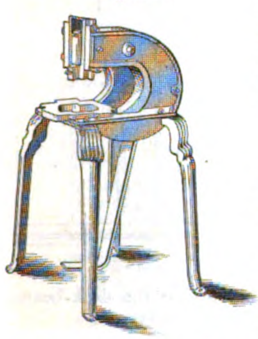
Fig. 5546.



Stamping-Press.

from turning when set for operation. A similar dog holds the swivel-step. See also COINING-PRESS.

Fig. 5547.



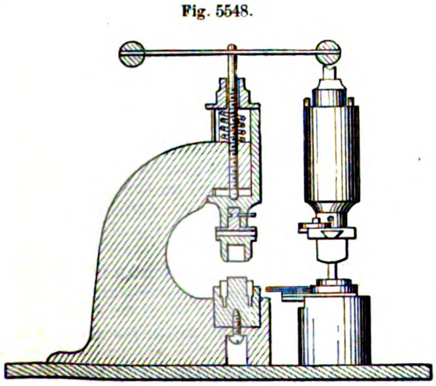
Stamping-Press for Ornaments and Jewelry.

Fig. 5549 is a fly-press for stamping monograms on letter-paper and envelopes; also, by change of dies, for embossing paper, leather, or other materials. The plunger is depressed by the revolution of the fly and returned by the spring.

Stamp-mill. 1. (*Metallurgy.*) One in which the rock is crushed by descending pestles which are lifted by water or steam-power.

The ordinary form consists of a row of vertical stamps lifted by cams upon a shaft, which rotates in bearings in the standards of the frame. The shaft is driven by steam or water power, and the cams are arranged upon it in a spiral series, so as to lift the stamps consecutively instead of simultaneously. This makes the draft upon the power of the engine more uniform, as one or more of the stamps are constantly being lifted while others are descending.

Fig. 5548.

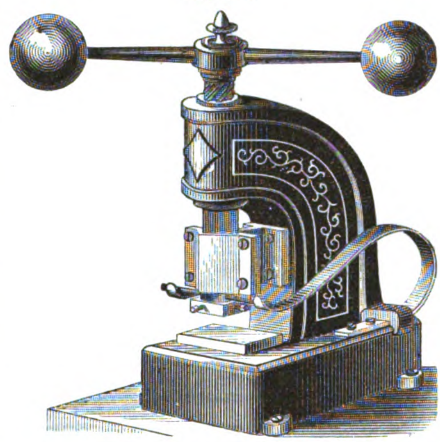


" *Fly* " *Stamping-Press.*

In the accompanying cut the upper platform is that from which the broken rock is fed to the stamps, which descend into a box whose perforated sides retain it until it is of sufficient fineness to pass through the meshes. It is then discharged by a spout to the amalgamator or other machine, by which the valuable portions are separated from the earthy.

Another form of stamp-mill is that in which the stamp is directly connected to the piston-rod of a steam-engine, in the manner of the steam-hammer, both the blow and the recoil being by the force of the steam in the cylinder above. Such is that in the illustration, Fig. 5551, next page. The broken ore is fed into the bell mouth of the chute and conducted to the stamp-box; the ascending and descending rods work the induction and eduction valves of the engine.

Fig. 5549.

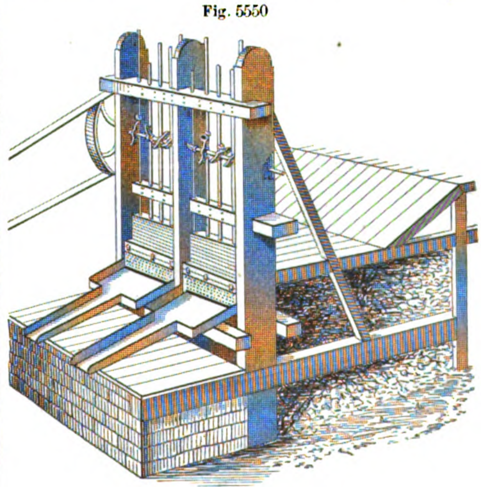


Monogram-Press.

Cosgriff's stamp-mill (Fig. 5551) has four stamps *a a*, surrounded by a screen *b* (the front is not shown in the illustration), and attached to the rods of pistons working in cylinders, which, with the steam-jacket *c* and sole-plate *d*, are cast in one piece; the whole is adjustable to different hights upon the pillars *e e* by means of nuts, so that it may be lowered as the stamps wear away. Steam is admitted alternately above and below the pistons by slide-valves working horizontally in the chests *f*, and operated partly by the steam and partly by the conical upper ends of the piston-rods rising and falling in the caps *g g*, through levers *h h* and connecting-rods. Each piston and its stamp may be worked independently.

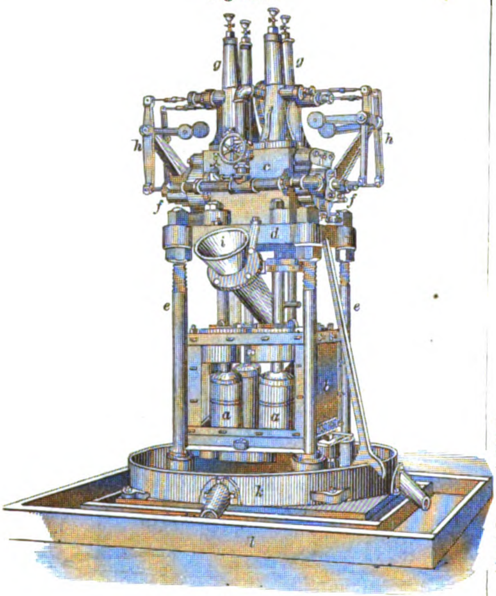
The stamping is done wet; the ore is fed into the hopper *i*, and, falling centrally between the stamps, is equally distributed to each. The crushed material passes through the screen into

Fig. 5550



Stamp-Mill.

Fig. 5551.



Stamp-Mill.

the annular trough *k*, into which a constant stream of water flows; the finer particles are carried off by spouts into the exterior trough *l*.

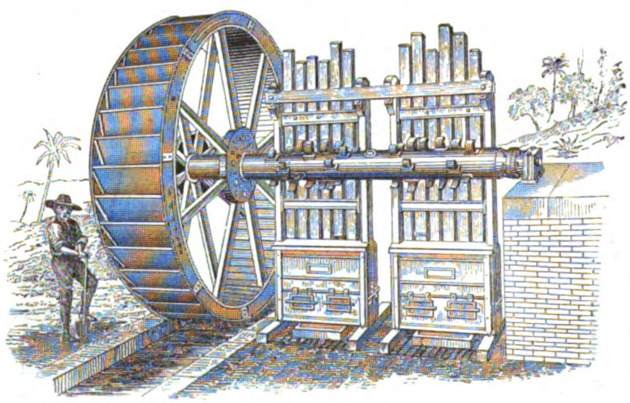
Fig. 5552 shows a mill of two batteries of six stamps each, worked by an undershot water-wheel.

2. (*Oil.*)

The stamping-mill for the trituration of oleaginous seeds, nuts, and fruit does not differ substantially from those used for the comminution of ores. The mortars are arranged in a row beneath the stamps, the latter sliding in guide-bars as they are alternately lifted by the wipers on the horizontal shaft, which is driven by gearing. Each stamp makes two blows at each revolution of the shaft.

At the ends of the machine are two wedge-presses, wherein the oleaginous magma is pressed after the pounding of the stamps. See OIL-MILL.

Fig. 5552.

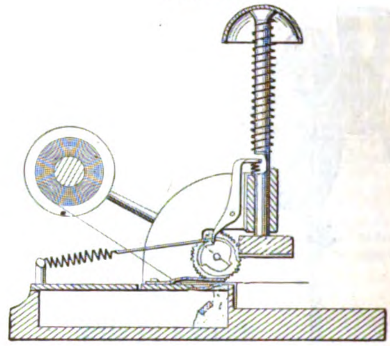


Stamp-Mill.

Stamp-moist'en-er. A wet pad for moistening the gummed side of postage and internal-revenue stamps.

Stamp-press. One for attaching stamps to letters, envelopes, or other articles. A postage-stamp affixer; or one for attaching internal-revenue stamps to dutiable articles.

Fig. 5553.

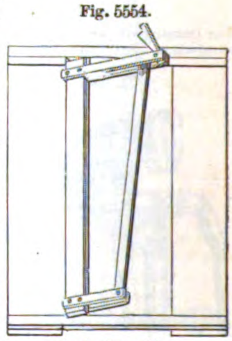


Instrument for Affixing Stamps.

The descent of the affixer causes the spring connecting with the feed-wheel to be tightened, and by releasing the spring-pawl holding the feed-wheel, the latter is rotated by means of the resilient power of the spring, and feeds a stamp forward ready to be cut off and affixed on the descent of the latter.

Stanch. A flood-gate for accumulating a head of water in a river to float boats over shallows, when it is allowed to escape.

Fig. 5554.



Cattle-Stanchion.

Stan'chion. 1. (*Architecture.*) A post, pillar, or support.

2. (*Machinery.*) A principal post of a frame; especially one giving lateral support.

3. (*Nautical.*) *a.* A post, to which man-ropes are attached at a gangway or stairs.

b. Posts which support the quarter-railing, netting, awning, etc.

4. (*Shipwrighting.*) *Stancheon; stanchel.* A post for supporting the deck-beams of wooden and iron vessels.

In iron ships they are generally applied to the alternate deck-beams, and in large ships are made about three to four inches diameter. They consist of simple round bars, to which is welded at each end a small cross, to form the head and foot, having two holes in each, by which they are bolted to the beams or keelsons above and below.

5. The vertical bars of a stall for cattle.

In the example, the stanchion-post is pivoted so as to swing horizontally; the movable stanchion-bar is pivoted to the lower arm and locked in the upper one.

Stan'chion-gun. 1. A small cannon mounted on a pivot.

2. A boat-gun for wild-duck shooting, mounted on the gunwale.

Stand. 1. (*Microscope.*) The table on which the object is placed to be viewed.

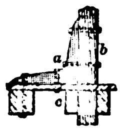
2. A piece of furniture on which an object is to be placed; as a *wash*-stand, a *flower*-stand, a *sewing-machine* stand, etc.

Stand'age. (*Mining.*) Space for water to accumulate in.

Stand'ard. 1. (*Shipbuilding.*) A knee-timber *a* above deck, having one erect and one prone arm,

bolted to the bitt *b*, or other object, and to the deck *c* and its beams.

Fig. 5555.



Deck-Standard.

2. A flag. The standard of the United Kingdom of Great Britain and Ireland quarters the ensigns of England, Scotland, and Ireland. It lost the horse of Hanover when William IV. died; the horse has of late been quartered at the "Prussian Arms."

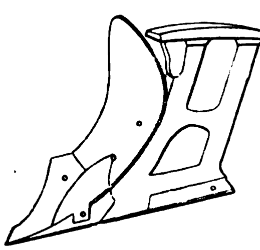
3. (*Carpentry.*) A post or vertical piece in a truss. A strut.

4. (*Machinery.*) A vertical principal post of a machine-frame.

5. (*Vehicle.*) An upright rising from the end of the bolster to hold the wagon-body laterally.

6. (*Husbandry.*) The *sheth* of a plow, projecting downward from the beam and affording a place of attachment for the mold-board and land-side.

Fig. 5556.



Plow-Standard and Attached Portions.

7. A measuring device for men or horses; the first expressed in feet and inches, the latter in hands and inches.

8. The determinate legal fineness and weight of coin, or the fineness of metal in other forms, so far as controlled by law. See also under COIN, page 591.

The standard of gold and silver at the United States Mint is 900 parts pure metal, 100 alloy.

Pure gold, 23.22 grains = $1.00. Hence the value of an ounce is $20 67.183+.

Pure silver, 357.03 grains = $1.00. Hence the value of an ounce is $1 36.166+.

Standard gold	= $ 18 60.465+	per ounce.
Standard silver	= $ 1 22.5	per ounce.
Gold double eagle	= 516	troy grains.
Gold eagle	= 258	troy grains.
Gold dollar	= 25.8	troy grains.
Silver dollar	= 412.5	troy grains.
Silver half-dollar	= 192	troy grains.
Copper cent	= 168	troy grains.
Nickel cent	= 72	troy grains.
Bronze cent	= 48	troy grains.

Silver coin less than one dollar is issued at the rate of 384 grains to the dollar.

The nickel cent contains 88 parts of copper and 12 of nickel.

The new bronze cent contains 95 parts of copper and 5 of tin and zinc.

The British standards are: Gold, $^{22}/_{24}$ of a pound, equal to 11 parts pure gold and 1 of alloy; silver, $^{222}/_{240}$ of a pound, equal to 37 parts pure silver and 3 of alloy.

A troy ounce of standard gold is coined into £3 17*s.* 10*d.* 2*f.*, and an ounce of standard silver into 5*s.* 6*d.*

Copper is coined in the proportion of 2 shillings to the pound avoirdupois.

The relative value of gold and silver has been variable.

Herodotus mentions it as	13 to 1.
Plato mentions it as	12 to 1.
Menander mentions it as	10 to 1.
Livy, B. C. 189,	10 to 1.
Julius Cæsar exchanged at	9 to 1.
Early Emperors (average),	12 to 1.
From Constantine to Justinian,	14 to 1.
Modern times, from	14 to 1 to 17 to 1.

9. A unit of value. See UNIT.

Stand'ard-gage. A gage for verifying the dimensions, or any particular dimension, of articles, or their component parts, which are made in large numbers, and required to be of uniform size. The practice of making each corresponding part exactly similar was first adopted with government small-arms, and has since been generally applied to fire-arms, sewing-machines, machine-made watches, and many other articles. By this means every part fits accurately in place when assembled with its fellows to form the complete article, without the necessity of trimming or filing. See list under GAGE. See also ASSEMBLING, page 171.

Stand'ard-knee. (*Shipbuilding.*) *a.* A bent timber, having one branch fastened against the upright side of a beam, and the other against the ship's side. One fayed vertically to the vessel's side, beneath or above a beam, is a *hanging* knee. See STANDARD.

Stand'ard-piles. (*Hydraulic Engineering.*) In a coffer-dam. Piles placed at regular intervals apart and connected by runners.

Stand'ing. A term applied to a relatively stationary portion of an object which has several parts, one or more of them moving. As, —

The *standing leaf* of a hinge; that attached to the post.

The *standing* part of a rope; the main portion around which the end is hitched.

The *standing* pulley of a compound system; that attached to a permanent object: the *runner* moves, shifts its position as the object moves, etc.

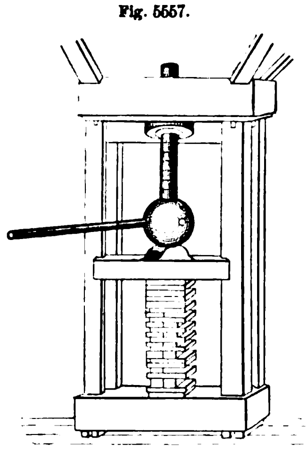
Stand'ing-block. (*Nautical.*) That block of a tackle or purchase which is attached to a stationary object, in contradistinction to the block which moves as the fall is hauled in or paid out. The latter block is called the *running*-block.

Stand'ing-bud'dle. (*Mining.*) A trough filled with water, in which pieces of lead ore are placed and stirred with a shovel.

Stand'ing-part. (*Nautical.*) *Of a hook.* The part attached to a block or chain, by which power is brought to bear upon it; the part opposite to the point.

Of a rope or tackle. The part made fast to the object; in contradistinction to the *fall* or part pulled upon.

Fig. 5557.



Standing-Press.

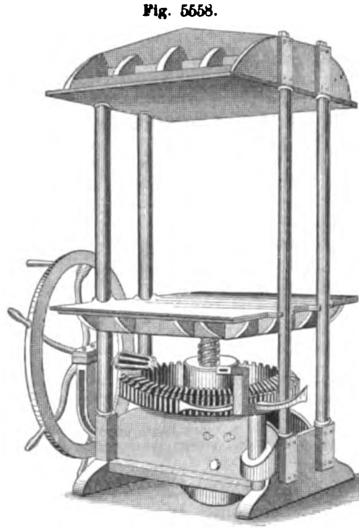
Stand'ing-press. A heavy press for book-binders or other trades. It is named from its being a heavy fixture, in contradistinction to copper-plate, hand printing-presses, and the large variety of portable presses.

The books are put in thin cases and placed between wooden boards, with their backs outward and projecting. The upper bed of the press is screwed down by means of a nut and lever, and allowed to remain for several hours, when they are ready to receive the covering. This may be either of cloth or leather, and the process for both is nearly the same.

Fig. 5558 is a press for smoothing the impression left by the type on printed sheets. The platen is lifted by a screw with an exterior thread, working within a hollow screw in the axis of a bevel gear-wheel turned by a pinion on the shaft of a large hand-wheel, to which the power is applied. A pawl, entering between two of the adjacent teeth on the periphery of the gear-wheel, prevents the latter from turning backward under great pressure.

Stand'ing-rig'ging. (*Nautical.*) The fixed ropes and chains whereby the masts and bowsprit are stayed securely. The term is used in contradistinction to *running*-rigging, which is rove through blocks and pulled upon. It includes, —

Fig. 5558.



Hoe Standing-Press.

Flemish-horses.	Parrals
Foot-ropes.	Pendants
Gammoning.	Ratlines.
Guys.	Shrouds.
Heel and crupper chains.	Slings.
Horses or ridge-ropes.	Stays.
Man-ropes.	Stirrups.
Martingales.	Trusses.

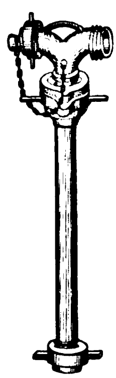
See RIGGING.

Stand'ing-vise. See BENCH-VISE.

Stand'ish. A tray for pen and ink.

Stand-pipe. 1. (*Steam-engine.*) A boiler supply-pipe of sufficient elevation to enable the water to flow into the boiler, notwithstanding the pressure of the steam.

Fig. 5559.



Stand-Pipe.

2. Stand-pipes are also used on the eduction-pipes of steam-pumps to absorb the concussions arising from pulsations and irregularities, caused by the unavoidable employment of bends and change in the direction of pipes. Stand-pipes for this purpose are erected on the eduction-pipe, as near the pump as possible.

3. (*Hydraulic Engineering.*) A curved vertical pipe, arranged as a part of the main in water-works to give the necessary head to supply elevated points in the district, or to equalize the force against which the engine has to act.

To avoid the expense of tall structures and the exposure to freezing in winter, the use of compressed air-vessels has been recommended.

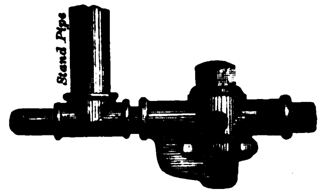
An open-ended safety-pipe may be placed above the bend of the siphon, and rising 20 or 30 feet to allow the water to rise when the pressure is excessive. When the water passes through the discharge leg at a slower rate than it is injected, it forms a column in the pipe on the apex of the siphon, and eventually runs over the top, if the disparity between the supply and demand be maintained.

The stand-pipe of the West Philadelphia Water Works, erected by Henry Howson in 1854, is a tube of boiler-iron 5 feet in diameter and 130 feet high, forming an ornamental column, with a base of cut stone and a spiral staircase terminating in a platform.

The stand-pipes of the London Water Works are of the following hights: —

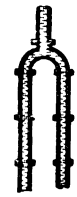
New River	84 to 145 feet.
Chelsea	85 to 135 feet.
West Middlesex	122 to 188 feet.
Grand Junction	100 to 151 feet.
Lambeth	185 feet
East London	60 to 107 feet.

Fig. 5560.



Stand-Pipe for Steam-Pump.

Fig. 5561.



Stand-Pipe.

The combined engine power is equal to 4,000 horses: delivery, 17,000,000,000 gallons annually. The horse-power is in excess; a reserve being kept. 8,500,000 gallons are raised by each horse-power annually, to hights varying from 60 to 188 feet; mean hight, 100 feet. Daily supply, 90 gallons per house. The New River Company supplies daily 700,000 persons with 40 gallons of water per head, at an expenditure of 4 cents per 1,000 gallons.

At Wolverhampton, England, water from a well 140 feet deep was pumped over a stand-pipe 180 feet in hight, making a lift of 320 feet. This was done to give the necessary pressure in the mains, there being no summit reservoir.

At the Erie, Pa., Water Works is a stand-pipe 220 feet in hight, resting on a rock elevated 14 feet above the water, making a total elevation of 234 feet. It is 5 feet in diameter, and is made of boiler-iron, the uppermost sections being 3/16 inch, and the lowermost 7/16 inch thick. It was erected by commencing with the top section and adding the lower ones in regular order, the whole being hoisted as each section was added, by means of a derrick and pulleys.

Hights to which Water may be projected through Engine-Pipes under Pressure.

Pressure per Square Inch.	Equivalent Head of Water.	Hight of Jet.	Ratio of Compression of Air in Air-Chamber.	Pressure per Square Inch.	Equivalent Head of Water.	Hight of Jet.	Ratio of Compression of Air in Air-Chamber.
Lbs.	Feet.	Feet.		Lbs.	Feet.	Feet.	
30	68	33	.5	90	204	165	.17
45	102	66	.33	105	238	198	.14
60	136	99	25	120	272	231	.125
75	170	132	.2	150	340	297	.1

4. (*Gas.*) .The vertical pipe leading from the retort to the hydraulic main.

Stang-ball. (*Projectile.*) Two half-balls united by a bar. A *bar-shot.*

Stan'hope. (*Vehicle.*) A sporting phaëton.

Stan'hope-lens. A lens of small diameter, with two convex faces of different radii, and inclosed in a metallic tube.

Fig. 5562.

Stanhope-Lens.

Stan'hope-press. A form of hand printing-press. A great improvement in its day. See Fig. 3948.

Stan'na-ry. (*Mining.*) A tin-mine, or tin-works.

Stan'no-type. (*Photography.*) A picture taken upon a tinned iron plate. A *tin-type.*

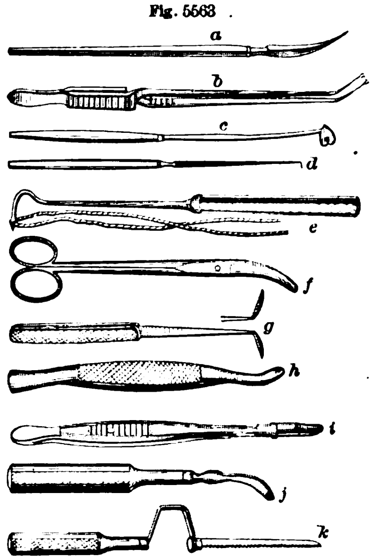
Stapes. (*Surgical.*) A bandage for the foot, making a figure-of-8 round the ankle.

Staph'y-lo-plas'tic Op'er-a'tion. (*Surgical.*) That for cleft palate. See STAPHYLORAPHIC INSTRUMENTS.

Staph'y-lor'a-phic In'stru-ments. (*Surgical.*) Instruments for operating for cleft palate. The edges of the cleft are pared, ligatures are passed through them, and they are brought together.

Uraniscoplastic instruments are allied to the former, being

Fig. 5563.



Tiemann's Staphyloraphic and Uraniscoplastic Instruments.

used in operations for engrafting in cases of deficiency of the soft palate.

a, double-edged staphyloraphy knife.
b, seizing forceps.
c, Sims' adjuster, for wire sutures.
d, tenaculum, for pulling the velum aside, holding the edges of flaps, etc.
e, Whitehead's spiral needle, for sutures.
f, curved scissors, for dividing the muscles.
g, Whitehead's knives, for paring the edges.
h, Sayre's periosteotome.
i, Sims' wire-twisting forceps.
j, Goodwillie's periosteum-levator.
k, Goodwillie's oral saw.

Staph'y-lo-tome. (*Surgical.*) A knife for operating upon the uvula or palate.

Sta'ple. 1. A bow of metal for holding a hook, ring, or lock-bolt.

2. (*Foundry.*) One of the pieces of nail-iron, a few inches long, on one end of which flat disks of thin sheet-iron are riveted. They do the work of *chaplets* in steadying and *holding down* a core, but differ from them in having the sharper end thrust into the sand till the distance of the plate, set by a gage, gives the required thickness of metal.

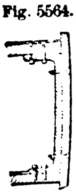
3. Fiber for manufacture: cotton, flax, wool.

4. (*Mining.*) *a.* A shaft uniting workings at different levels.

b. A small pit.

Sta'ple-knee. (*Shipbuilding.*) An iron knee with two arms, one bolted to the under side of a deck-beam, the other to the top of a hold-beam; the middle portion to the ship's side. A *staple-ledging* knee, or deck-standard knee.

Fig. 5564.



Staple-Knee.

Fig. 5565.

Staple-Punch.

Sta'ple-punch. The staple-punch has two points, and is used to prick blind-rods and slats for the reception of the staples which connect them.

Star. (*Pyrotechny.*) 1. A small piece of inflammable composition, which burns with a colored flame, depending on the character of the ingredients employed.

They are usually formed by pressing the composition, while wet, into a cylindrical mold, and afterward dredging with mealed powder. Sometimes the composition is formed in a large cake, which is afterward divided into cubical pieces.

They are used as ornaments for rockets, for filling wooden shells, and in Roman candles.

The following recipes are given for different colored stars: —

White. 4 niter, 2 sulphur, 1 mealed powder; or 9 niter, 3 sulphur, 2 antimony.

Yellow. 1 charcoal, 1 sulphur, 6 nitrate of soda; or 20 chlorate of potassa, 10 bicarbonate of soda, 5 sulphur, 1 mastic.

Red. 5 chlorate of potassa, 20 nitrate of strontia, 4 gum dammar; or 20 nitrate of strontia, 12 chlorate of potash, 11 sulphur, 2 charcoal, 2 antimony, 1 mastic.

Blue. 2 chlorate of potassa, 1 ammoniated sulphate of copper, 1 gum dammar; or 20 chlorate of potassa, 14 carbonate of copper, 12 sulphur, 1 mastic.

Green. 12 chlorate of potassa, 24 nitrate of baryta, 8 sulphur, 1 lamp-black; or 12 nitrate of baryta, 28 chlorate of potassa, 15 sulphur, 1 mastic.

Violet. 9 chlorate of potassa, 4 nitrate of strontia, 6 sulphur, 1 carbonate of copper, 1 calomel, 1 mastic.

Proof spirit, in which gum benzoin has been dissolved, is used for giving consistency to the mass.

2. The series of radial spokes, forming handles, on the roller of a copperplate or lithographic printing-press.

3. (*Printing.*) A reference mark (*) used in printing. An *asterisk.*

Star'board. (*Nautical.*) The right-hand side of a vessel, looking from aft forward; in contradistinction to *port*, which was formerly called *larboard.*

Starch. Starch and cotton goods originated in the East. The institutes of Menu, 800 B. C., refer to the stiffening action of starch on fabric.

Pliny informs us that starch was prepared from wheat by the inhabitants of Chio. The method of starching linen was publicly taught in England in the year 1560 by a Dutch woman, a Mrs. Dingham, the wife of Queen Elizabeth's coachman. She charged £ 5 for showing the process, and £ 1 extra for showing how to manufacture the starch. This was 260 years before Beau Brummel, who made his grand début in starched cravats.

Starch is found in the cells of all plants except fungi, in the form of minute granules, varying in diameter from $^1/_{240}$ to $^1/_{4000}$ of an inch. It is composed of 24 parts carbon and 20 each of oxygen and hydrogen, being nearly identical in composition with cellulose, into which it is charged by heat or the action of sulphuric acid. Its color is changed to a deep blue by iodine, which thus serves as a delicate test of its presence.

The granules are separated from the gluten and other principles by washing, and form an insoluble precipitate, being only mechanically suspended in the water. When dried and examined through the microscope, they are found to be made up of concentric layers, and appear beautifully colored under the influence of polarized light. Though constructed on one general type, the granules obtained from each kind of plants have in general peculiar characteristics, by which their origin may be readily determined.

Those from the potato are among the largest, while those of the cereals generally are much smaller. The granules of arrow-root resemble those of the potato, but are somewhat smaller.

Treated with dilute sulphuric acid, or heated to 300° Fah., starch is converted into dextrine, or British gum, which is largely employed as a cheap substitute for gum-arabic. By farther ebullition with the dilute acid, this substance is transformed into glucose or grape-sugar. See DEXTRINE; SUGAR.

The same process occurs in the germination of seeds by the action of the peculiar substance called *diastase*, into which the albumen of the seed is converted under the influence of warmth and dampness. The same action takes place in the process of malting.

In England, wheat is generally used for making starch, the ordinary process being as follows: —

The grain, crushed between rollers, is thoroughly wetted and allowed to stand for 4 or 5 days, until fermentation takes place; it is then removed to a vat, where more water is added, and allowed to ferment for from 2 to 3 weeks, when the mass is transferred to a stout basket, where it is washed by a continuous stream of water, and at the same time stirred with a shovel until the starch is completely separated from the bran.

It is received in a *back* or vat beneath, from whence it is taken and strained through hair-sieves into cisterns, where it is allowed to settle for 24 hours, after which the water above is decanted by tap-holes at different levels in the side. The upper part of the deposit, termed *slimes*, is removed, and the lower and impure starch is again agitated with fresh water and passed through a finer sieve; when the starch has subsided again from the strained liquid, the latter is drawn off, the second *slimes* are removed, and the remainder is again agitated with water and passed through the sieve. It is now allowed to become solid by evaporation, a little smalt or artificial ultramarine added to give it the required bluish tint, and any trace of acid removed by the addition of an alkali; while still moist it is shoveled into boxes lined with fine canvas, and having perforated bottoms When tolerably dry it is cut into pieces 5 or 6

inches square, partially dried, and finally stoved to render it completely so.

In this country, Indian-corn and also potatoes are very generally used for making starch: potatoes are prepared by thoroughly washing and then crushing in clear cold water; the resulting starchy matter flows into vats beneath, where it is allowed to settle, and is afterward washed one or more times, dried in stoves and packed; the refuse of the potatoes, the pomace and skins, being carried off by a current of water. These factories are small, and only operate during the latter fall and early winter, requiring as they do plenty of cold water, fermentation in this case being inadmissible.

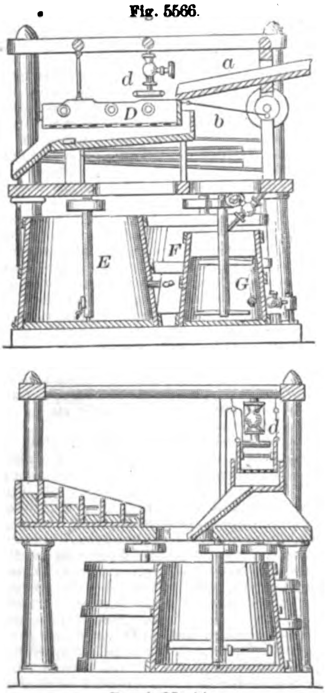
The application of maize to this purpose was patented by James Coleman in 1841, and was successfully practiced in the ensuing year at Oswego, N. Y., by Thomas Kingsford. The Kingsfords at present have probably the largest starch factory in the world, having bins five stories in depth, capable of holding 2,000,000 bushels of corn, and turning out annually some 4,000 tons of starch.

From the bins the grain is passed through fanning-mills, which remove impurities, and is then conducted to large vats, where it is macerated and softened to facilitate the separation of the albumen and gluten. After this process it is ground and pulped by a series of burr stones and heavy iron rollers, and is next transferred to drums or sieves, where the starch is washed out by the action of water, the non-farinaceous portion remaining within the sieves being finally allowed to escape through openings at their ends and conducted away to receptacles, whence it is taken and used as food for cattle.

The starch is received in vats, where it is agitated by means of stirrers operated by water or steam power, and is supplied with water and chemicals to purify it. When the superfluous water has been partially withdrawn, and it is in a semi-fluid state, it is run into molds, where it settles into solid cakes, which are broken into square cakes; these are placed in a kiln and dried at a low heat, and the cakes are scraped to remove impurities, which appear as a yellow crust on the surface. They are now again dried, causing them to fall into little pieces, which assume the peculiar forms so well known. They are then packed into barrels or boxes, according to quality. The highest grades, as corn-starch for puddings, or *maizina*, being ground fine, measured, and automatically put up and pressed in the packages by an arrangement of devices which prevent wastage and obviate the production of dust.

Various forms of apparatus are used for washing out and drying the fecula; the general principles of all, however, being similar.

Fig. 5566.

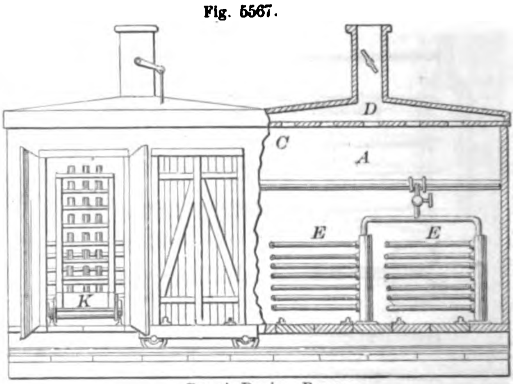


Starch-Machine.

In the apparatus (Fig. 5566), the pulpy mass passes from the trough *a* to the vibrating separator *D*, having at bottom a bolting-cloth, and supplied with water from a pipe *d*; the feculous matter is received in a vat, as *E F*. After settling, the water is drawn off and caustic alkali added. The contents of the vat are then agitated and transferred to a winding, inclined trough *b*, where the starch is deposited while the gluten is dissolved by the alkali. The starch is then transferred to another vat, as *G*, agitated and washed with water, after which it is again allowed to settle, drained and dried.

The drying-room (*A*, Fig. 5567) is provided with a series of racks *K*, has ventilating openings *C D*, and is heated by pipes *E E*. The cakes of starch are conveyed to the chamber by trucks running upon tracks and transferred to the shelves.

Fig. 5567.



Starch Drying-Room.

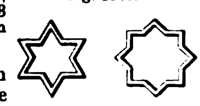
An incombustible starch, according to Hager, is made by pouring 50 parts hot water upon 10 parts pulverized burned bones, and adding gradually 6 parts sulphuric acid. The mixture is kept in a warm place, and occasionally stirred for two days, when 100 parts distilled water are added and the solution filtered; to the filtrate, a soluble phosphate of lime, are added 5 parts sulphate magnesia in 15 distilled water, and enough ammonia stirred in to impart an ammoniacal odor. The precipitated double phosphate of ammonia and magnesia is filtered, dried, and pulverized. Two parts of the powder are mixed with 1 tungstate of soda and 6 wheat starch, and a little blue carmine added. For use, it is mixed with twice its quantity of cold water, and sufficient boiling water stirred in to form a slimy liquid, in which the goods are immersed.

Star-fort. (*Fortification.*) Inclosed works having alternate *salient* and reëntering angles; the *faces* form with the *flanks* angles greater than a right angle.

A *star-fort* may be constructed either on a triangle or a square; in the former case it has 6 salient angles, and in the latter case it has 8.

Each face may be 90 yards long, and in construction is divided into 8 equal parts. On the middle one an equilateral triangle is erected.

Fig. 5568.



Star-Forts.

Star-gage. (*Ordnance.*) An instrument for measuring the diameter of the bore of a cannon at any part of its length. It consists of a graduated brass tube carrying four steel points at one end; two of these are movable, and are pushed outward by means of a tapering slider in the tube, enabling small variations in the caliber of the piece to be accurately measured.

Star'ling. (*Hydraulic Engineering.*) An inclosure consisting of piles driven closely together into the bed of a river, and secured by horizontal pieces at the top. The space between the rows of piling, being filled with gravel or stone, forms an effectual protection for the foundation of a pier. A *sterling.*

The starlings of the piers of the bridge erected across the Euphrates by Semiramis (1944 B. C.), to unite the two portions of the city, are distinctly described by Diodorus Siculus (B. C. 40).

Start. 1. (*Hydraulics.*) One of the partitions which determine the form of the bucket in an overshot wheel. *Strut.*

2. (*Mining.*) The lever of a crab or gin, to which the horse is attached.

Start'er. An apparatus for giving an initial motion to a machine, especially such as may be at rest on a dead-center. Used in sewing-machines, steam-engines, etc.

Start'ing-bar. (*Steam-engine.*) A hand-lever for starting the valve-gear of a steam-engine.

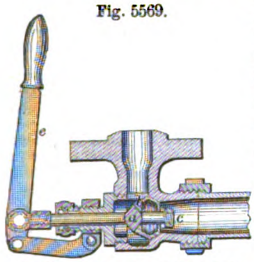
Start'ing-bolt. One used to drive out another. A *drift-bolt.*

Start'ing Steam-cyl'in-der. (*Steam-engine.*) A small low-pressure engine, used for starting a large marine engine.

Start'ing-valve. (*Steam-engine.*) *a.* A device introduced by Bourne in 1852. A small valve used in starting the main valves of large steam-engines when setting the engine to work.

Bourne, in 1836, introduced small cylinders to move the link motion which controls the action of the valves of the main engine.

Fig. 5569.



Starting-Valve for Gifford Injector.

b. A valve adapted for the Giffard Injector. It has an interior valve *a* and a larger valve *b*. The range of the former relatively to the latter, in which is its seat, is regulated by the play allowed by the nut *c*. Opening of the valve *a*, by pulling the lever *e*, allows a small but sufficient body of steam to pass, to raise the water.

Another pull opens the valve *b* and starts the injector.

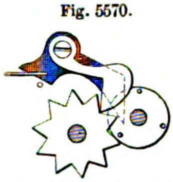
Start'ing-wheel. (*Steam.*) A wheel operating the valves in starting the engine.

Starting-bars and *starting-gear* have a similar purpose.

Star-wheel. (*Horology.*) A wheel having radial projections, which engage with a pin on the hour-wheel, employed in repeating-clocks. Also used in meters and registers.

The drop and attached pawl are carried by a spring, and are lifted by pins on the disk. The pins escape first from the pawl, which drops into the next space of the star-wheel. When the pin escapes from the drop, the spring throws down the drop, whose pin strikes the pawl; this acts against the side of a tooth, and gives the star-wheel a partial revolution.

Fig. 5570.



Star-Wheel (from Mechanical Movements).

State-room. 1. (*Nautical.*) A small cabin, usually for two passengers, on a steamer.

2. (*Railway.*) An apartment on a sleeping-car. In the example, the rooms open into a side passage, and the doors of the rooms, when swung open 90°, cross the passage, cutting off access to the room, and giving space for disrobing.

Sta'tion. 1. (*Shipbuilding.*) A long measuring-rod, also called a *room-and-space staff*, whereby the positions of the timbers of the frame are regulated.

2. (*Railway.*) A regular stopping-place for trains.

3. (*Surveying.*) The position of an instrument at the time of an observation.

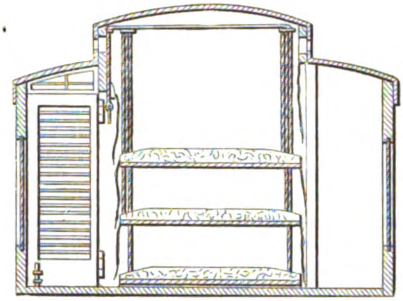
Sta'tion-a-ry En'gine. (*Steam-engine.*) *a.* One permanently placed, as distinguished from a locomotive or portable engine.

Fig. 5572 is a perspective view of an engine manufactured by Woodbury and Booth, Rochester, N. Y.

b. A form of engine for drawing carriages on railroads by means of a rope.

Until 1829, or thereabout, the question of the comparative economy and efficiency of stationary engines and locomotives was still undeterminate. The success of the

Fig. 5571.



State-Room on Car.

"Rocket" and the counsels of experts determined the question. See Rope-railway.

Stationary railroad-engines were long used on the inclined planes of the Alleghanies when the Pennsylvania Railroad followed the Holidaysburg route.

They are also used on the Morris and Essex Canal, State of New Jersey, in raising the boats from one level to another. See Inclined Plane.

For a number of years the incline of the London and Birmingham Railway of England, between the out-town and city termini, 1¼ miles, was ascended by means of a rope wound upon a cylinder by two stationary engines, at Camden Town.

The railway over a part of the Andes to Santiago is operated by a rope and stationary engines.

Sta'tion-bill. (*Nautical.*) A list containing the appointed stations of all the officers and crew of a vessel.

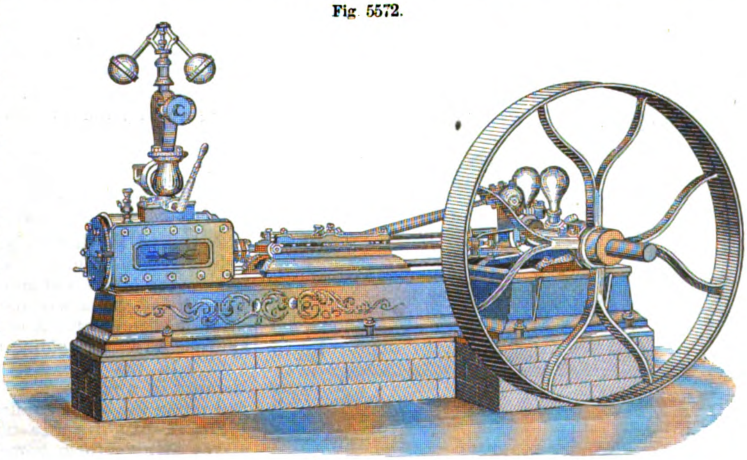
Sta'tion-cal'en-dar. A device for indicating a railway-station. They are of two general descriptions.

1. A dial or bulletin-board at a railway-station, to indicate the hours of starting of trains for given destinations; or the time of starting of the next train for a given place.

2. A device on board a car, consisting of an endless ribbon or map, which unrolls as the car proceeds, and exposes the names of the stations in order at a slit as the train approaches the stations, one after another. The map of the route, or the list of stations, is wound and unwound from a pair of rollers, which receive motion from some part of the car, say one of the axles.

Sta'tion-point'er. A circular plotting instrument, having a standard radius and two movable ones. By laying off two observed angles right and left from a central object, and laying it over the

Fig. 5572.



Stationary Engine.

objects on a chart, the position of the observer is indicated.

Sta'tion-staff. (*Surveying.*) An instrument for taking angles.

Stat'u-a-ry-brass. An alloy of copper, zinc, and tin, used for statuary, generally known as bronze. The proportions of the metals used are indefinite. Analyses of Keller's statues at Versailles give copper, 91.4 ; zinc, 5.53 ; tin, 1.7 ; lead, 1.37. Gun-metal, containing copper 9, tin 1, is frequently employed. See BRASS ; BRONZE ; ALLOY.

Stat'u-a-ry-cast'ing.

Herodotus and Diodorus Siculus refer to massive statues set up in the temple of Belus, in Babylon, at a date supposed to be about 2230 B. C. The massive statues of Memnon, Osymandyas, and other Egyptian kings, are of stone, and attest a great degree of skill, so that it becomes impossible to determine when the arts of modeling and sculpture were invented in or introduced into the land of the Nile. The Egyptian statuettes are frequently of metal.

The Roman Colossus set up by Nero, being a figure of himself, was placed before his Golden House, near the site of the temple of Venus, at Rome. It was of bronse, the work of Zenodorus, and Pliny gives its hight as 110 feet, — larger than that of Rhodes.

About 1491 B. C., "he [Aaron] received them [the golden ear rings of the people] at their hand, and fashioned it with a graving tool, after he had made it a molten calf." — Exodus xxxii. 4.

"The smith with the tongs both worketh in the coals, and fashioneth it [an idol] with hammers, and worketh it with the strength of his arms." — Isaiah xliv. 12 (712 B. C.).

In the year 120 B. C., a Chinese general brought back from a country north of the desert of Gobi a golden statue of Buddha as a trophy.

"The magnificent statues of brass and iron, which issue from the foundries of Tolon-Noor, are renowned not only throughout Tartary, but even in the most distant countries of Thibet From its vast workshops all the countries which profess the religion of Buddha receive their supply of idols, bells, vases, and other utensils employed in their idolatrous service The large images are cast in several pieces, and afterward soldered together During our stay at Tolon-Noor we saw a single statue of Buddha which made in its various pieces the load of 80 camels. It was intended as a present to the Tale Lama." — ABBÉ HUC'S *Travels in Tartary*, 1844-46.

The great statue of Buddha in Nirvana — that is, in a state of utter annihilation of external consciousness — is at Kamakura, half a day's march from Yokohama, in Japan. The statue represents Buddha sitting in the Oriental manner, upon a lotus. The statue is of bronze, is 50 feet high and 96 in circumference at the base. It is hollow, and the interior is fitted up as a temple, with images. It was cast about 600 years ago, in sections of a few feet square and an inch or more in thickness. The joints were so well fitted, that after the lapse of centuries they are only to be detected by discoloration arising from the weather. It is placed on a pedestal 5 or 6 feet high, and the head is covered with small knobs representing the snails which, tradition says, came to protect Buddha from the heat of the sun.

Fig. 5573.

The Daibutz. Buddha in Nirvana (Kamakura, Japan).

This statue was received many centuries ago from a far western country, doubtless Tolon-Noor, which is yet the great foundry for the lands over which the religion of Buddha prevails.

Schwanthaler's colossal bronze statue of the feminine genius "Bavaria," is 54 feet high, and erected on a pedestal 30 feet in hight, in front of the "Ruhmeshalle," at Munich. A winding staircase in the interior leads to the head, wherein is a chamber large enough to contain 28 persons. Openings are afforded among the curls for viewing the prospect.

The casting was made at five different times, commencing with the head. This was in 1844. The bust was the largest portion, and for it 20 tons of bronze were melted.

The present system of casting statuary from wax patterns is as follows: —

1. Take a cast in plaster sections, which together form a matrix.
2. Cover the inside of the sections with a shell of wax.
3. Place the sections in position to form a mold.
4. Fill the inside with clay or *slush*, to form a core, with supports to sustain it independently of the mantle.
5. Remove the plaster sections, the wax adhering to the clay.
6. Work up the wax surface into complete form, by hand.
7. Coat with porous clay composition to form a mantle.
8. Bake in a furnace, melting or burning out the wax.
9. Run the metal into the baked clay mold.

Figures of large size have been made by the deposition of copper by electro-metallurgy upon a core or model of clay.

The church of St. Isaac at St. Petersburg is decorated with a large number of statues and figures in relief obtained by this process.

Stat'ue. A sculptured figure in stone, or a casting in metal from one molded in clay.

Stat-u-ette'. A small statue. Statuettes and other artistic forms in plaster are made very closely to resemble silver in appearance by being covered with a thin coat of powdered mica. This powder is mixed with collodion and then applied to the objects in plaster with a brush, after the manner of paint. The mica can be easily tinted in various colors. It can be washed in water, and, unlike silver, is not liable to become tarnished by sulphureted gases.

Stau'ro-scope. A kind of polariscope invented by Von Kobell, of Bavaria, about 1855, and particularly designed for investigating the effects of polarized light upon crystals belonging to different crystallographic systems. — POGGENDORF, Ann. 95-320.

Stave. 1. (*Coopering.*) One of the strips which compose the sides of a cask, tub, or bucket.

The undressed strip, as riven or sawn from the block, is also called a stave.

Staves are made by machinery, different machines being used for the several operations of

Sawing.	Bilging.	Howeling.
Riving.	Dressing.	Crozing.
Chamfering.	Shaving.	Setting.
Cutting.	Planing.	Finishing.
Bending.	Jointing.	

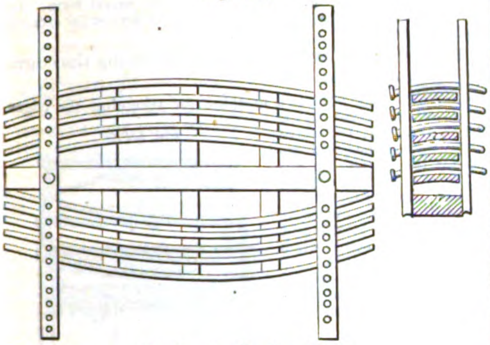
2. One of the boards joined laterally to form a hollow cylinder, curb for a well or shaft, the curved bed for the intrados of an arch, etc.

3. One of the bars or rounds in a lantern-wheel.

Stave-bend'er. A device for bending steamed stuff for staves, or holding them in shape after being bent. In the example, the steamed staves are clamped in a rack and kiln-dried, so as to assume and retain the shape required.

Stave-bilg'ing Ma-chine'. One for bending staves to give them bow-shape at the bilge ; also their hollowing shape. See STAVE-BENDER.

Fig. 5574.

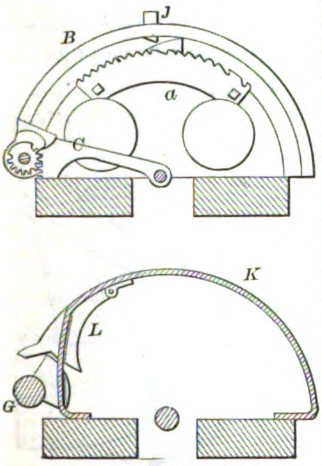


Machine for Bending Staves.

Stave-cham'fer-ing Ma-chine'. One for beveling the ends of staves at the chine.

Fig. 5575 is a machine for chamfering the ends of and crozing barrel-staves at the same time. A stave is inserted in the machine, held by two ribs *B* at the ends, and clamped between them and a central curved bar *K*, by means of two vibratable clamps *L*, operated by segment rack-levers *C* and pinions at each end of the shaft *G*. The croze is formed by a toothed cutter *a*, and the ends are chamfered by upper and lower cutters seen at *J*. Each stave, as it is inserted, pushes the preceding one forward, they occupying the same relative position as in the completed barrel, uniformity is secured, and splitting off the wood at the edges of the staves is prevented. See also STAVE-CROZING MACHINE.

Fig. 5575.

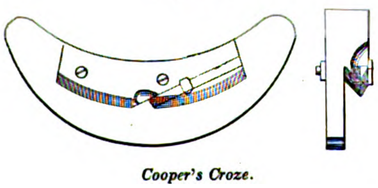


Chamfering and Crozing Machine.

Stave-croz'ing Ma-chine'. The *croze* of a cask is the *kerf* on the inside, into which the edge of the barrel-head is inserted. The cooper's *croze* is a kind of toothed plane with a curved face to cut the *kerf* in the cask. The previous rounding of the inside of the barrel to make a fair surface to work on is done by the *howel*. The *howel* may also make the *chamfer*, which is the bevel at the end of the stave forming the *chine*.

In *stave-crozing* machines the kerf is usually cut by a saw; in barrel-crozing machines the staves, after being set up, are subjected to the action of the crozing-saw. In some cases two saws and a cutter croze, cut off, and chamfer the stave simultaneously. Wilde, August 12, 1862; Cutter, June 14, 1870.

Fig. 5576.



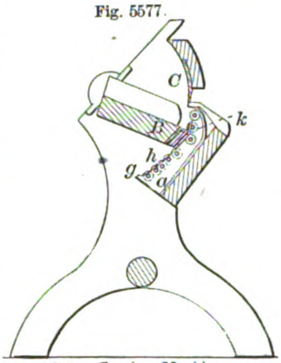
Cooper's Croze.

Stave-cut'ter. A machine for cutting staves from the bolt.

In the machine (Fig. 5577), the stave-bolt is held upon the swinging-bed *B*, and presented to the action of the curved knife *C*.

A series of curved ribs *a* on the fixed bed carry alternating rollers *g h*, which prevent the side of the block from coming in direct contact with the ribs, and permit the chips and splinters to pass between them. When the stave is completely severed, it is caught by a spring *k* and prevented from falling back as the table descends.

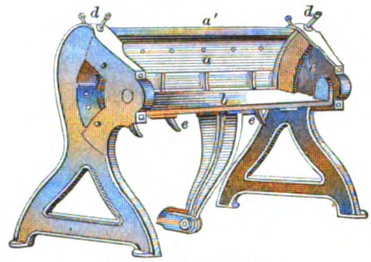
Fig. 5577.



Stave-Cutting Machine.

In Crossett's stave-cutter, Sept. 24, 1861 (Fig. 5578), the bar *a'* with the fixed knife *a* is adjusted as to hight in segmental grooves in the heads *c c* by screws *d d*, and held by set-screws behind. The table *b* is pivoted at each end, and is tilted upward, in order to present the block from which the staves are riven to the action of the knife; its rear edge is slotted to receive a series of curved vertical guides *e e* attached to the front of a bar connecting the ends of the machine; chips fall through the interspaces between the guides. See also Crozier and Currier's patent, March 29, 1859.

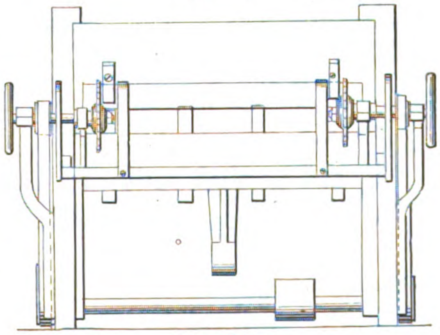
Fig. 5578.



Crossett's Stave-Cutter.

Fig. 5579 is a machine designed to slice from a block, and at the same time saw the staves to an exact length. As soon as the stave is sliced off, two adjustable circular saws cut the stave to the desired length, it being held in place by two circular springs until the next succeeding stave is cut.

Fig. 5579.

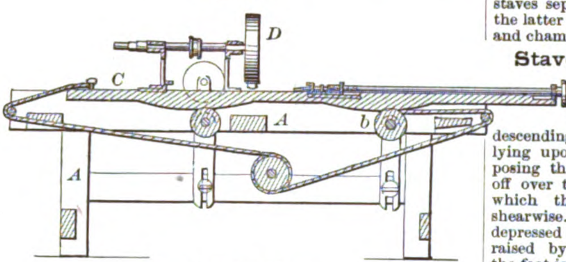


Stave-Cutter.

Stave-dress'ing Ma-chine'. The machine (Fig. 5580) is designed for dressing the inside of staves of uniform size, as those for beer-barrels.

These are held upon a table *C*, which is traversed back and forth upon rollers *b* journaled in the bed *A*, so as to present them to the rotary-cutter *D*. The bottom of the bed has a

Fig. 5580.

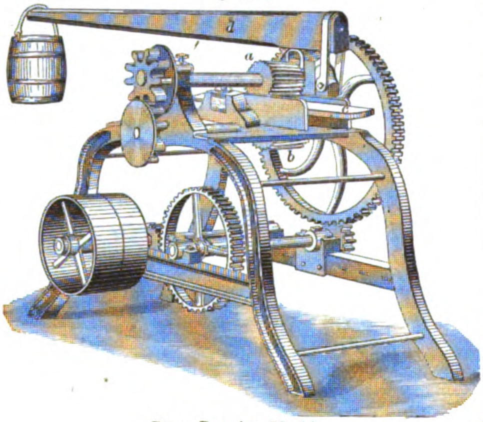


Stave-Dressing Machine.

curve corresponding to that of the staves to lift them up to the cutter in proportion as their curvature tends to cause them to recede from it. The staves may be held down by upper rollers or other suitable means.

In Fig. 5581, the rived stave *c* is drawn in between the two

Fig. 5581.



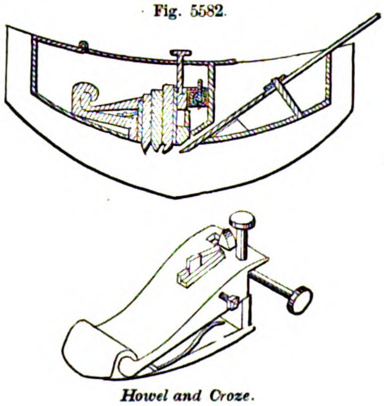
Stave-Dressing Machine.

fluted rollers *a b*, and presented to the action of convex and concave faced revolving cutters, which *hollow* and *back* the stave in the direction of its length, dressing the inside and outside of the stave respectively. A weighted lever *d* regulates the pressure on the upper feed-roller.

Stave-how'el-ing Ma-chine'. The cooper's *howel* is a plane for smoothing the insides of staves or of barrels about where the croze comes.

Fig. 5582 is a tool in which the *howel* and *croze* are combined. The crozing portion, shown in the lower figure, is removable from the case carrying the howeling bit when the former is not needed.

Fig. 5582.



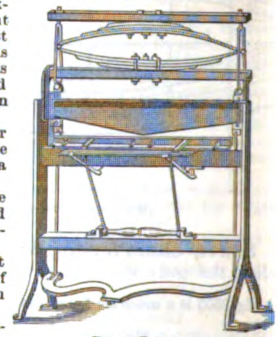
Howel and Croze.

In howeling-machines the work is performed either on the staves separately, or after they are set up in barrel form. In the latter case it is frequently associated with devices for crozing and chamfering.

Stave-joint'er. A machine for truing the edges of staves.

Fig. 5583 is a machine for trimming the edges of staves by a descending cut, the stave lying upon a bed and exposing the part to be cut off over the edge, against which the cutter works shearwise. The cutter is depressed by a treadle and raised by a spring when the foot is withdrawn.

Fig. 5583.



Stave-Jointer.

In Crozier's stave-jointer the stave is held in a frame and dressed by knives on a revolving head.

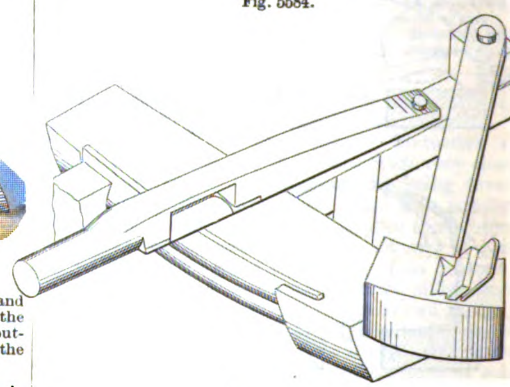
In Seymour's machine the stave lies upon a bed and is jointed by a guillotine knife.

In Doane's machine it passes between a pair of saws set at an angle with each other.

Fig. 5584 is a bench attachment. The staves are clamped in their bent position on a frame, to which are pivoted a double-acting knife and a swing plane.

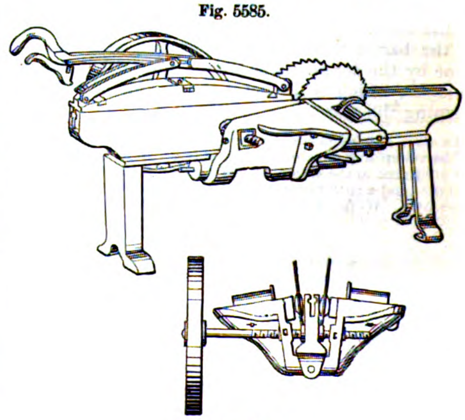
In Fig. 5585, the stave is clamped upon the curve-topped carriage, and is passed between the saws, which are carried upon inclined adjustable arbors. See also STAVE-SAWING MACHINE.

Fig. 5584.



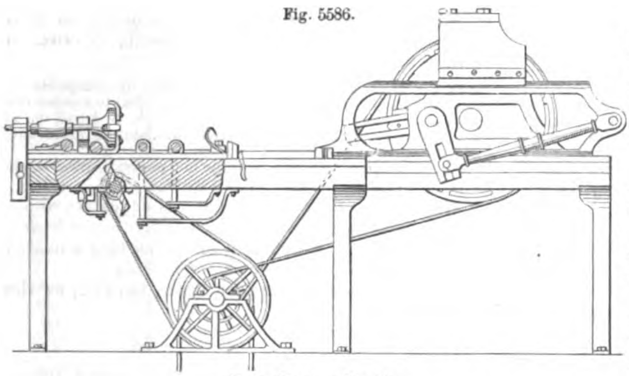
Stave-Jointer.

Fig. 5585.



Jointing-Saw.

Fig. 5586.



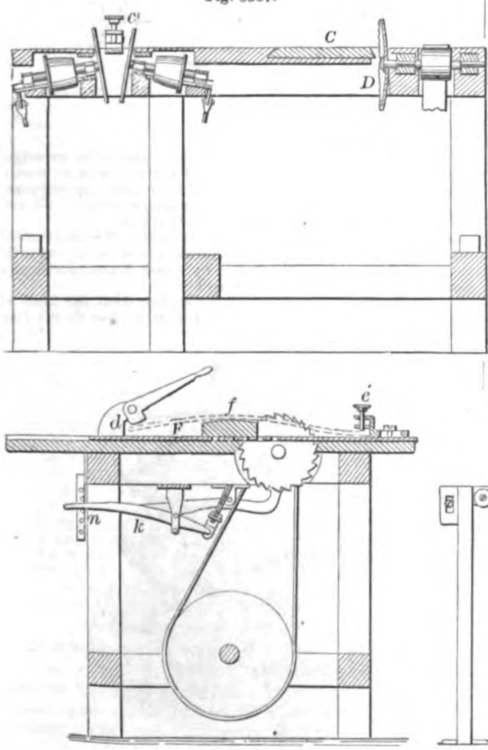
Stave-Planing Machine.

Stave-plan'ing Ma-chine'. A machine in which staves are faced by a plane.

In Fig. 5586, the stave is pushed beneath a stationary plane-bit to shave the outer face, and its lower surface is dressed by the revolving cutter. The pusher consists of a sliding-frame, which is reciprocated by a pitman connected to a radially adjustable wrist on a rotating bell-crank, whose other arm has a slot traversed by a pin on the driving-wheel. The driving-wheel and rotating crank-shaft are journaled eccentrically, so that the movement of the pin along the slot will cause a slower motion in the feeding than in the return motion of the pusher.

Stave-riv'ing Ma-chine' One for splitting balks of timber into slabs suitable for making staves. The slab of rived timber undergoes treatment for bending, sawing to a length, hollowing, backing, dressing, chamfering, crozing; some of these operations, however, are performed after the staves are set up.

Fig. 5587.



Stave Sawing and Jointing Machine.

The riving of staves is usually by frow and mallet (see Fig. 2108). Dorr's riving-tool has a set of knives in a frame, so as to check the end of the balk for a number of staves (or shingles) at once. The knives are not quite parallel, but have divergence answering to the radial marks in the timber; for instance, the medullary rays in oak and some other woods.

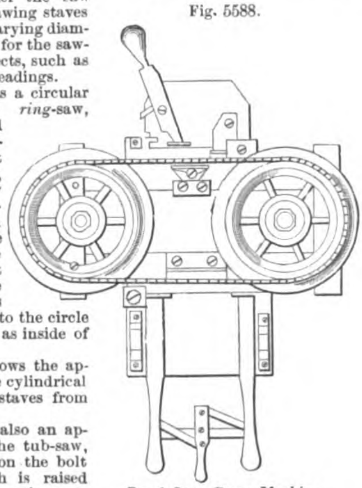
Stave-saw'ing Ma-chine'. (*Coopering.*) *a.* One for sawing staves from the log, bolt, or balk.

b. One for sawing the edges of staves, otherwise known as *jointing*. See STAVE-JOINTING MACHINE.

The machine (Fig. 5587) is designed to saw staves from the bolt and *joint* or impart the required bevel to their edges. The bolt is placed on the sliding-table *C*, which is advanced while the stave is cut to the required circular form by the dished saw *D*. The stave is then transferred to the other end of the table, where it is held and bent between the two clamps *d e'*, the center being supported by the block *f*. The table *F* is then advanced, presenting the stave to the action of two circular saws, which are suitably inclined to impart the desired radial bevel to each edge. The saws may be brought nearer together or separated, without altering their inclination, by means of a lever *k*, which is engaged with a rack *n* to hold it in fixed position, and actuates a bell-crank arrangement which moves frames carrying the saw-spindles.

Fig. 5588 shows a stave machine using a band-saw, which works upon pulleys in connection with adjustable feed-tables, so as to render the saw available for sawing staves for vessels of varying diameters, and also for the sawing of flat objects, such as shingles and headings.

Fig. 5588.



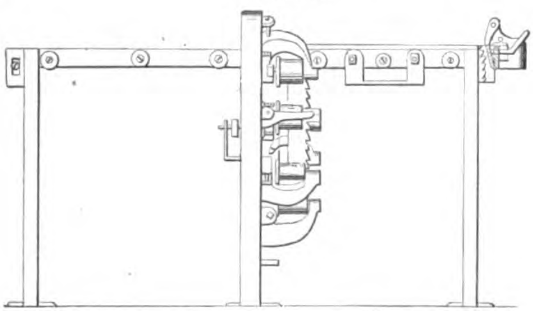
Band-Saw Stave-Machine.

Fig. 5589 has a circular band-saw, or *ring*-saw, hung upon and between friction-rollers set in a true circle, so that the saw is put in motion and driven by one of the rollers. These rollers are set in adjustable brackets, so as to be adjusted to the circle outside as well as inside of the saw.

Fig. 5590 shows the application of the cylindrical saw to sawing staves from the bolt.

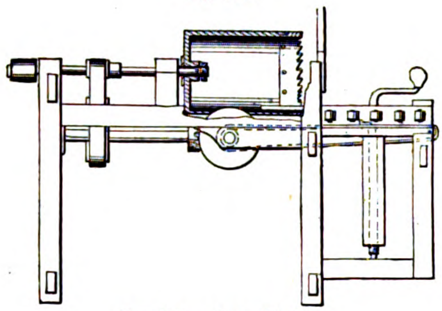
Fig. 5591 is also an application of the tub-saw, which acts upon the bolt of wood which is raised against it, the reciprocating, vibratory table, with its head-block, being pivoted at such a point as to cause the saw to cut a transverse circle on the outside of the stave to conform to the outside diameter of the barrel when completed. The cams and flanges *Q R* act against rollers on the

Fig. 5589.



Ring-Saw Stave-Machine.

Fig. 5590.



Barrel-Saw Stave-Machine.

arms of the feeding-table, giving the same the necessary vibration.

In Hurlbut's stave-machine (Fig. 5592), the saws are capable of being so adjusted as to give the required bevel to the edges of the staves as they are presented to the action of the saws by the forward movement of the carriage. The angle at which the saws are set varies according to the dimensions of the barrels for which the staves are designed.

Stave-set'ter. (*Coopering.*) A device to hold staves as they are consecutively set up, in order to form a barrel or cask.

In Fig. 5593, the chine hoop is suspended by clamps over a concave table, which holds the head in position to receive the staves which form the barrel. When the hoop is driven on to hold the staves in place on the head, the clamp is withdrawn and the barrel removed from the table.

Fig. 5594 shows by a plan view the independent spring-heads which hold the staves against the truss-hoop.

Stav'ing. 1. A casing of staves or planks which forms a *curb* around a turbine or similar water-wheel.

2. (*Forging.*) Shortening or compacting a heated rod or bar by endwise blows. *Upsetting.*

Stay. A lean-to, support, brace, tie, etc., as the case may be.

Of an *axle-tree.*

Of the *splinter-bar.*

Of a *chain-cable;* the transverse piece in a link.

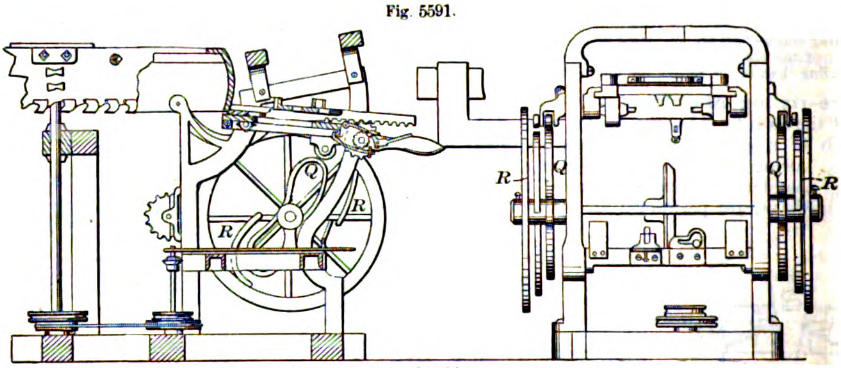
Of a *core-box;* the spindle that supports the core in some kinds of hollow castings, as shells.

Of a *crane;* the prop or strut which supports the jib.

Specifically: —

1. (*Nautical.*) A strong rope which stiffens and

Fig. 5591.



Stave Machine.

supports a mast in its erect position, by connecting its head to some part of the hull, or to a part stayed from the hull.

a. The *fore-and-aft* stays lead forward in the vessel's line amidships.

b. The *back* stays pass somewhat abaft the shrouds, and are attached to the side of the vessel, at the *channels.*

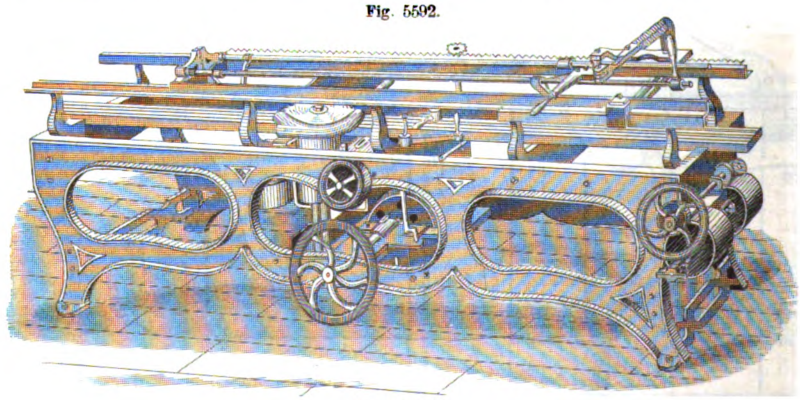
c. The *breast* and *standing* stays lead from the mast-heads down to the gunwale on each side.

d. Spring stays are *preventer* stays to assist the principal ones. The *fore-and-aft* stays support the *staysails* by means of *hanks.* The stays are named from the masts they support; as the *fore*-stay, *foretopmast*-stay, *maintopmast*-stay, *jib* and *flying-jib* stay, the *bob*-stay, etc. See Staysail.

e. The *triatic stay* is connected at its ends to the heads of the fore and main masts, and has a thimble spliced to its bight for the suspension of the *stay-tackle,* by which boats, machinery, and heavy freight are hoisted aboard.

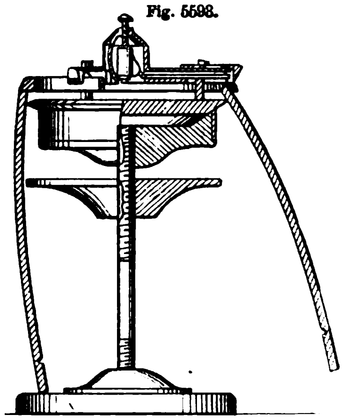
f. A *jumper-stay* is a movable stay leading from the head of a mainmast to a pair of eye-bolts in the deck close to the after

Fig. 5592.



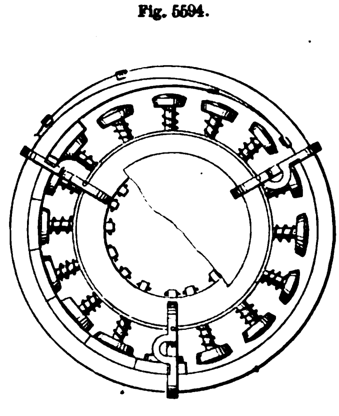
Stave-Machine.

Fig. 5593.



Stave-Setter.

Fig. 5594.



Stave-Setter.

part of the fore-rigging; the weather jumper-stay alone being set up.

g. A *short stay* refers to the position of the anchor when it is nearly *under foot*, in heaving in.

h. To *stay* a vessel is to tack her. To *miss stays* is to fail in tacking. To *heave in stays* is to put a vessel about by tacking.

2. (*Steam.*) *a.* A *rod*, *bar*, *bolt*, or *gusset* in a boiler, to hold two parts together against the pressure of steam, as the *tube-stays*, *horizontal*, *vertical*, and *water-space stays*, etc.

b. Sling-rods (*sling-stays*) connecting the locomotive boiler to its frame.

c. Rods beneath the boiler supporting the inside bearings of the crank-axle of an English locomotive.

3. A bar in a frame to prevent lateral deviation of another bar. See TRUSS.

4. A *guy* supporting the mast of a *derrick*, etc.

5. (*Mining.*) A piece of wood used to secure the pump in an engine-shaft.

6. (*Apparel.*) A corset.

The garment with busk and stiffening slips of metal, wood, or whalebone is a comparatively modern invention. The ancient Greeks and Romans had belts and cinctures, but no female cuirasses. In the time of Galen, under the Antonines, the physicians wrote against these bands, which interfered with the vital functions, but their protests were received then, as now, with indifference. The ladies of the time of Louis IX. of France, like the "first gentleman in Europe" of nearly six centuries later, had their dresses stitched upon them to secure a tight fit without creases. Lord Alvanley's "fat friend" would stand for two hours like a royal Turveydrop, while the wrinkles were cut out of his coat and the seams taken up by *fine-drawing*.

The introduction of bones and metal into the female breastplate is credited to the court of Isabel of Bavaria, about 1417, and the illiberal chronicler has suggested that the device was padded to conceal deformity, and stiffened to act as a *scoliosis brace*. Catharine de Medici introduced the fashion into France.

The Emperor Joseph II. proscribed the corset and tried to discourage its use by arraying malefactors in it, much as the English authorities endeavored to set a seal of condemnation upon cotton goods by hanging criminals in cotton shirts.

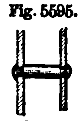
The dresses in one loose length, girdled at the waist and secured by brooches at the shoulders, was substituted by the separate waist and skirt in the fourteenth century by Queen Philippi, wife of Edward III. of England, and Queen Jeanne of Bourbon.

With the moral and hygienic features of the question this *Mechanical Dictionary* has nothing to do. The tortoise seems to get along safely in his carapace, which is the most straitly laced armor now extant among vertebrates. The armadillo is another notable instance, but his strait-jacket is open all down the belly, and allows of expansion, whether the increase in girth arise from emotion, sufflation, or overeating.

"Let me not stay a jot for dinner." — LEAR.

Stay-bolt. (*Steam.*) A bolt connecting two plates, so as to make them mutually sustaining against internal pressure. It is much used in the water and steam-jackets of locomotive and other boilers. Ostrander's stay is tubular; it has a solid head outside, but inside is open into the fire-box, so that a breakage is revealed by the leakage of water into the fire.

Fig. 5595.



Stay-Bolt.

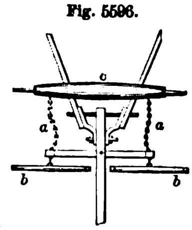
Stay-busk. (*Wear.*) A stiffener in a corset.

Stay-chain. (*Vehicle.*) One of the chains which connect the ends of the double-tree with the fore-axle, so as to limit the sway of the former. *a a* are the *stay-chains*, *b* the *double-tree*, *c* the *fore-axle*. In carriages, straps effect the same end.

Stay-foot. (*Sewing-machine.*) An attachment to the presser-bar of a sewing-machine to guide a seam-stay in some kinds of ladies' and children's shoes.

Stay-gage. (*Sewing-machine.*) An attachment to the cloth-plate to guide a strip over the goods or leather, so as to be laid upon and sewn over a seam to cover and strengthen (stay) it. Used also as a guide in sewing or trimming.

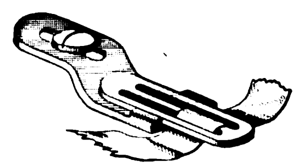
Fig. 5596.



Stay-Chains.

It is attached to the cloth-plate with the flat-headed screw accompanying it, and adjusted so that the needle will strike the binding as desired. Insert the binding as in the seam stay-foot, but pass the seam to be stayed above the gage and under the presser-foot, and guide the seam so as to stitch the binding as near the seam as is desired.

Fig. 5597.



Seam-Stay Gage.

Stay-hole. (*Nautical.*) The grommet or hole in a staysail through which the *hanks* pass; by the latter the sail runs on the stay.

Stay-lace. A braided strip to fasten a corset.

Stay-pile. (*Hydraulic Engineering.*) A pile driven into a bank and affording an anchor for the main piles which form the face of the quay, to which it is connected by *land-ties*. See PILE.

Stay-rod. 1. (*Steam-engine.*) *a.* One of the rods supporting the boiler-plate which forms the top of the fire-box, to keep the top from being bulged down by the pressure of steam.

Fig. 5598.

Staysails

b. Any rod in a steam-boiler which supports plates against internal strain by connecting parts exposed to rupture in contrary directions.

c. A tension-rod in the frame of the marine steam-engine.

2. A tie-rod in a truss or building, which prevents the spreading asunder of the parts connected.

Staysail. (*Nautical.*) A *fore-and-aft* sail supported by a *stay* of a vessel.

a, foretopmast staysail.
b, fore-staysail.
c, maintopmast staysail.
d, main top-gallant-mast staysail.
e, mizzen-staysail.
f, mizzen-topmast staysail.
g, main-royal staysail.
It is usually three-cornered.
The parts and appliances are known as, —
The *head*, — the upper corner.
The *tack*, — the lower forward corner.
The *clew*, — the lower after corner.
The *leech*, — the after edge.
The *sheet*, — a rope for hauling aft the *clew*.
The *halyard*, — for raising.
The *down-haul*, — for lowering the sail.

Stay-tack'le. (*Nautical.*) Tackle suspended from the triatic stay, and used for hoisting in heavy butts of water, freight, boats, blubber, etc.

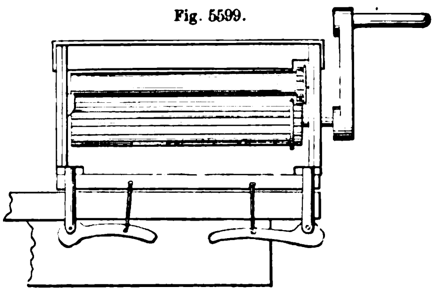
Stay-wedge. (*Locomotive.*) One of the wedges fitted to the inside bearings of the driving-axles, to keep them in their proper position in the stays.

Stead. 1. A frame, as of a bed.

2. A building, as a *homestead*. The *steading* is the collection of buildings, say the house, stables, barns, and other out-houses of a farm.

Stead'y-pin. 1. (*Founding.*) One of the pins — generally three or four, in one flask — which, by fitting into holes in the *lugs* of another, enable the two parts to be restored to their original position after the pattern is *drawn*. This term is also applied to the dowels or pins which hold patterns together when the whole is made in two or more parts, for convenience in molding.

Fig. 5599.



Steak-Crusher.

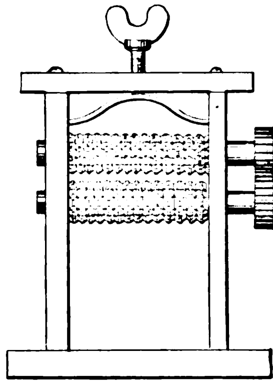
2. A dowel-pin in a sectional structure.

Steak-crush'er. A household implement to mash tough steaks before cooking.

The instrument is clamped to the table and the steak passed between the rollers, the upper one of which is smooth and the lower one corrugated.

Steak-mash'er. In Fig. 5600, the top roll tends to roll the steak in one direction, while the other roll acts upon it in like manner in the opposite direction; the fibers are thus twisted and rolled while being mashed.

Fig. 5600.



Steak-Masher.

Steal'er. (*Shipbuilding.*) The endmost plank of a *gore-strake*, which stops short before reaching the stem or stern.

Steam. The elastic aëriform condition of water heated to the boiling-point.

A steam-boiler from which a hot-air blast or an air-blast mixed with steam is blown into the fire to urge the combustion is shown in Hero's "Spiritalia." See folio edition "Veterum Mathematicorum," Parisiis, MDCXCIII., a copy of which is in the Patent-Office Library.

Applications of Steam.

Name.	Nationality.	Invention.	Date.
Hero	Greek	Rotary steam-engine (*recoil principle*)	B. C. 150
Hero	Greek	Cylinder and piston in pumps	150
Hero	Greek	Water fountain caused by pressure of steam	150
Anthemius	Lydian	Steam caldron and escape-pipe	A. D. 540
Gerbert	French	Steam-played organ	1000
Leonardo da Vinci	Italian	Steam-gun	1500
Blasco de Garay ?	Spanish	Steamboat (*Barcelona*)	1543
Baptista Porta	Italian	Steam water-elevator (*boiler and reservoir separate*)	1600
Solomon de Caus ?	French	Steam water-elevator (*boiler and reservoir identical*)	1620
Giovanni Branca	Italian	Steam-blast to rotate fan-wheel applied to pumping and grinding	1629
Marquis of Worcester	English	Steam water-elevator (*two boilers acting alternately*)	1655
Marquis of Worcester	English	Four-way cock	1655
Dr. Papin	French	Steam water-elevator (*separation of the steam and water by a float in a cylindrical reservoir*)	1695
Dr. Papin	French	Steam water-elevator (*charging reservoir by atmospheric pressure*)	1695
Dr. Papin	French	Atmospheric engine (*piston raised in a cylinder by steam beneath it, and returned by atmospheric pressure*)	1695
Dr. Papin	French	Air-chamber (*on the water eduction to correct the intermittency of the discharge*)	1695
Dr. Papin	French	Safety-valve	1695
Savery	English	Injection condensing spray (*the vacuum steam-pump*)	1698
Newcomen	English	Boiler separate from cylinder	1705
Newcomen	English	Walking-beam	1705

APPLICATIONS OF STEAM (*continued*).

Name.	Nationality.	Invention.	Date.
Newcomen	English	Separation of the steam and the water to be raised from mutual contact or contact with the same parts	A.D. 1705
Potter	English	Valve-gear	1716
Leupold	German	Effective steam pressure on piston in non-condensing engine.	1720
Allen	English	Steamboat (*hydraulic propeller*)	1730
Hull	English	Steamboat (*stern-wheel*)	1737
Smeaton	English	Boiler with flues	1750
Bernouilli	French	Steamboat (*artificial fins*)	1757
Genevois	Swiss	Steamboat (*duck's-foot*)	1757
Watt	English	Jacketing the cylinder	1769
Watt	English	Separate condenser	1769
Watt	English	Crank	1769
Watt	English	Air-pump for engine	1769
Watt	English	Double-acting engine	1769
Watt *	English	Rotary, direct-action engine (*with annular cylinder, pistons, and valvular abutments*)	1769
Symington	Scotch	Steam-carriage	1770
Watt	English	Expansion engine	1778
Watt	English	Arrangement of connecting-rod, crank, and fly-wheel	1780
Watt	English	Double engine	1781
Watt	English	Sun and planet motion	1781
Jouffroy	French	Steamboat (*Saone*)	1781
Rumsey	American	Steamboat (*hydraulic propeller, Potomac*)	1782
Watt	English	Steam-driven tilt-hammer	1783
Evans	American	Steam-carriage	1783
Watt	English	Parallel motion	1784
Murdoch	English	Steam-carriage	1784
Bramah	English	Rotatory engine on screw-propeller shaft	1785
Fitch	American	Steamboat (*reciprocating paddles, Delaware*)	1786
Miller	English	Steamboat (*paddle-wheels*)	1787
Symington	Scotch	Steamboat (*side paddle-wheels, Dalswinton*)	1788
Symington	Scotch	Steamboat (*middle paddle-wheels, Forth and Clyde Canal*)	1789
Evans	American	Stern-wheel (*Schuylkill*)	1789
Fitch	American	Steamboat (*screw-propeller, New York*)	1789
Trevethick	Welsh	Locomotive (*high pressure*	1802
Symington	Scotch	Steamboat ("*Charlotte Dundas*")	1802
Fulton	American	Steamboat (*side-paddles, Seine*)	1803
Evans	American	Steam-dredge	1803
Fulton	American	Steamboat (*side-paddles, "Clermont," Hudson*)	1807
Woolf	English	Double-cylinder expansion-engine	1804
Stevens	American	Steamboat twin screw-propeller (*Hudson*)	1804
Niepce	French	Hot-air engine carriage	1806
Stevens	American	Steamboat ("*Phœnix," New York to Philadelphia*)	1808
Blenkinsop	English	Locomotive	1811
Bell	Scotch	Steamboat ("*Comet," Clyde*)	1812
Hedley	English	Locomotive ("*Puffing Billy*")	1812
Dodd	English	Steamboat ("*Majestic," English waters*)	1813
Koenig	German	Steam printing-press	1814
Bell	English	"*Comet*" steamed from Glasgow to London	1815
Captain Rogers	American	Ocean steamboat ("*Savannah," 350 tons, crossed the Atlantic*)	1819
Perkins	American	Steam-gun	1824
Stephenson	English	Locomotive	1824
Johnson	English	Steamboat ("*Enterprize," to India, around Cape of Good Hope*)	1825
Stephenson	English	Rocket locomotive	1829
	Dutch	Steamboat ("*Curaçoa," from Holland to West Indies*)	1829
Nasmyth	English	Steam-hammer	1838
	English	"*Great Western*," 1,340 tons, crossed Atlantic in 18 days	1838
	English	"*Sirius*," crossed Atlantic in 19 days	1838
	English	"*Archimedes*," screw, government vessel	1838
Cunard packets	English	Line of mail packets, Atlantic	1840
"President"	American	Passenger vessel (lost), Atlantic	1841
	English	"*Great Britain*," screw, Atlantic	1843
Nasmyth	English	Steam-hammer	1845
Collins	American	Line of mail packets, "*Pacific*," "*Baltic*," etc., Atlantic	1850
	English	"*Great Eastern*," Atlantic	1858
	French	"*La Gloire*," armor plates, government vessel	1859
	English	"*Warrior*," armor plates, government vessel	1860
Winans	American	Cigar steamers	1860
Ericsson	American	"*Monitor*" (Timby's turret), government vessel	1862

* Watt also introduced, at various periods, the rotary-ball governor, which he devised from the old windmill governor; the throttle-valve; floating water-gage; steam-gage; steam indicator and register; packing the piston with lubricant instead of water.

Terms used: —

Pressure, the elastic force expressed in pounds per square inch.

Temperature, the heat indicated by a thermometer.

Density, the weight of a unit of its volume compared with that of water.

Relative volume, the space occupied by a given volume compared with that of the water which produced it.

Pure steam; in which the water is perfectly vaporized, none being held in mechanical suspension.

Wet steam; in which portions of water have passed off with the vapor, and are held in mechanical suspension.

Saturated steam; same as *wet* steam.

Dry steam; steam without water mechanically suspended therein.

High-pressure steam; steam at a pressure considerably above the boiling-point.

In England, a pressure above 25 pounds to the square inch is often spoken of as high pressure. In America, above 50 pounds to the square inch. The customs vary.

Low-pressure steam; below 25 or 50 pounds pressure to the square inch, as the case may be. See previous definition.

Superheated steam; that which has been brought to a temperature higher than the boiling-point corresponding to its pressure, so as to be in the condition of a permanent gas. Also known as *surcharged* steam, *anhydrous* steam, or *steam-gas*.

In the following table and calculations, the unit of measure is 1,700 cubic inches.

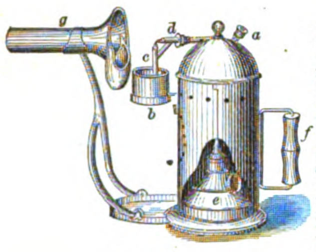
Elastic Force, Temperature, Volume, and Density of Steam.

From a Temperature of 32° *to* 387.3°, *and from a Pressure of* .2 *to* 408 *Inches of Mercury.*

Temperature.	Elastic Force per Square Inch.		Volume.	Density.	Temperature.	Elastic Force per Square Inch.		Volume.	Density.
	In Mercury.	In Pounds.				In Mercury.	In Pounds.		
Deg.	Ins.	Lbs.	Cub. Ft.		Deg.	Ins.	Lbs.	Cub. Ft.	
32	.2	.098	187407	.0000053	264.3	75.48	37	729	.001371
35	.221	.108	170267	.0000058	265.9	77.52	38	712	.001404
40	.263	.129	144529	.0000069	267.5	79.56	39	695	.001438
45	.316	.155	121483	.0000082	269.1	81.6	40	679	.001472
50	.375	.184	103350	.0000096	270.6	83.64	41	664	.001506
55	.443	.217	88388	.0000113	272.1	85.68	42	649	.00154
60	.524	.257	75421	.0000132	273.6	87.72	43	635	.001574
65	.616	.302	64762	.0000154	275	89.76	44	622	.001607
70	.721	.353	55862	.0000179	276.4	91.8	45	610	.001639
75	.851	.417	47771	.0000209	277.8	93.84	46	598	.001672
80	1	.49	41031	.0000244	279.2	95.88	47	586	.001706
85	1.17	.573	35393	.0000282	280.5	97.92	48	575	.001739
90	1.36	.666	30425	.0000329	281.9	99.96	49	564	.001773
95	1.58	.774	26686	.0000375	283.2	102	50	554	.001805
100	1.86	.911	22873	.0000437	284.4	104.04	51	544	.001838
103	2.04	1	20598	.0000477	285.7	106.08	52	534	.001872
105	2.18	1.068	19693	.00005	286.9	108.12	53	525	.001904
110	2.53	1.24	16667	.000059	288.1	110.16	54	516	.001937
115	2.93	1.431	14942	.000066	289.3	112.2	55	508	.001968
120	3.33	1.632	13215	.000075	290.5	114.24	56	500	.002
125	3.79	1.857	11723	.000085	291.7	116.28	57	492	.002032
130	4.34	2.129	10328	.000096	292.9	118.32	58	484	.002066
135	5	2.45	9036	.00011	294.2	120.36	59	477	.002096
140	5.74	2.813	7938	.000125	295.6	122.4	60	470	.002127
145	6.53	3.1	7040	.000142	296.9	124.44	61	463	.002159
150	7.42	3.636	6243	.00016	298.1	126.48	62	456	.002192
155	8.4	4.116	5559	.000179	299.2	128.52	63	449	.002227
160	9.46	4.635	4976	.0002	300.3	130.56	64	443	.002257
165	10.68	5.23	4443	.000225	301.3	132.6	65	437	.002288
170	12.13	5.94	3943	.000253	302.4	134.64	66	431	.00232
175	13.62	6.67	3538	.000282	303.4	136.68	67	425	.002352
180	15.15	7.42	3208	.000311	304.4	138.72	68	419	.002386
185	17	8.33	2879	.000347	305.4	140.76	69	414	.002415
190	19	9.31	2595	.000385	306.4	142.8	70	408	.002451
195	21.22	10.4	2342	.000426	307.4	144.84	71	403	.002481
200	23.64	11.58	2118	.000472	308.4	146.88	72	398	.002512
205	26.13	12.8	1932	.000517	309.3	148.92	73	393	.002544
210	28.84	14.13	1763	.000567	310.3	150.96	74	388	.002577
211	29.41	14.41	1730	.000578	311.2	153.02	75	383	.00261
212	30	14.7	1700	.000588	312.2	155.06	76	379	.002638
212.8	30.6	15	1669	.000599	313.1	157.1	77	374	.002673
214.5	31.62	15.5	1618	.000617	314	159.14	78	370	.002703
216.3	32.64	16	1573	.000635	314.9	161.18	79	366	.002732
218	33.66	16.5	1530	.000653	315.8	163.22	80	362	.002762
219.6	34.68	17	1488	.000672	316.7	165.26	81	358	.002793
221.2	35.7	17.5	1440	.000694	317.6	167.3	82	354	.002824
222.7	36.72	18	1411	.000708	318.4	169.34	83	350	.002828
224.2	37.74	18.5	1377	.000726	319.3	171.38	84	346	.00289
225.6	38.76	19	1343	.000744	320.1	173.42	85	342	.002923
227.1	39.78	19.5	1312	.000762	324.3	183.62	90	325	.003076
228.5	40.8	20	1281	.00078	328.2	193.82	95	310	.003225
229.9	41.82	20.5	1253	.000798	332	203.99	100	292	.003389
231.5	42.84	21	1225	.00081	335.8	214.19	105	282	.003546
232.5	43.86	21.5	1199	.000834	339.2	224.39	110	271	.00369
233.8	44.88	22	1174	.000851	342.7	234.59	115	259	.003861
235.1	45.9	22.5	1150	.000869	345.8	244.79	120	251	.003984
236.3	46.92	23	1127	.000886	349.1	254.99	125	240	.004166
237.5	46.94	23.5	1105	.000904	352.1	265.19	130	233	.004291
238.7	48.96	24	1184	.000922	355	275.39	135	224	.004464
239.9	49.98	24.5	1064	.000939	357.9	285.59	140	218	.004587
241	51	25	1044	.000957	360.6	295.79	145	210	.004761
243.3	53.04	26	1007	.000993	363.4	306	150	205	.004879
245.5	55.08	27	973	.001027	366	316.19	155	198	.00505
247.6	57.12	28	941	.001062	368.7	326.39	160	193	.005181
249.6	59.16	29	911	.001097	371.1	336.59	165	187	.005347
251.6	61.2	30	883	.00113	373.6	346.79	170	183	.005464
253.6	63.24	31	857	.001166	376	357	175	178	.005617
255.5	65.28	32	833	.0012	378.4	367.2	180	174	.005747
257.3	67.32	33	810	.001234	380.6	377.1	185	169	.005919
259.1	69.36	34	788	.001269	382.9	387.6	190	166	.006024
260.9	71.4	35	767	.001304	384.1	397.8	195	161	.006211
262.6	73.44	36	748	.001337	387.3	408	200	158	.006329

Steam-at′om-iz-er. (*Surgical.*) An instrument in which steam is employed for generating spray from a medicinal liquid when applied locally in that form.

Fig. 5601.

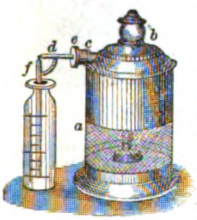


Steam-Atomizer.

Fig. 5601 consists of a sheet-metal case provided with a wooden handle *f*, and having a dome-shaped boiler at top for containing water. For use, the safety-valve *a* is removed, the boiler half filled with water, and the lamp *e* lighted. The spray-tube *c* is inserted in the cup *b* which contains the liquid, and the spray-tube *d* inserted in its socket. The blast of steam from the tube *d* causes the fluid to rise in the tube *c*, and be finally ejected in a shower at its top. The combined face-shield and drip-cup *g* serves to direct the jet of spray upward or downward, and as a receptacle for any fluid which is not forced through it. See Atomizer.

In Fig. 5602, *a* is the holder, containing a spirit-lamp, over which is the boiler *b*, provided with a safety-valve and a wooden ring, so that it may be removed without burning the hand; *c* is a tube leading from the boiler, into which the blunt-pointed canula *d* is inserted and packed with perforated pieces of india-rubber or leather, by means of a screw *e*. The sharper-pointed canula *f* is inserted in the bottle containing the liquid, and when steam is generated in the boiler, it, issuing from the canula *d*, first exhausts the air from the bottle, and then the liquid, rising in the canula *f*, is dissipated in the form of spray.

Fig. 5602.



Steam-Atomizer.

Steam and Smoke En′gine. The name given to a form of engine in which the expansive force of the heated gases from the fire is combined with that of the steam.

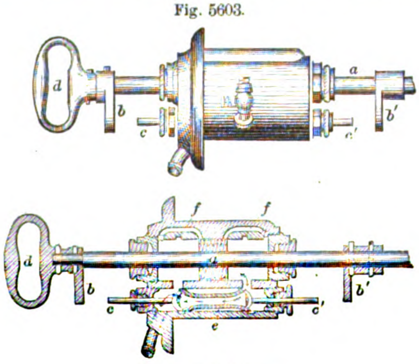
Oliver Evans' *volcanic* engine was of this class.

Bennett's also, U. S. patent, 1838. See Aëro-steam Engine, pages 20–23.

Steam Bell-ring′er. (*Railway Engineering.*) A device for ringing the bell of a locomotive by steam pressure from the boiler.

In Fig. 5603, the piston-rod *a* is attached directly to the crank of the bell, which is caused to ring automatically by opening the cock of the induction-pipe and moving the piston until one of the tappets *b b′* strikes the end of one of the valve-stems *c c′*. To stop the bell, hold the handle *d* so as to leave the bell in a perpendicular position. It is not necessary to shut off steam. The valve *e* receives steam in the center, and exhausts at the ends; relief-passages *f f* allow the air or vapor in the ends of the cylinder to escape around the piston, and, by removing the resistance, permit the piston to yield to the momentum of the bell until it stops. It may also be rung by hand by means of the handle *d*.

Fig. 5603.



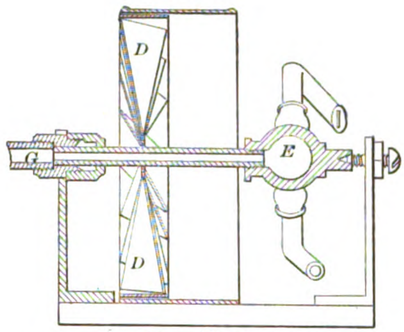
Steam Bell-Ringer.

Steam-blow′er. 1. A blower driven by a steam-engine.

2. A blower in which steam is mingled with the air-blast.

In Fig. 5604, *D* is a fan placed in a chamber adjoining the furnace. Steam from the boiler is admitted through the pipe *G* to the hollow shaft of the fan, and serves to turn the reaction-wheel *E* which rotates the fan. The current of air produced by the fan is mingled with the escaping steam and forced into the furnace beneath the grate.

Fig 5604.



Steam-Blower.

Steam′boat. A name applied to a vessel propelled by steam. The term especially belongs to steam river-craft; ocean-going craft being called steamers, steamships, etc.

The problem of the application of steam to the propulsion of vessels occupied many minds before the design was accomplished. Some had even gone so far as to make plans and test them.

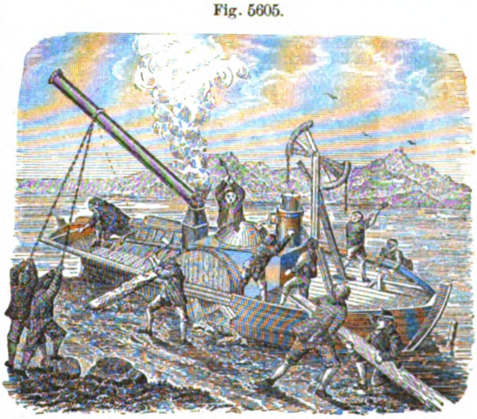
Blasco de Garay, 1543, the Marquis of Worcester, 1655, Denys Papin, 1695, Savery, 1698, and others, had prophesied, proposed, or tried steam navigation.

The modes of propulsion were applied in the following order as to date: —

Hydraulic propeller	1730
Stern paddle-wheel	1737
Artificial fins	1757
Screw	1785
Side paddle-wheels	1787
Duck's-foot side paddle-wheel	1788
Middle paddle-wheel	1789
Sets of reciprocating paddles	1789

See list under Steam. See also Propeller, pages 1808, 1809.

Fig. 5605.



Destruction of Denys Papin's Steamboat in 1695, *by the Bargemen of the Seine* (*by Figuier*).

Fig. 5605 shows a view of Papin's boat as it existed in the imagination of M. Figuier. It is next to impossible to exaggerate the merits of M. Denys Papin of Blois, but it will not be safe to warrant the illustration given by his lively countryman. The device of using wheels instead of oars, the propelling power being men or animals, was employed by the Egyptians and Romans in their war-galleys. When the Romans passed over to Sicily they were transported thither in ships moved by wheels, set in motion by oxen.

Dr. John Allen, of England, in 1730, suggested the use of the backwardly discharging pump, now known as the *hydraulic propeller*.

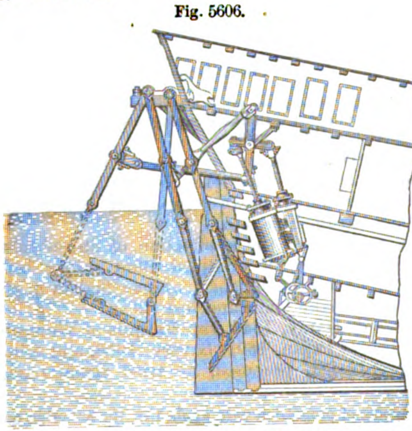
In 1737, Jonathan Hulls published a pamphlet in England describing a method of propelling a vessel by steam, for which he had secured a patent. He proposed placing the wheel at the stern, that being the proper place for it, because water-fowl pushed their web feet behind them. He used an atmospheric steam-engine, and obtained a rotary motion by an arrangement of cords and pulleys. This was before Watt's application of the crank to the steam-engine. See CRANK.

In 1757, Bernouilli (French) and Genevois (Swiss) experimented with steamboats, the first using a kind of artificial fin, and the latter the duck's-foot propeller.

In 1775 we are informed that M. Perier navigated a small steamboat on the Seine.

In 1781 the Marquis Jouffroy constructed and ran a steamboat on the Saone. Fig. 5606 shows the peculiar features of the engine and the mode of propulsion of the boat. The duck's foot seems to have formed the type. The boat was 140 feet long, 15 feet beam.

Fig. 5606.

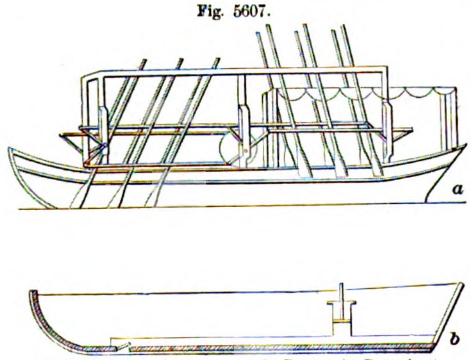


Marquis de Jouffroy's Mode of Propelling Boats.

In 1782, James Rumsey, of Sheppardstown, Va., made a public experiment on the Potomac with a boat about eighty feet long, and propelled by a steam-engine working a vertical pump in the middle of the vessel, by which the water was drawn in at the bow and expelled through a horizontal trunk at the stern. She went at the rate of four miles an hour when loaded with three tons in addition to the weight of her machinery, one third of a ton more. The whole machinery, including boiler, occupied a space but little over four feet square (see *b*, Fig 5607).

In 1786, Benjamin Franklin and Oliver Evans suggested substantially the same mode of propulsion, namely, the power of steam upon a column of water received at the bow and ejected at the stern on a line with the keel. The plan has been lately

Fig. 5607.



a, Fitch's Steamboat. *b, Rumsey's Steamboat.*

revived, and several vessels have been built in England to test it. See HYDRAULIC PROPELLER.

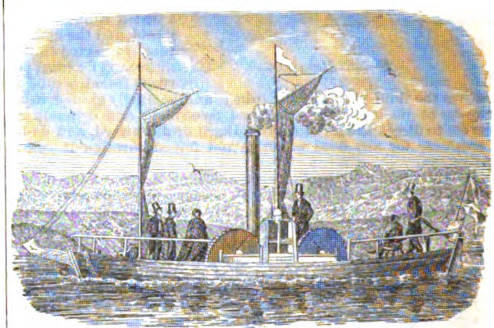
In 1786, John Fitch, a watchmaker of Philadelphia, made public his plan of paddling a ship by steam, the device resembling vertical paddles, six on each side, working alternately. His vessel was launched on the Delaware in 1788, and performed her trip of 20 miles to Burlington, where she unfortunately burst her boiler, and whence she floated back to the city. She was repaired, and made several subsequent trips. The cylinder was 12 inches diameter, had 3 feet stroke (*a*, Fig. 5607).

In 1796, he tried a steamboat, 18 feet long, 6 feet beam, on the Colleet Pond, New York City, where the "Tombs" prison now stands. The screw and paddle-wheel are said to have been used coactively in this vessel.

Fitch went West, died suddenly in 1799, and was buried at Bardstown, Kentucky.

William Symington, in 1788, applied a steam-engine to the

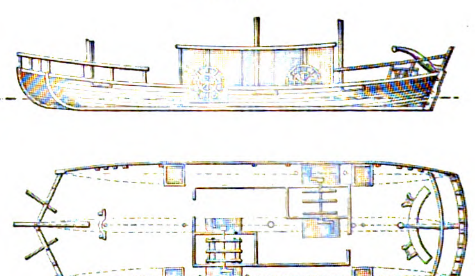
Fig. 5608.



Patrick Miller's Steamboat (1788).

pleasure-boat of Patrick Miller, of Dalswinton. This boat was furnished with side paddle-wheels, and was laid up in the winter. In 1789 a boat 60 feet long was propelled on the Forth and Clyde Canal at the rate of 7 miles an hour. Patrick Miller published an account of the invention in the year 1787.

Fig. 5609.



Miller's Boat, Dalswinton, Scotland (from his Plan in 1787).

Symington's steam-vessel, constructed in 1789, had a central space running lengthwise between the two boats, which were placed side by side and decked over. Each boat was 25 feet long and 7 feet beam, and the engine was placed on a platform. The engine had 4-inch cylinders, and drove a couple of paddle-wheels, fore and aft of the engine, which was placed amidships. The engines were atmospheric, and their pistons were connected below to an oscillating lever, or beam, much as in the present manner. Chains proceeding from the upper sides of the pistons passed over a pulley above, and the motion of this pulley, made continuous, was transmitted by an endless chain and pulleys to pulleys on the shafts of the wheels. This was substantially the same contrivance for changing the reciprocating to a rotary motion that involved the use of a ratchet and was adopted by Hulls, 52 years before.

In Symington's second boat ("Charlotte Dundas"), 1802, Fig. 5610, we find that he still kept the trough extending from stem to stern of the boat, but abandoned the wheel forward of the engine, and also Hull's chains and pulleys, adopting instead the double-acting steam-engine, connecting-rod, and crank invented by Watt some years previous to the time of the trial-trip of Symington's single-wheel steamboat.

Fulton called to see Symington, and took a trip with him.

Symington designed his boats for passenger or freight trans-

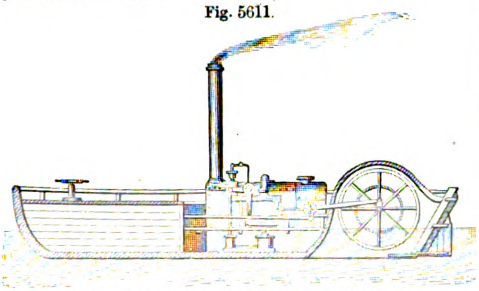
Fig. 5610.

Symington's Steamboat, "Charlotte Dundas."

portation on canals, or for towing other boats on canals, and does not seem to have used them in river, much less in ocean navigation.

His boat was used to convey passengers rather as a curiosity than as a regular business. Boats were towed by it in the canal at the rate of $3\frac{1}{2}$ miles an hour. It was abandoned from the fear (that still attends their use) that they would wash and injure the canal banks.

Fig. 5611.



The Machinery of the "Charlotte Dundas."

Oliver Evans' dredging-machine was built in 1789, by order of the Board of Health of Philadelphia. It was a flat scow, with a small steam-engine on board for working the mud-raising machinery, and propelled itself $1\frac{1}{2}$ miles on wheels to the Schuylkill, and then, by means of a stern paddle-wheel, navigated the river to its junction with the Delaware, and up that stream to Philadelphia.

Oliver Evans was a very ingenious man, and Jefferson remarked in regard to his patented *hopper-boy*, that it was "too valuable for any man to have an exclusive right to it." A curious reason truly. Jefferson, in the liberality of his own heart, carried the anti-monopoly idea to an extreme.

In 1802, Oliver Evans agreed to build a boat to run between New Orleans and Natchez on the Mississippi. The high-pressure engine was built in Philadelphia, the boat in Kentucky, but the boat was destroyed by a hurricane before the engine arrived, and the latter was used to run a saw-mill for a long period.

In 1804, John Stevens, of Hoboken, N. J., built a steamboat at his own foundry and shops, the motive-power of which was a screw-propeller with an engine supplied by a flue boiler.

In August, 1807, Fulton's boat (the "Clermont") started from New York for Albany. The Legislature of that State had promised to any persons who would accomplish the distance by a steam-vessel in 36 hours the exclusive use of the waters of the Hudson for steam-navigation. The "Clermont" performed the trip in 32 hours. Mr. Stevens built the steamboat "Phœnix," but was precluded from using it on the Hudson by the monopoly of Fulton. It was then placed on the water between New York and New Brunswick, when Mr Stevens conceived the project of sending it around to Philadelphia by sea, which he successfully carried out.

In 1808 it left New York for Philadelphia, in charge of his son, Robert L. Stevens. On the passage a storm arose, but the "Phœnix" made a safe harbor at Barnegat, whence it proceeded to Philadelphia, and plied for many years between Philadelphia and Trenton. This steamer was the first to navigate the ocean, and accomplished the distance between New York and Philadelphia in three days.

After the monopoly of the waters of the Hudson by Livingston and Fulton had ceased, Robert L. Stevens built the steamboat "New Philadelphia," and it started off at the speed of $13\frac{1}{2}$ miles an hour. The increase of speed was due to the false bow, making a sharp cut-water.

In 1827, R. L. Stevens completed and placed upon the Hudson the double-engine, large steamer "North American," which accomplished the distance between New York and Albany in about nine hours.

In 1834, Mr. Stevens established the Camden ferry line in connection with the Camden and Amboy Railway, and subsequently invented the present usual system of connections between pistons and cranks, and also the division of the paddle-board into portions arranged like steps, so as to prevent too great jar on the water.

The machinery and boat of Stevens' screw-propeller is shown in Fig. 4747, page 2071. The machinery is still preserved in the Stevens Institute of Technology in Hoboken, N. J.; in 1844 it was again placed on a boat, which it propelled at the rate of 8 miles per hour.

Mr. A. L. Holley claims for the Messrs. Stevens of Hoboken that they were the originators of many, if not most, of the improvements in modern naval warfare. He claims that the Messrs. Stevens, father and son, either originated, or first developed, the following important features of modern naval warfare: Twin screw, 1805; armor plating, 1812; inclined armor, 1812 and 1841; training guns by rotating the vessel, 1812 and 1862; engines and screws below water in war-vessels, 1841; large engines to work expansively at ordinary times, and with maximum power in action, 1841; concentrated fuel, (working to petroleum?) 1841; iron hulls for war-vessels, 1841; wrought-iron rifled gun, 1841; the Armstrong lead-coated elongated shot, 1841; concentrated protection, a central battery, a belt of armor at the water line, and a shell-proof deck, 1843 to 1854; protecting the hull by immersion to fighting-draft, by means of water let into compartments for the purpose, 1843 to 1854; wrought-iron engine-framing, and a wrought-iron ship of 420 feet length, 1843 to 1854; loading a gun below deck by steam power, 1862.

We now come to a man whom success crowned, *Fulton*. Perhaps in the fullness of the meed of praise the claims of others have been not fully regarded. He had the benefit of the previous experiences of Hulls, Jouffroy, Ramsey, Rumsey, Symington, Evans, and Fitch, and the choice of six different modes of propulsion, each of which had been used by one or other of his predecessors. He was not slow to acknowledge his indebtedness (see his letters to Bell), worked faithfully at his boat and machinery, and achieved success.

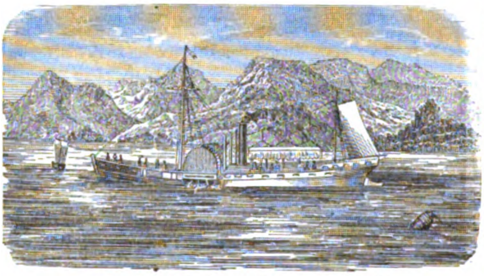
Much unnecessary acrimony has been shown in Great Britain in reference to the respective claims of the American trio, Rumsey, Fitch, and Fulton (stated in order of date), and those of Symington and Bell. The hard words have been principally bestowed upon Fulton, because he was manifestly the most practical and successful. The ungenerous and untruthful remarks seem frivolous to one who has read the pleasant and confidential correspondence that took place between Fulton, Bell, and Miller, the latter being the person that bore the expense of the Symington experiments.

Had it been possible, it would have been better for the British journalists to have written the "History of Steam Navigation," leaving out the name of Fulton. A parallel experiment has been made by the same parties in writing the "History of Electric Telegraphs," leaving out the names of Henry, Draper, Morse, Farmer, and others. Of course they have not heard of Hughes, Phelps, Edison, Stearns, Little, Anders, Pope, and House. One such treatise(?) is before the writer, and its complacent appropriation of all the glory is amusing.

Fulton visited Symington about 1801 or 1802, and they had a pleasant chat and a trip together eight miles up the Forth and Clyde Canal. Fulton spoke highly of his host's boat, and referred to the value of steam-vessels on the vast rivers of the United States. After the death of the Duke of Bridgewater, and the abandonment of Symington's plans as unsuitable *for canals*, the inventor ran his boat into a creek, where she rotted away, and the ingenious mechanic died a disappointed and impoverished man. He was faithful in his day and generation, and will not be forgotten in the history of steam-navigation. Mr Bell visited the boat in its desolate condition.

Robert Fulton was born in Little Britain, Lancaster County, Pa., in 1765, and studied as a watchmaker. He afterward studied as a painter with Benjamin West. He brought forward his ideas of steam-navigation in 1793, and corresponded with Lord Stanhope on the subject in 1794. He took out three British patents, — a double-inclined plane to be used in transportation, a flax-spinning machine, and a rope-machine. He submitted his plan for improving canal navigation to the British government in 1796, and patented it in 1797. He pursued the subject in correspondence with Earl Stanhope during his stay in France, which continued seven years. During this period he made experiments with his submarine and torpedo boat. Chancellor Livingston had designed to avail himself of the conditional grant in 1798 of the State of New York for navigating the Hudson by steam, and being U. S. Ambassador in Paris during the period of Fulton's residence there, they became mutually interested in the projects for steam-navigation. Experiments on the Seine were instituted, and in 1803 a paddle-boat 60 feet long was launched on the river. A previous boat had been broken in two by the weight of machinery. Fulton returned to the United States in 1806, and, in concert with the Chancellor, commenced the building of the "Clermont," of 160 tons. This vessel was launched on the East River, and was fitted with the Boulton and Watt steam-engine, purchased for the purpose in England.

Fig. 5612.



Fulton's Steamboat, "Clermont," 1807.

Fulton's boat, the "Clermont," ran in 1807, and had the following proportions: —

Length, 133 feet.
Depth, 7 feet.
Breadth, 18 feet.
Burden, 160 tons.
1 cylinder, 2 feet diameter, 4 feet stroke.
Paddle-wheels, 15 feet diameter, 2 feet dip, 4 feet broad.
Boiler, 20 feet long, 7 deep, 8 broad.
Speed, 5 miles per hour, up stream.
She reached Albany in 32 hours.

Fulton invented the outside bearing of the paddle-wheel shaft, and the paddle-box as a guard for the wheel. He was the first to proportion the sizes and strengths of the parts, and to bring the combination of engine and boat to a system. To him more than to any other one man is due the credit of the introduction of steam-navigation. The verdict of his countrymen is about right after all. It is not always that the general voice blends so harmoniously with the facts.

Charles Brown had built for Fulton, between 1806 and 1812, six steamboats of lengths varying from 78 to 175 feet, and tonnage 120 to 337, prior to the practical working of any steamboat in Europe.

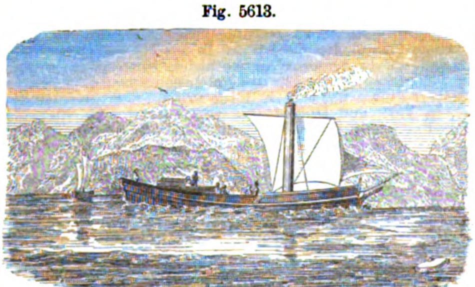
Fulton built the first steamboat on the Western rivers, at Pittsburg, in 1811. The "Orleans," of 100 tons, was a sternwheeler, took her first freight at Natchez for New Orleans, and plied for three or four years on the river between those points. She made her first trip from Pittsburg to New Orleans in 14 days. The next vessel was the "Comet," of 25 tons, in 1814. She made three or four trips, was taken to pieces, and the engine set up in a cotton factory. The third was the "Vesuvius," in 1814. She made a number of trips, but eventually exploded.

Fulton afterward devoted his attention to a submarine battery, for which he obtained a patent in 1813. In 1814 a steam man-of-war was launched under the name of "Fulton the First."

He died in 1815.

Bell's steamboat, the "Comet," was built in Greenock, and plied in 1812 between Glasgow and Greenock. It had 40 feet keel, 10½ feet beam, was fitted with a portable engine of 3 horsepower, and was propelled by paddle-wheels. He lost money by the operation, but had a safe, practical boat which made trips all round the coasts of the British Islands.

Fig. 5613.

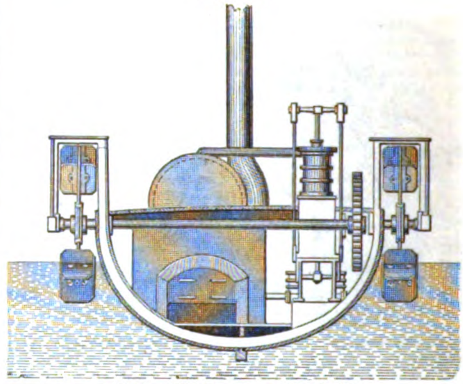


Bell's Boat, "Comet."

In 1814, there were 5 steamers making regular passage in Scottish waters, and none in England or Ireland In 1820, England had 17; Scotland, 14; Ireland, 3. In 1840, it stood thus: England, 987; Scotland, 244; Ireland, 79.

The "Majestic" was navigated from Glasgow to Dublin in 1814, by Dodd. In 1817, 7 steamboats plied on the Thames under Dodd's direction. A Parliamentary commission of 1817 stated the necessity of steam as a marine and river motor, and

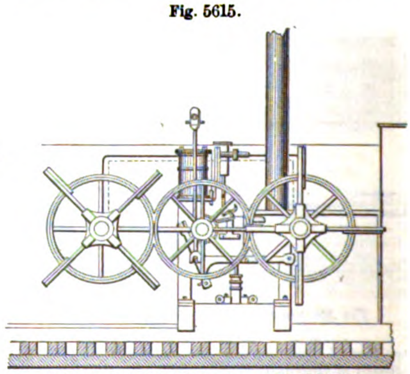
Fig. 5614.



"Comet" (Transverse Section).

cited the extensive use of the same in America, "which preceded by some years the establishment of practical steam-vessels carrying passengers in any part of Europe." (TEMPLE)

Fig. 5615.



"Comet" (Side Elevation of Machinery).

In 1818, Mr. Scarborough, of Savannah Ga., purchased in New York a ship of about 350 tons burden, which was then on the stocks, to settle the question of the ability of a steam-vessel to navigate the ocean. This ship was the "Savannah." He engaged as engineer Captain Moses Rogers, who had been familiar with the experiment of Fulton. Captain Stevens Rogers, of New London, Conn., was employed to navigate the vessel. Under his command the "Savannah," having been duly equipped with engine and machinery, steamed out of New York Harbor on the 27th day of March, 1819, bound to Savannah on her trial trip, which was successfully made.

On the 26th of May in the same year she left Savannah for Liverpool, making the trip in 22 days, during 18 of which she was propelled by steam-power From Liverpool the "Savannah" went to Copenhagen, Stockholm, St. Petersburg, Cronstadt, and Arundel, and from the latter port returned to Savannah, making the passage in 25 days.

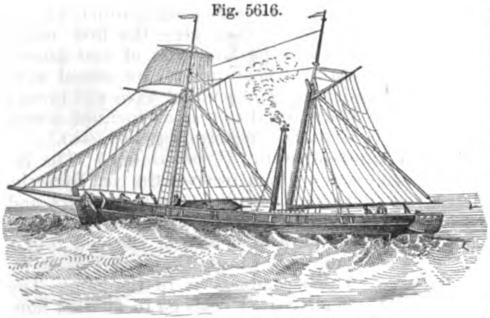
The log-book of the "Savannah" was sent to the Navy Department in 1848. Captain Stevens Rogers died in New London in 1868. The "Savannah" was built by Crocker and Ficket in New York, and her engines made at Elizabethtown, N. J.

In 1824, the "Enterprize," under Captain Johnson, made a voyage to India, doubling the Cape of Good Hope.

The "Curaçoa," in 1829, made several voyages between Holland and the West Indies.

The screw-propeller, after being several times suggested, and well proved by John C. Stevens, of Hoboken, was more distinctly noticed when brought forward by Ericsson in 1836. Ericsson's propeller, the "Francis B. Ogden," was tried on the Thames in 1837. The same year the propeller of Francis P. Smith was also tried. The latter put the screw in the deadwood. Ericsson's second vessel, the "Robert F. Stockton," was launched on the Mersey in 1838; she crossed to the United States in 1839, and was purchased by the Delaware and Raritan Canal Co. Captain Ericsson subsequently built the "Enterprize." He was the first to couple the engine directly to the propeller-shaft. He did for England and America with the screw-propeller what Fulton did in America and Bell in England for the paddle-wheel. The "Archimedes," English gov-

Fig. 5616.

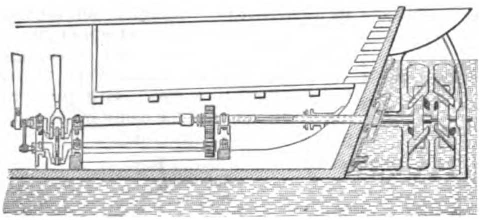


The "Robert F. Stockton" Propeller.

ernment vessel, was built in 1838, and fitted with a propeller; the "Rattler," in 1842.

In 1838 the "Sirius" and "Great Western" crossed the Atlantic from Bristol to New York, the former in 19 and the latter in 18 days.

Fig. 5617.



Machinery of the "Robert F. Stockton."

In the same year the "Archimedes," an English government vessel, was fitted with a screw.

In 1840 the famous Cunard line of Transatlantic steamers was established. The first steamer of the line was the "Britannia," which sailed from Liverpool, July 4, 1840. The company commenced with four ships, having an aggregate of 4,602 tons; the service has now grown to a fleet of 60 vessels, some of nearly 5,000 tons, and an aggregate tonnage of 120,000 tons. For 35 years the service has been regularly maintained; at first once, then twice, and more latterly thrice a week, in each direction, without the loss of a vessel, a passenger, or a mail-bag. This immunity from accident is extraordinary when we consider that the ships of the company have made over 4,000 voyages and carried 2,000,000 passengers.

The dimensions of one of the later vessels may be given. Like all the vessels belonging to the line, the "Scythia" was built on the Clyde, and, like many others of them, constructed and engined by Messrs. J. & G. Thomson, of Glasgow. This steamer is 482 feet in length between the perpendiculars, 42 feet 6 inches in molded width, and 36 feet in depth, and has a builders' measurement of 4,556 tons. The "Scythia" is propelled by compound direct-acting engines of 600 horse-power nominal, but capable of being worked up to five times that amount. The cylinders of these engines are respectively 60 and 104 inches in diameter, and the piston has a stroke of 4 feet 6 inches. The vessel is divided into seven water-tight compartments by six strong iron bulkheads, which extend from the keel up to the main deck, which latter, it may also be stated, consists of strong plated iron covered with wood. The iron plating, being securely riveted to each of the beams and ribs of the ship, adds greatly to its general strength and security. The "Scythia" is provided with twelve lifeboats of large size, all constructed on the self-righting principle, and all fitted with lowering appliances by which they can at once and safely be lowered into and placed in the water, while there is an abundant supply of life-buoys in every part of the ship. She is fitted to accommodate 1,500 individuals, including her crew. Of that number there is ample accommodation for 300 first-class and 1,000 second and third class passengers. The vessel lately made her trial trip on the Clyde, an average speed of 15 knots per hour.

The Collins line was started soon after the Cunard, but was not so successful, a number of the vessels being lost.

The rate of speed has been gradually increased, the figures being approximately as follows: —

"Savannah"	1819	26 days.
"Sirius"	1838	19 days.
"Great Western"	1838	18 days.
"Pacific" and "Baltic"	1851	9 days, 19 hours.
"Arabia" and "Persia"	1851 to 1861	9 days, 12 hours.
"Scotia" and "City of Paris"	1863 to 1866	8 days, 12 hours.
"City of Brussels" and others	1866 to 1873	7 days, 20 hours.

The following are some of the fastest trips on record: —

The "Daniel Drew" ran from Yonkers to New York, a distance of $14\frac{1}{2}$ miles, in 35′ 45″, or at a rate of over 25 miles per hour.

The "Chauncey Vibbard" ran from New York to Albany, 160 miles, in 6 hours and 40′. In deep water she averaged 24 miles an hour.

The "Mahroussee," built in England by Samuda, designed by Lang; oscillating engines by Penn, — obtained a speed on her trial trip of $21\frac{1}{2}$ statute miles an hour. Length, 360 feet; breadth, 42 feet; depth, 29 feet; wheels, 33 feet diameter; tonnage, 3,141; horse-power, 800.

An Indian dispatch-boat for the Orissa canals, built by Thornycroft, London, has a length of 87 feet; beam, 12 feet; draft of water, 3 feet 9 inches. The speed contracted for was 20 statute miles per hour. The hull, the working parts of the engines, and the propeller are of Bessemer steel, and the woodwork is of teak. The trial trip of the boat gave the following results: With tide, 25.08 miles per hour; against tide, 24.15 miles per hour; a mean speed of 24.61 miles per hour. In another official trial it was shown that the boat could keep up a speed of 22 miles per hour without losing steam.

The regularity of passage is extraordinary, as may be seen by a statement of the passages of the Inman steam-ships "City of Chester" (4,566 tons) and "City of Richmond" (4,607 tons), covering the whole of the year 1874: —

"CITY OF CHESTER." Voyage.	d.	h.	m.	"CITY OF RICHMOND." Voyage.	d.	h.	m.
First	8	1	38	First	8	11	58
Second	8	5	58	Second	8	2	38
Third	8	11	28	Third	8	9	48
Fourth	8	2	8	Fourth	8	18	23
Fifth	8	4	33	Fifth	8	7	18
Sixth	8	6	8	Sixth	8	21	48
Seventh	8	8	38	Seventh	8	2	48
Average	8	5	47	Average	8	10	38

The six largest steam-ships in the world, excepting naval vessels, are the "Great Eastern," owned by the International Telegraph Construction and Maintenance Company, 674 feet long, 77 feet broad, 22,500 tons; the "City of Pekin," belonging to the Pacific Mail Steam-ship Company, 6,000 tons, 423 feet long, 48 feet broad; the "Liguria," of the Pacific Steam Navigation Company, 4,820 tons, 460 feet long, 45 feet broad; the "Britannic," of the White Star Line, 4,700 tons, 455 feet long, 45 feet broad; the "City of Richmond," of the Inman Line, 4,600 tons, $453\frac{1}{2}$ feet long, 43 feet broad; and the "Bothnia," of the Cunard Line, 4,500 tons, 425 feet long, $42\frac{1}{2}$ feet broad. See Ship, Fig. 5001, page 2154.

Taking the largest of these, we may give the details.

PARTICULARS OF THE "GREAT EASTERN" STEAM-SHIP.

Material. *Iron.* Builders. *J. Scott Russell & Co.*

Gross tonnage	22,500 tons.
Nominal horse-power, total	2,600 H. P.
Length between perpendiculars	680 feet.
Length on deck	691 feet.
Breadth, extreme	83 feet.
Depth of side	58 feet.
Estimated draft, light	20 feet.
Estimated draft, laden	30 feet.

Screw engines. *James Watt & Co., makers.*

Nominal horse-power of screw engines	1,600 H. P.

Description. *Horizontal direct-acting (ungeared).*

Number of cylinders. *Four.*

Diameter of each cylinder	84 inches.
Length of stroke	4 feet.
Number of strokes of engine per minute	55

Kind of boilers. *Tubular.*

Pressure of steam	25 lbs.

Kind of screw-propeller. *Four blades, ordinary.*

Diameter of screw	24 feet.
Pitch of screw	44 feet.

Paddle-wheel engines. *J. Scott Russell & Co., makers.*

Nominal horse-power of paddle-wheel engines	1,000 H. P.

Description. *Oscillating.*

Number of cylinders. *Four.*

Diameter of each cylinder	74 inches.
Length of stroke	14 feet.

Kind of boilers. *Tubular.*

Pressure of steam	25 lbs.

Kind of paddle-wheels. *Common.*

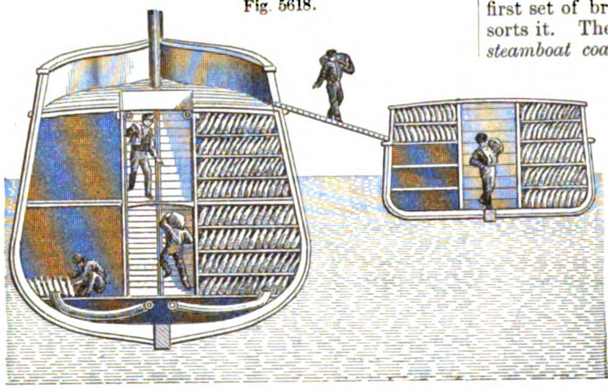
Diameter of paddle-wheels	56 feet.
Length of floats of paddle-wheels (*reefing*)	13 feet.
Depth of floats of paddle-wheels	3 feet.
Total coals carried	10,000 tons.

In a recent number of the Statistical Society's "Journal," a table was given showing the number of vessels, tonnage, etc., of all the mercantile navies of the world for 1870 and 1873. It appears that in 1873 sailing-vessels had decreased — as compared with 1870 — in number by 5.44 per cent; in tonnage by 11.57 per cent; in average size by 6.67 per cent. Steamers had in the same time increased in number by 24.59 per cent; in tonnage by 54.94 per cent; in average size by 24.41 per cent. The total number of sailing-vessels was, in 1870, 59,518, with a tonnage of 16.042,498 tons; in 1873, 56,281, with a tonnage of 14,185,836: the average size being, in 1870, 270 tons; in 1873, 252 tons. Of steamers, the total numbers were, in 1870, 4,182,

with 2,793,532 tons, average size 676 tons; in 1873, 5,148, and 4,328,193 tons, averaging 841 tons each. In 1870, Great Britain carried 6,993,153 tons in 23,165 sailing-vessels, and 1,651,767 tons in 2,426 steamers; in 1873, 5,320,089 tons in 20,832 sailing-vessels, and 2,624,431 tons in 3,061 steamers.

Fig. 5618 is a transverse section through a steamer whose hold is fitted with racks for holding sides of meat for Transatlantic transportation. Such are proposed to carry the surplus meat of Texas or Buenos Ayres to a European market. The proposition has been many times made, but the instance illus-

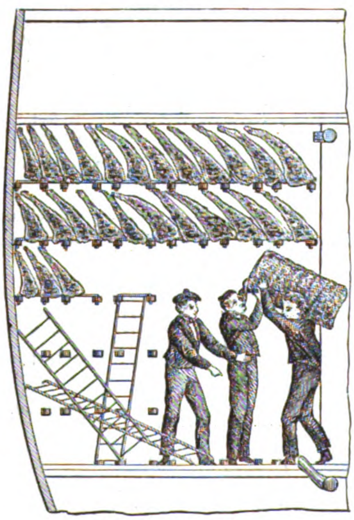
Fig. 5618.



Refrigerating-Steamer (Section through the Steamer and Barge).

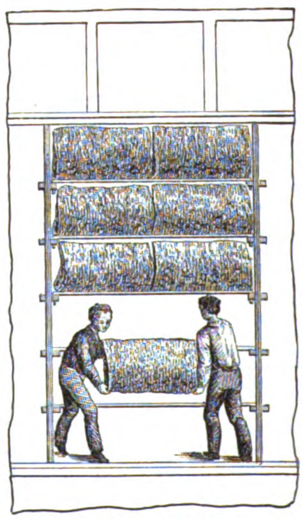
trated is that of the steamer "Frigorific," 900 tons, intended for the La Plata and Paris trade. The barge shown alongside is intended for the river Seine transportation between Havre and Paris. Both ship and barge are fitted with the Tellier refrigerating apparatus, in which a low degree of temperature is imparted to an air-blast which passes around large plates cooled by the expanded vapor of methylated spirit. See ICE-MAKING, pages 1164-68, and Plate XXVI. Some of these refrigerating devices employ ice, and others cool the air by the expansion

Fig. 5619.



Refrigerating Steamer.
(Transverse Section.)

Fig. 5620.



Refrigerating Steamer.
(Longitudinal Section.)

of previously condensed vapor. See also REFRIGERATOR, pages 1910, 1911.

Steam'boat-ing. (*Bookbinding.*) Cutting simultaneously a pile of books which are as yet uncovered, that is, are *out of boards.*

Steam'boat-roll'ers. (*Coal-mining.*) The large coal-breaking rollers at the mines. The *lump* coal is dropped through holes in the platform into a hopper, thence between a pair of heavy rollers known as *steamboat-rollers,* as they give the first rough breakage and produce the large size of coal known as *steamboat coal.* These rollers are armed with steel teeth, and revolve on parallel axes and toward each other. The coal falls on to an inclined screen known as the STEAMBOAT-SCREEN (which see).

Steam'boat-screen. (*Coal-mining.*) The inclined barrel-screen which receives the coal from the first set of breakers, known as *steamboat-rollers,* and sorts it. The meshes hold the large size, known as *steamboat coal,* and pass it out at the end into a chute known as the *steamboat-chute,* which conducts it to the bin. The smaller-sized coals go to another hopper, and thence to a second pair of crushing-rollers, known as the *breaker-rolls;* thence to the long screen which sorts it into various sizes, — *pea, chestnut, stove, egg, furnace,* and *broken,* which is next below the steamboat.

Steam-boil'er. A vessel in which water is converted into steam for the purpose of supplying steam-engines, lard-tanks, pulp-digesters, cooking-vessels, dye or bleaching vats, tanks for impregnating wood with preserving solutions, and for many other purposes. A *steam-generator.*

Boilers are known by names indicating *shape,* as, —

Cylindrical. Spherical.
Hay-stack. Wagon.
Kettle.

Or *position,* as, —

Horizontal. Stationary.
Portable. Upright or vertical.

Or *use,* as, —

Locomotive. Marine.

Or *construction,* as, —

Flue. Sectional.
Drop flue. Multiflue. Return flue. { Instantaneous generators. Flashers.
Sheet flue. Internal fire.
{ Tubular. Water tube. Two-stack. Turn-over.
Drop tube. Superheaters.

Or the *inventor,* or *locality of invention,* —

Cornish. Smeaton.
{ London. Small Cornish.

The following is the official classification of steam-boilers: —

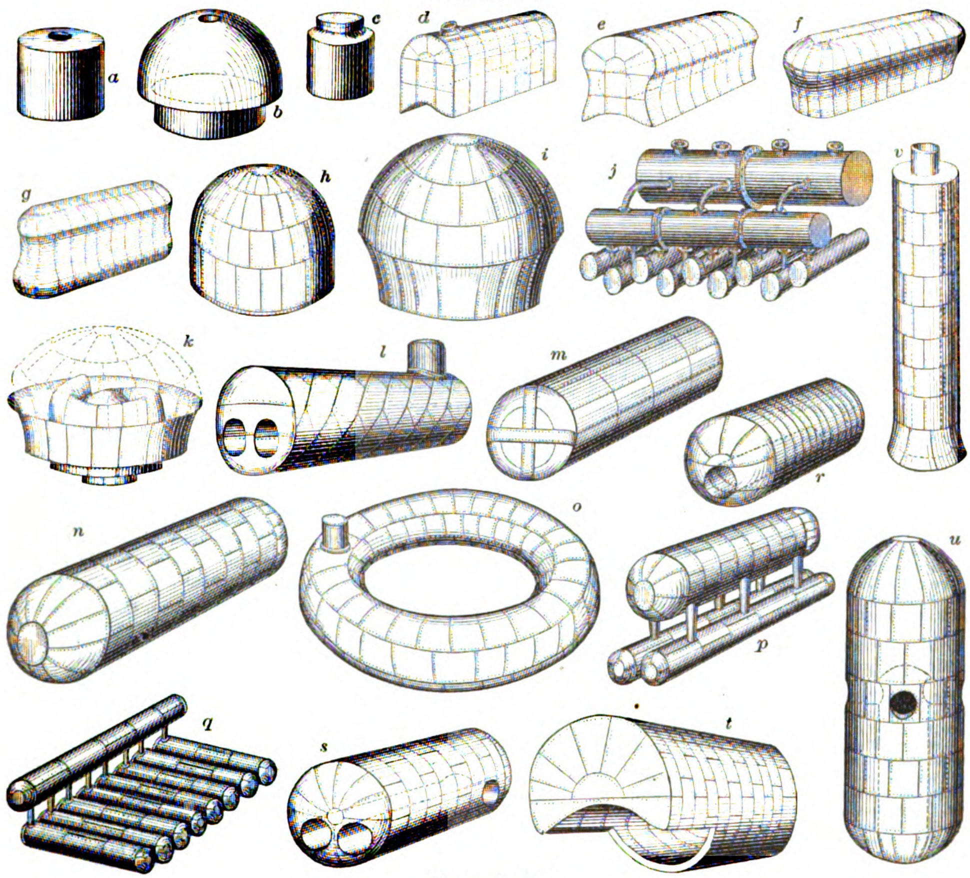
Boiler attachments.
Chemical vapor-boilers.
Cleaners.
Circulation.
Condensers.
Coverings.
Draft-regulators.
Fire-tube boilers.
Flashers.
Flue and tubular.
Furnaces.
Furnaces, hydrocarbon.
Grates and grate-bars.
Heaters and feeders.
Incrustation.
Indicators.
Sectional.
Spark-arresters.
Superheaters.
Tubes and flues.
Water fire-boxes.
Water-tube.
Miscellaneous.

The early form of steam-generator was a sphere, as seen in the Æolipile of Hero; the boilers of Worcester, Papin, and Savery. The flue wound spirally around the outside.

For this was substituted a boiler with a hemispherical top and flat or arched bottom; as in those of Newcomen and Leupold.

The wagon-boiler — so called from its shape, resembling a wagon with a tilt — was used by Watt, and continues to be used to the present day. It has some variation in its forms, and the sides are sometimes strengthened by stays against collapsing or bulging. It is only used with low pressures.

Fig 5621.



Forms of Boilers.

Fig. 5621 shows 22 forms of steam-boilers, from a report by Mr. Marten, of the Midland Steam-Boiler Inspection and Assurance Company of England.

a was the *Savery* boiler.

b, the *tun* boiler.

c, the *flange* boiler.

d e f g are forms of *wagon* boilers.

h, *haystack* boiler.

i, *balloon* boiler.

j, a boiler of nine cast-iron pipes, a transverse larger connecting-pipe, and an upper one forming a steam dome.

k, an improved *haystack* boiler, with a central dome-like fireplace and helical flue.

l, *cylinder* boiler with flues and boiler-plate head.

m, *cylinder* boiler with cast-head banded.

n, *cylinder* boiler with hemispherical ends.

o, *ring* boiler.

p, the *elephant* boiler, or French boiler.

q, the *retort* boiler.

r, the *cylinder* boiler with single flue.

s, the *cylinder* boiler with two flues opening at the front and at the sides near the rear end.

t, the *Butterley* boiler, fired internally and uniting the *wagon* and cylindrical forms.

u, *upright* boiler with hemispherical ends. *v*, *chimney* boiler.

Plate LXI. shows a variety of steam-boilers.

In Fig. 5622, *A* represents a transverse section, and *B* a longitudinal section of the wagon boiler, so termed from its resemblance in shape to the tilt or cover of the old-fashioned road wagon.

a is the fire-grate; *b b*, the flue surrounding the boiler; *c*, feed water-pipe; *d*, steam-pipe; *e*, external safety-valve; *f*, internal safety-valve; *g g'*, gage-cocks.

The feed water-pipe *c* descends in the boiler to a point below that at which the surface of the water should stand; the steam pressure within the boiler supports a column of water in the pipe, at a hight dependent on the amount of the pressure. A float *h* in the pipe is connected by a chain *i* passing over two pulleys, with a rod *j*, which supports the flue-damper. When there is an undue steam pressure on the boiler, the float *h* rises, causing the damper to fall, partially closing the flue-opening, diminishing the draft, and moderating the heat of the furnace until the evaporation within the boiler is reduced to its proper amount. If, on the contrary, the steam pressure is too low, the float *h* falls, opening the damper and increasing the evaporation.

The float *k* rests on the surface of the water within the boiler, and is attached by a wire *l* which passes steam-tight through a collar in the top of the boiler to the extremity of a lever *m*, having a weight *n* at its other end; a rod is connected at *o* to this lever, and has a valve *p* fitting a seat in the bottom of the hot-water cistern *q*. As the float *k* rises and falls, it, through the medium of the rod *l*, opens or closes the valve *p* more or less, so as to maintain the water in the boiler at a nearly uniform level. The hot-water cistern *q* is supplied from a reservoir which receives the water of condensation by means of a pump operated by the action of the engine.

The external safety-valve *e* is a lever of the third kind, whose weight may be adjusted so as to blow off at different degrees of pressure. The waste steam may be discharged into the open air or utilized for heating the feed-water. The internal safety-valve *f* is a lever of the first kind, its weight being so adjusted as to admit air to the *boiler* when the steam pressure falls below that of the atmosphere. See SAFETY-VALVE.

Fig. 5623 is a perspective view of a wagon-boiler, one half the top being removed to show the interior.

Steam-boilers, before the invention of Smeaton (1740 – 1770), were *globular*, or segments of spheres, and were *heated from the exterior exclusively*. Smeaton invented flue-boilers, so that the fire might reach the interior. He devised the horizontal, lengthened cylindrical boiler, traversed by a flue.

Oliver Evans, of Philadelphia, used a flue-boiler with his engine, which was alternately a steam-

dredge, steam-scow, and stone-saw. Patented February 14, 1804. Extended by Congress February 7, 1815.

Captain John Stevens, of Hoboken, had a flue-boiler on his boat in 1804. See SCREW-PROPELLER, pages 2070, 2071.

Trevethick had a flue-boiler in his locomotive of 1802 - 1805. It had two flues, one direct and the other reverting, the chimney being over the fire-box.

Several of the locomotives tried at the Liverpool and Manchester Railway, 1829, were similarly furnished.

The cylindrical steam-generator is a strong form, economical of material.

In one English form the fire passes underneath the boiler longitudinally, thence turns and passes alongside of the boiler, traversing a brick flue; it then crosses in front and returns along a flue on the other side; reaching the chimney after traversing three times the length of the boiler.

In the form invented by Smeaton, and usual in the United States, there are no brick flues at the side, but two or more tubular longitudinal flues in the boiler, through which the caloric current returns to the front end, and then is conducted to the chimney.

Woolf's steam-boiler, patented in England in 1803, and very successful at the Cornish mines, was an extension of the cylindrical system, a large number of cylinders of comparatively small diameter being connected together and to an upper cylindrical steam-chest.

One of his boilers having 8 tubes of cast-iron may be taken as an illustration. These tubes are, say, 6 inches in diameter, and are connected to each other by bent tubes at their extremities, having communications to a larger cylinder above, employed as a reservoir for the steam. The furnace is divided by a wall longitudinally into 2 parts, and the 8 tubes are fixed horizontally across both these.

Steam-generators with interior furnaces have been made to assume a number of forms.

Fig. 5624, Plate LXI., illustrates some of these, — *a*, section, and *b*, elevation, of oval boiler; a very old form.

c, plan, and *d*, elevation, of an old boiler with spiral flue.

e, section of cylindrical boiler with central flue, in which is the fire-space and two smaller return flues.

f, wagon-boiler, with central cylindrical flue.

Fig. 5625 shows three usual forms of boilers, —

a, the portable-engine boiler.

b, the vertical stationary boiler.

c, the single-flue cylindrical boiler with steam dome.

The boiler with *numerous small flues* was first introduced upon George Stephenson's locomotive, the "Rocket," in 1829. It was mainly by the heating surface thus obtained that it was enabled to beat Braithwaite and Ericsson's "Novelty," and Hackworth's "Sanspareil." The inventor of the small boiler-flues was Henry Booth, the Secretary of the "Liverpool and Manchester Railway Company." Flues on a larger scale had been used by Smeaton 79 years before. Linings and diaphragms used to aid circulation were invented by Jacob Perkins, and used by him and several of his pupils, and by others.

Galloway's boiler, English (Fig 5626), had a double furnace, and combines the tubular and flue construction. The main flue is supported by a series of hollow legs, around which the flame plays, and through which the water circulates. These water-legs are placed zigzag. The furnaces, being distinct, may be fired alternately, so that one will consume the smoke of the other.

Tippet's boiler (Fig. 5627), English patent, 1828, was a large cylinder with a smaller interior cylinder, which formed the fire-place and flue. From the external cylinder *a*, which contains water, proceed three rows of open vertical pipes *b b b*, which support a semi-cylindrical steam-chest *c*. At the rear of the main boiler *a* is a short pipe *d*, communicating with a short cylinder *e*, which receives the direct impact of the flame as it comes from the main flue, and from which the flame proceeds upward, enveloping the vertical tubes and coursing along the under side of the semi-cylinder, whose bottom is covered with water. The flue dives in front, passes under the main boiler *a*, beneath and back of chamber *e*, and over the top of the chamber *c* to the chimney.

In Fig. 5628, *A* is a front elevation, *B* a transverse, and *C* a longitudinal section of Horton's boiler. The upper and lower parts *a b* are cylindrical and connected by a space *c* with vertical sides, through which the transverse flues *d d* pass. The fire-spaces are in the lower flues *e e*, and the heated products of combustion after passing through these are reverted through the small flues *f f*, which expose a proportionately greater area of surface to the water above, in order to compensate for the heat lost in passing through the lower flues.

Field's boiler, *A* (Fig. 5629) has a number of vertical tubes *a* fitted into the crown sheet *b* over the fire-space. These are closed at their lower ends, but open into the boiler above, as shown at *B*, and contain smaller tubes *c*, open at both ends and funnel-shaped at top. The application of heat causes the water in the outer tubes to expand and rise through the annulus between the two tubes, while the cooler water in the upper part of the boiler flows downward, causing a rapid circulation in each direction and preventing incrustation. The upright boilers of the dummy locomotives of the Hudson River Railway, built in 1858 and 1859, had cylinders around the tubes to separate the downward from the upward currents; the down flow of solid water is between the shell and the insulating cylinder, and the up flow of foam is among and around the tubes.

Montgomery's boiler (Fig. 5630) has a series of vertical tubes *a a* passing through the central longitudinal flue *b*, and connecting the upper and lower water-spaces *c c*; a diaphragm *d*, through which the tubes pass, serves to divide their length into two portions, the flame in its hottest condition coming in contact with the portion of the tubes above the diaphragm; on reaching the back part of the flue the flames are reverted, and pass under the diaphragm to the front of the boiler, in order to reach the chimney; the object is to keep the upper ends of the tubes at a constantly higher temperature, so as to create a continuous ascending current in the tubes and down through the water-ways at the sides and ends. The steam generated in the tubes sweeps upward with the water instead of through it, and carries with it the sedimentary impurities, which tend rather to accumulate when the current descends and is relatively quiet. *e* is a steam-drum, *f* the grate.

Sectional Steam-Boilers. — Steam-boilers made in detachable portions, which are fastened together by packed or screw joints. They admit of renewal of portions as they may become worn, also of removal for scaling off the incrustation, also of building up of such number of sections as may give the heating surface and capacity desired. Such are Harrison's, Root's, etc. See *infra*. See also TUBULOUS BOILER.

Hancock's sectional boiler, English patent, 1827, consisted of vertical and parallel flat rectangular chambers, which were connected at bottom and top to preserve equality of contents, and were separated by vertical fillets which divided the intervening space into flues. The chambers are of sheet-iron, and extend across the furnace-chamber. The tendency of the flat chambers to bulge by the pressure is counteracted by the vertical bars.

Hemispherical bosses were projected from the surfaces of the plates to increase the heating surface.

Perkins' sectional boiler was intended for generating steam of high intensity, say a temperature of 700° to 1000° Fah. A series of cast-iron bars 5 inches square, perforated throughout longitudinally with holes of 1½ inches diameter, were arranged in 3 tiers, across a furnace, their ends projecting through the furnace walls, where they were connected so as to form them in continuity. Water was injected by a pump into the upper two tiers, which were kept full, and passed from thence to the lower tier. The water in the two upper tiers, at a temperature of say 700° to 800° Fah., was discharged by a valve-box into the lower tier, which was maintained at about 1000°, where it was flashed into steam, and passed to a strong steam-drum, whence it was drawn for the use of the engine.

See also Payne, English patent, No. 555, November 12, 1736 "Throwing water upon hot iron, which is immediately rarefied into elastic impelling force, to be applied to give motion to hydroulo-pneumeticall, or other engines and machinery."

Such steam-boilers are technically known as flashers. See INSTANTANEOUS GENERATOR, pages 1190, 1191, Figs. 2685, 2686.

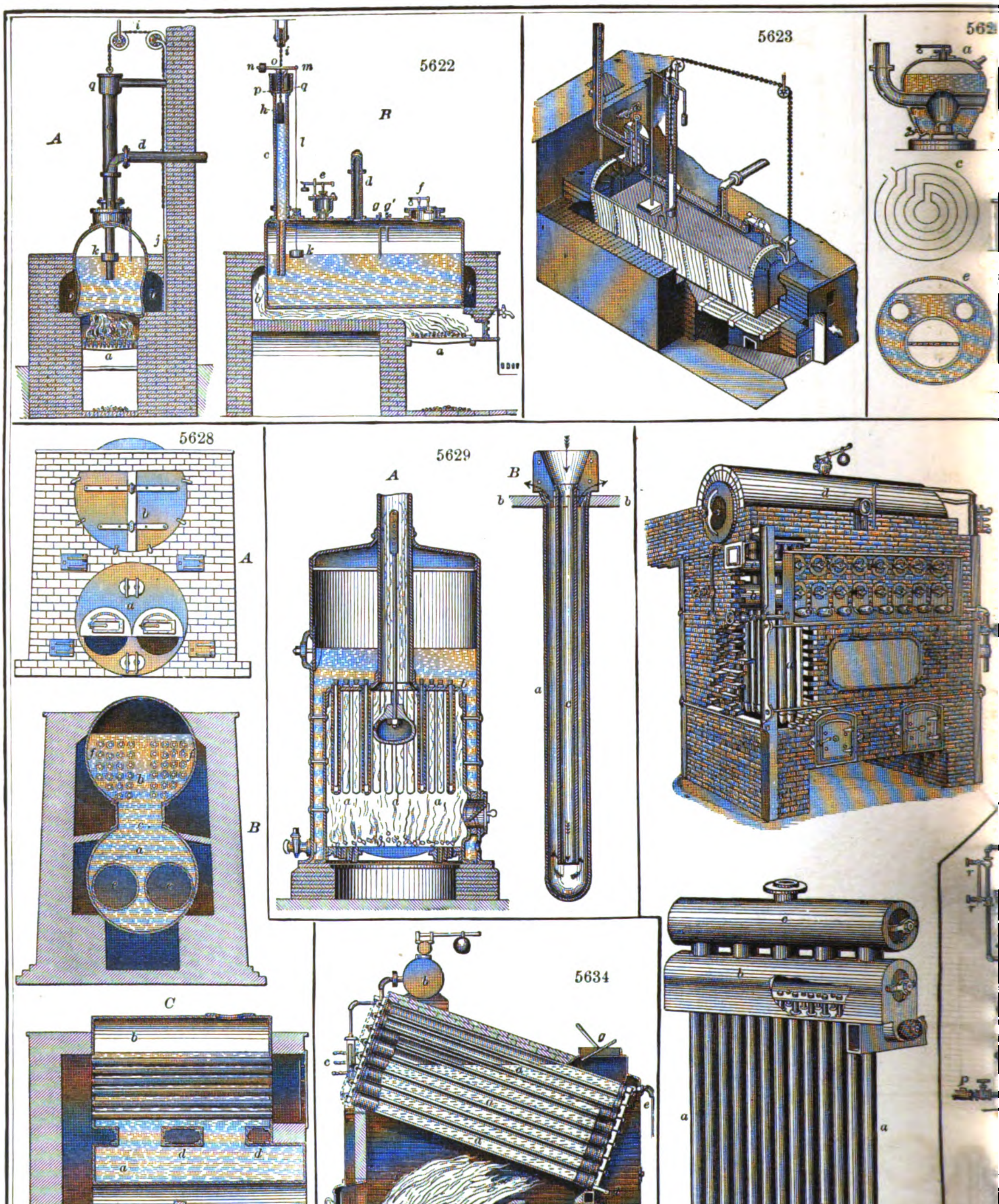
McCurdy's sectional boiler consisted of a pyramidal pile of horizontal tubes, within each of which was a tube closed at each end, and maintained by a coil of wire at a given distance from the inclosing tube. The object was to expose a thin film of water to the action of the fire. The tubes were connected by other pipes, and the water was pumped through the pipes consecutively.

Howard's sectional boiler (Fig. 5631) consists of a series of horizontal pipes *a*, from which arises a system of vertical tubes *b*. The flame of the furnace impinges against the bottom of the pipes *a*, and is diverted toward the front of the boiler, being prevented by a diaphragm *c c* from coming in contact with the upper part of the tubes *b* until, after passing through a flue at front, it is redirected backward, heating the upper portions of these tubes before entering the exit flue *d*. Within the upright tubes *b* are smaller tubes, for the purpose of causing a continuous upward and downward circulation of water.

Hancock's boiler for road locomotives, 1838, was composed of communicating sections provided with hemispherical projections on each side, and held together by stay-bolts.

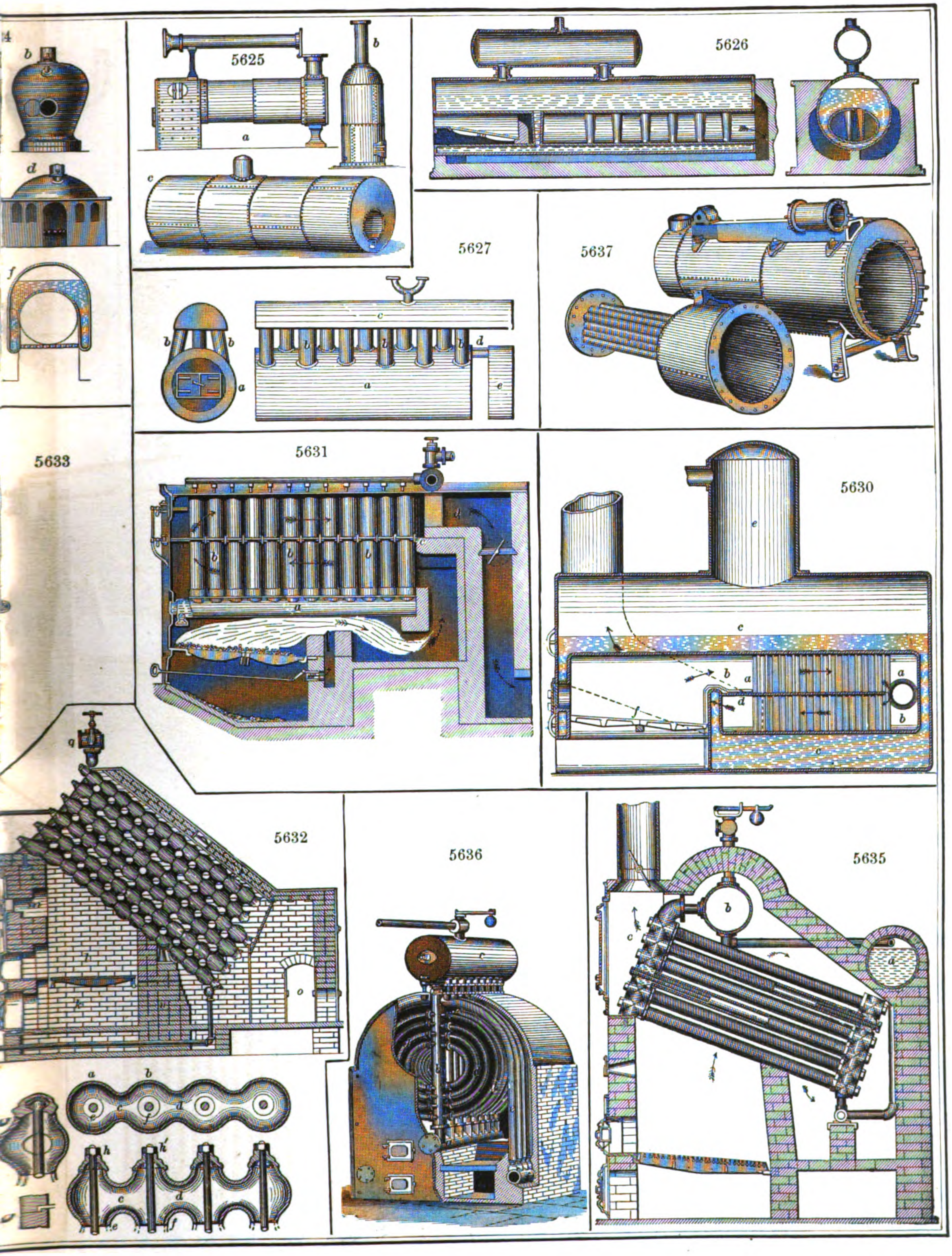
In English patent No. 111, of 1856, small retort-boilers were connected together, so that the various parts of the apparatus might be replaced, or increased steam capacity obtained by an increase of their number; and in English patent 2047, of 1857, small bottle-shaped chambers, each separately heated by gas, were connected by pipes to a common steam-receiver.

In Harrison's patent of 1859, however, we first find these general principles embodied in such form as to make the *multilocular* boiler a practical success.



VARIOUS FORMS O

PLATE LXI.



STEAM-BOILERS.

See pages 2327 - 2328.

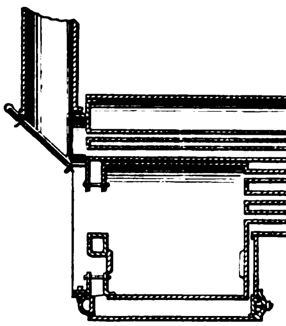
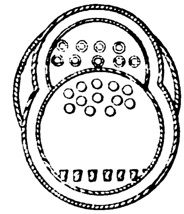


Fig. 5638.



Steam-Generator.

An important feature in the Harrison boiler (Fig. 5632) was that it enabled the employment of cast-iron, and also that boilers of various forms and dimensions might be built up from the same elements, or *units*, as they are termed; these consist of sets of spherical or spheroidal chambers *a b*, etc., united by curved necks *c d*; each set or unit, which may consist of any desired number of these spheroids, is cast in one piece, particular care being taken with the cores so as to insure a uniform thickness to the walls. Other necks *e f* at right angles to the first enable any number of these units to be securely united together, so as to form steam-tight joints by means of circular rabbets *g*; the sections are held firmly together by through bolts extending from end to end of the boiler, and tightened by nuts *h h'*. These bolts also serve to hold in position the caps *i* which close the extreme sections of the boiler, and which are similarly rabbeted.

Fig. 5632 illustrates a Harrison boiler in position. It is set at an angle of about 40° with the horizontal, and properly secured at each end to the brickwork of the furnace. *k* is the ash-pit; *l*, the fire-chamber; *m*, a door through which a steam-pipe is introduced for cleansing the boiler from soot, etc., when necessary. The products of combustion are deflected upward by the bridge wall *n*, not coming in contact with the lower rear portion of the boiler until after they are diverted downward by the inclined roof of the furnace; they finally pass off through the flue *o*. A comparatively small portion of the boiler is exposed to the direct action of the flame. The boiler, when in operation, is kept about two thirds full, the upper portion serving as a steam space. *p* is the water-supply pipe; *q*, safety-valve; and *r r'*, gage-cocks.

Wiegand's sectional steam-boiler (Fig. 5633) is composed of a series of separable sections of uniform size connected to one feed-pipe and one steam-drum. Each section is made up of a double row of pipes *a* entering the bottom of a tank *b*, to which they are secured, and having removable caps *c* at bottom. These contain smaller pipes *d*, extending nearly to their lower ends, the upper ends of the small pipes being secured in a horizontal plate somewhat above the bottom of the tank. Water is supplied to and blown off from the section through the same orifice in the front end of the tank, and the steam passes from the center of the tank into the drum.

The whole apparatus, except the top of the drum, is exposed to the heat of the furnace. The tanks are filled with water to the level of the partition; the heated water ascends through the annular spaces between the larger and smaller pipes, while cooler water descends through the small pipes, maintaining a constant circulation.

Root's sectional boiler (Fig. 5634) consists of a series of wrought-iron tubes *a a a*, inclined from front to rear, screwed into square cast-iron caps, and connected at their ends by elbows. The tubes in each row alternate for convenience of cleaning, etc., and the upper tier have a common connection with the steam dome *b*, to which a safety-valve is attached. This dome and the elevated ends of the tubes serve as a steam space. *A c* are the usual gage-cocks, *d* is the feed-water pipe, and *e* the steam-pipe; *f*, the furnace. The heated gas, after circulating among the pipes, is conducted off by the chimney *g*.

Fig. 5635 is a form of steam-boiler in which the *sections* are formed of tubes united at their ends, so that currents of water are continuously circulating from the cooler to the hotter portions. The feed-water is supplied to the coolest or bottom part of the boiler from a hot-water chamber *a* above, and steam generated in the upper ends of the tubes is collected in the drum *b*. The heated products of combustion follow the course indicated by the arrows, so that the upper ends of the tubes are constantly maintained at the highest temperature, but *baffling-plates* may be provided, causing them to follow a more circuitous course to more nearly equalize the temperature at different parts of the boiler, and finally discharge them by the chimney *c*.

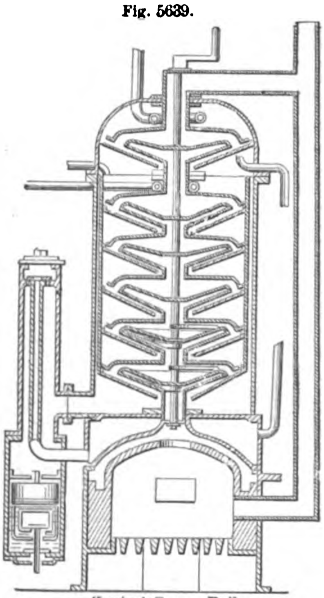
The boiler, Fig 5636, consists of a central pipe *a* resting on the partition-wall of the furnace; from this ascends a series of vertical tubes *b* communicating with the steam-drum *c*, and to which is joined the series of tubular curved sections *d d d*; other curved tubes *e* arising from pipes *f* on either side near the base of the furnace also communicate with the tubes *b* and with the steam-drum. The pipes and sections are united by screw joints, and any one which proves defective may be readily taken out and replaced by a new one. Injury or rupture of any one part leaves the remainder unimpaired. Any sediment which may be deposited is blown off through the base tubes.

A boiler for locomotives and portable steam-engines, specially constructed for being taken apart, is shown in Fig. 5637. It possesses no irregular curves or unbraced flat surfaces, but is everywhere of cylindrical form, which is the safest form for resisting pressure. It is here represented with the fire-box and tubes removed, and lying at its side. The cut shows how, by merely unscrewing a set of nuts from the front and rear ends of the boiler, the whole of the fire-box, fire-sheet, and tubes may be withdrawn. In case any incrustation on the tubes or interior surface of the boiler has taken place, it may be easily removed, after which the tubes and fire-box are replaced and firmly fixed by means of the nuts, which, through the intervention of copper-packing, hold everything together.

Fig. 5638 is a boiler of somewhat similar character, in which the fire-chamber flues, rear chamber, and reverting-flues are attached together, and are removable from the shell which forms the exterior wall of the boiler.

Many unusual forms of steam-boilers have been either suggested or made, intended to secure compactness or economize fuel. The two points are not perfectly attainable in one structure. The Cornish boiler and the locomotive are representatives of the two ends of the scale.

Fig. 5639.



Vertical Steam-Boiler.

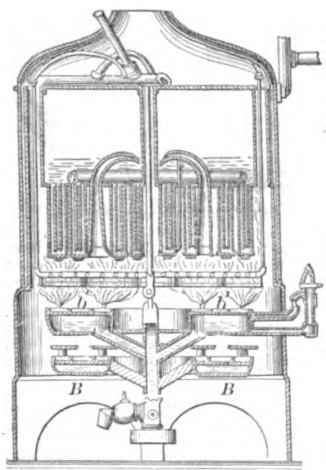
Fig. 5639 is a boiler in which a thin current of water is passed down over heated plates, flowing alternately outward and inward; the caloric current being deflected against the plates. A cold-air chamber is interposed between the arch of the furnace and the superheater. The water is pumped into the heater, which has a perforated distributor over one of the heating vessels, and is drawn therefrom through a pipe, and forced through another pipe to a second distributor that discharges into the upper part of the generator. The steam-generator communicates through a pipe with the lower side of the seat of an annular valve at whose upper side is a chamber communicating through the central opening of the valve with the superheater, so that when the pressure in the generator is in excess of that in the superheater the steam escapes through the valve-ports.

Fig. 5640 is a steam-boiler for using liquid hydrocarbons as fuel. It has a swinging reservoir *b' b'*, which is suspended in the fire-box of the generator, and has immediately below it another reservoir *B B* to contain naphtha, or other light oils, to be used in igniting the fuel in the upper reservoir. The upper reservoir is provided with a fluid-level indicator, which is placed outside the furnace, for the purpose of indicating the hight of the oil in said reservoir. In the top plates of the oil reservoir perforations are made, through which the gas escapes as it is formed, and is ignited by coming in contact with deflectors placed directly above it. Directly over the above-named deflectors are placed a series of cups for receiving and distributing the steam which is conveyed to them through the coiled pipes from the exhaust of the engine, or directly from the generator, for the purpose of being decomposed by the heat, and thus burned as auxiliary fuel.

Fig. 5641 is a coiled pipe mash-boiler for brewers' use. The

supply steam-pipe *b* and the discharge water-pipe *c* enter at the same opening in the boiler, the latter within the former, and each is so coupled with the semicircular sections of coiled pipe *f f* as to form hinges upon which the said coils swing.

Fig. 5640.



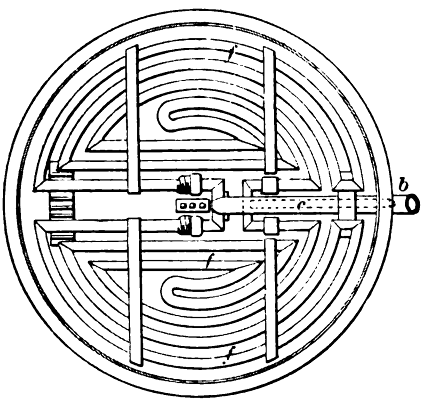
Liquid Carbon Steam-Boiler.

To obviate the destructive effect of the fire upon the boiler-plates, several plans have been proposed.

Manby, English patent, 1821, caused a circulation of hot oil through the boiler. The oil was heated in a close vessel, and conducted by a pipe to a vermicular system of pipes in the boiler, again descending to be reheated, keeping up a continuous circulation.

Alban's English patent, 1825, has a number of vertical tubes, closed below and opening above into a common steam-pipe. These tubes are plunged into a cistern of lead, which is kept in a melted condition by a furnace beneath. The water-pipe traverses the steam-pipe, and has a series of apertures on its lower side, just over the vertical tubes of the generator. The water from the feed-pipe drips into the tubes and flashes into steam. See B, Fig. 2685, page 1190.

Fig. 5641.



Brewers' Boiler.

In the cases cited, the oil and lead respectively are in contact with all the parts exposed to the direct action of the fire, and either of them yields a heat to the water sufficiently great for the generation of steam of any reasonable pressure.

" Some Cornish boilers have not less than 30 feet, or even 40 feet, heating surface to one foot of grate. This appears to be more than is justified by any corresponding gain, and certainly more than would be advisable in any marine or locomotive boiler.

" In boilers burning 13 lbs. coal per hour on each superficial foot of grate a proportion of 18 feet to each foot will be found to give good results. Where slow combustion, however, and extra size are not objectionable, advantage may be found by increasing the amount. In calculating the surfaces, it is usual not to include the bottoms of square flues, and one fourth of the surface of circular flues should be deducted on the same principle.

" Water in rapid circulation absorbs heat more rapidly than iron itself. The circulation of the water also tends to wash off the globules of steam from the surface of the metal, and thus prevents priming and also the formation of calcareous incrustation and deposition of sediment.

" 1 cubic foot of water, converted into steam per hour = 1 horse-power. 4 to 5 feet heating surface is requisite for each horse-power. Boiler should contain 4 or 5 times as much water as it boils off per hour. Steam space should be at least ten times that consumed at a stroke of the engine." — G. H. Knight.

The evaporative capacity of the *steam-generator* is predicated upon the requirements of the engine it is to serve.

The resistance on the piston being estimated, say, equal to 20 lbs. per square inch of its surface, the boiler must be capable of supplying steam at 20 lbs. pressure per square inch in such measure as to drive the piston at that speed.

Assuming the speed to be 200 feet per minute, or 12,000 feet per hour, and that the area of the piston is 5 square feet; then, to enable the piston to advance through 12,000 feet, a column of steam must follow it 12,000 feet in length and 5 square feet in its section, which gives 60,000 cubic feet of steam.

Steam having a pressure of 20 lbs. per square inch bears to the bulk of water which produces it the proportion of 1,281 to 1; therefore, if we divide 60,000 by 1,281, we shall find the number of cubic feet of water which must be supplied in the state of steam, by the generator to the cylinder, in 1 hour.

This division gives 47, nearly. The boiler, therefore, must in this case evaporate 47 cubic feet of water per hour, or, according to the conventional standard of boiler-makers, be a boiler of 47 horse-power.

Steam-boil'er A-larm'. (*Steam.*) An attachment to a steam-boiler to indicate excessive pressure of steam or lowness of water, as the case may be. See High-pressure Alarm; Pressure-gage; Low-water Alarm; Steam-gage, etc.

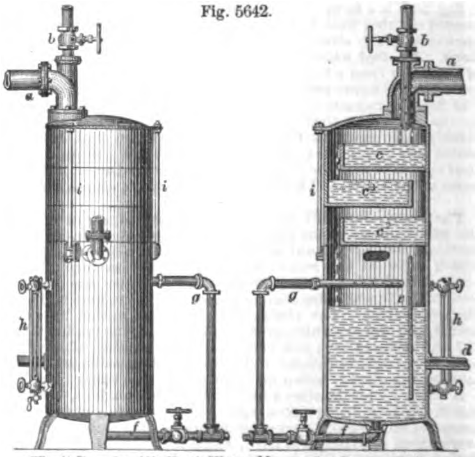
Steam-boil'er Feed'er. An apparatus for supplying water to steam-boilers. See Boiler-feeder; Feed-pump, etc.

In McMurray's apparatus (Fig 5642), the exhaust steam entering through the pipe *a* is met by the feed-water, which is discharged in a spray from the perforated foot of the pipe *b* and is condensed, being received in the pan *c*, and thence overflowing successively into the pans c^1 c^2, gradually depositing its sediment until it reaches the bottom of the apparatus, the purified water being returned to the boiler by the pipe *d*. *e* is a diaphragm extending across the lower compartment of the apparatus from a point just below the line of highest water to a short distance below the pipe *d*, in order to prevent greasy impurities floating on the surface from entering this pipe. *f* is the sediment blow-off pipe, and *g* the pipe by which grease and scum are blown off; *h* is a gage for ascertaining the hight at which the water stands. The several chambers are each in a separate compartment, and are united by bolts *i* passing through lugs on the cover and bottom compartments, so as to be readily detachable for cleaning.

Steam-boil'er Fur'nace. The chamber in which fuel is burnt, beneath or inside of a steam-boiler. Many forms are shown under Steam-boiler. Modifications bearing special names are to be found in the list under Steam-engine.

In Fig. 5643, *A* is an elevation, one side being removed, *B* a transverse vertical, and *C* a horizontal section of Smith's smoke-consuming furnace. *a* is the boiler, *b* the fire-space, *c c d d* longitudinal, and *e e* transverse flues. Air entering the flues *c c* through openings at the rear of the furnace is heated by the walls, and passing through the flues *c c* in the direction shown by the arrows, is admitted beneath the grate through the openings *f f*. The flues *d d* at the front of the furnace are provided

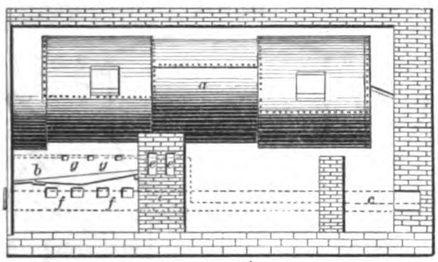
Fig. 5642.



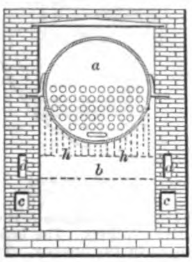
The "Standard" Feed-Water Heater for Steam-Boiler.

with registers; the air entering them is conducted through openings $g\ g$ in the walls, and openings $h\ h$, communicating

Fig. 5643.



A

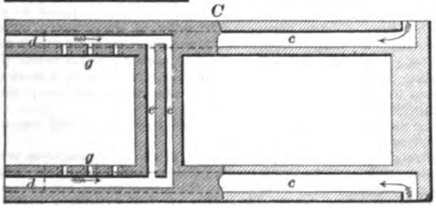


B

with the flues $e\ e$ in the bridge i, into the fire-space above the fuel, having been heated by contact with the furnace walls.

The amount of air chemically required to each lb. of bituminous coal is 150 cubic feet, of which 45 feet are required for the various combustible gases given off, and 105 for the solid carbon; *but combustion will not take place after the carbonic-acid gas bears a proportion of ¼ to the atmosphere*; the factor 150 therefore becomes

C



Smith's Steam-Boiler Furnace.

in practice $105 \times 4 + 45 = 465$ cubic feet atmosphere required in practice to 1 lb. of bituminous coal. In combustion of the gases, the bulk of the products is to the bulk of air required to furnish the oxygen as 11 to 10; the amount is therefore 50 cubic feet (not allowing for increase of temperature).

In perfect combustion of carbon, the resultant gases (carbonic acid and nitrogen) are of exactly the same bulk as the amount of air, that is, 105 cubic feet (not allowing for increase of temperature). The total amount of the products of combustion in a cool state would therefore be $50 + 105 = 155$ cubic feet; but, in practice, to this must be added $105 \times 4 = 420$, the amount of air required to dilute the carbonic-acid gas, $420 + 155 = 575$ cubic feet resultant gases.

The average temperature of a furnace being about 1000° Fah., the products of combustion are increased to about thrice their original bulk. The bulk therefore of the products of combustion which pass off must be $575 \times 3 = 1{,}725$ cubic feet. At a velocity of 36 feet per second, the area to allow this quantity to pass off per hour is about 2 square inches to each pound of coal.

Hence, in a furnace in which 13 lbs. of coal are burnt on a square foot of grate per hour, the area of flue to every foot of grate is $2 \times 13 = 26$ square inches; and the proportion to each foot of grate, if the rate of combustion be higher or lower than 13 lbs., may be found in the same way.

The system of admitting air to the gases in a subdivided form, in whatever part the admission may take place, is very advantageous.

The fires should be kept thin and open, feeding by small quantities at a time, or by *a system of coking the coal, allowing the combustion of it to be slow at first.*

The grate-bars should be as narrow as possible, making up in depth what they want in width; $\frac{1}{2} \times 4$ inch are good proportions.

The spaces between the bars should be as wide as the nature of the fuel will allow; for coal, from $^7/_{16}$ to $^9/_{16}$, according to the kind.

Space in furnace above fire-bars should be about 3 cubic feet per superficial foot of grate.

The area of the entrance of the ash-pit should not fall short of ¼ of the area of the grate, and in order to facilitate the supply to the back part of the grate the bars should incline downward about one inch to the foot; 2½ feet is sufficient depth for an ash-pit cleared out once a day. See also SMOKE-CONSUMING FURNACE.

Steam-box. A box or chest above the boiler to form a reservoir for steam. A *steam-chest.*

Steam-brake. (*Railway Engineering.*) A device for bringing the power of steam under pressure to act upon the car-wheels and stop their motion.

It has been applied in many ways: —

By mechanical devices connected between the cars of a train, and actuated by the power of the engine, or by a supplementary engine.

By a steam-winch on the locomotive winding a rope or chain which passes throughout the length of the train and actuates devices under each car.

By steam conducted by a pipe throughout the train and actuating pistons in cylinders beneath the cars, the pistons actuating the brake-levers.

By air-pipe throughout the train connecting cylinders beneath each car with an air-exhaust or air-pressure pump upon the locomotive. See BRAKE; CAR-BRAKE.

Steam Ca-nal′-boat. The first steamboats used in Scotland were made for canal purposes. Symington's first boat was built at Dalswinton and the second on the Forth and Clyde Canal. The project was abandoned when it was found that the canal-banks were likely to be injured by the swash of the wave produced. When the project was revived by Fulton, Stevens, and Bell, in 1807, it was upon the Hudson, the Delaware, and in British waters. See STEAMBOAT.

In 1871 the Legislature of New York offered a reward of $100,000 for the best practical application of steam-power to the propulsion of boats navigating the Erie Canal. About two thousand propositions were presented to the board of commissioners appointed to investigate the merits of the various plans proposed; and in order to thoroughly test the practicability of the different schemes, the board required that the competitors should place full-sized boats on the canal, which were to make actual trips both ways, carrying full loads of freight, the speed and consumption of fuel in each case being carefully observed and recorded under the supervision of the chief engineer of the board. After two years' experiment, the first prize was awarded to Mr. William Baxter. The trial-boat submitted by him had attained on her last trip an average speed of 3.09 miles per hour, consuming 14.82 pounds of coal per mile, and carrying 200 tons of freight. The nearest competitor made 2.41 miles per hour, burning 75.89 pounds of coal to the mile. The average speed of the horse-drawn boats is 1.5 miles per hour, and the cost of towage 35 cents per mile. The saving in cost of transportation by the use of steam is estimated at $3,000,000 dollars annually, assuming the present business of the canal as a basis. Boats of this kind are now habitually making the round trip from New York to Buffalo and back in two weeks, occasionally in 12 days, and a speed of 6 miles an hour has been attained on the canal without detriment to its banks. These boats are of the propeller class, and employ the Baxter marine engine, a simplified form of surface-condensing engine, which together with its boiler occupies no more room on board than the space allotted for stabling in the ordinary towage-boats. By the use of steam on the canal, it is claimed that grain may be transported from Chicago to Liverpool *via* New York in 20 days.

The Baxter steam canal-boats are about 97 feet long by 17 feet 7 inches wide, and, with a load of 215 tons, draw 6 feet of water. There are two houses on the deck, — one at the bow for the men and another at the stern for the engine. The motive-power is a common upright boiler, a trifle larger than those used for unloading ships on the docks, and a small vertical compound engine. The three cylinders are mounted on a cast-iron frame, having four uprights that serve for supports and bearings. They stand side by side, the two high-pressure cylinders at the sides, and the larger low-pressure cylinder in the center. The slides and ports for all three cylinders are placed in a small horizontal cylinder at the side, and one connection moves them all at once. The feed-pump and the pump for the condenser are connected with the small cylinders, and the rod of the larger cylinder is connected with the shaft, and the three cross-heads are united and move together. The exhaust from the two high cylinders is thrown into the low-pressure cylinder, and its exhaust is thrown into the condenser. This consists of a copper pipe that goes out board at the side, takes a turn under the boat and enters at the opposite side, and finally leads to the tank, heating the feed-water as it goes. There is no exhaust into the smoke-stack, and the water of the river or canal acts as an out-board surface condenser, and there is little waste of water.

Steam-car. A car drawn by steam-power. See STEAM-CARRIAGE; RAILWAY-CAR, etc.

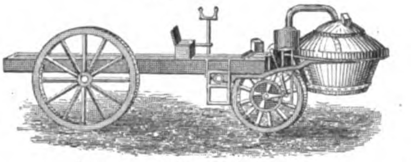
Steam-car′riage. A term of somewhat general import. A steam-driven carriage. It was originally constructed for common roads; afterward for tram

road; then for rails. (See LOCOMOTIVE.) It has now been again adapted to common roads. See ROAD-LOCOMOTIVE; ROAD-ROLLER; TRACTION-ENGINE.

Savery proposed the use of the high-pressure steam-engine for propelling carriages.

Dr. Robinson, in 1759, suggested to Watt the use of steam for the purpose; the latter afterward specified it in general terms in one of his patents, but never practically carried out the idea.

Fig. 5644.



Cugnot's Steam-Carriage.

Cugnot, a Frenchman, constructed a steam-carriage in 1769, and exhibited it before Marshal Saxe. It carried four persons at the rate of 2 to 3 miles an hour, but, owing to the smallness of the boiler, it was necessary to stop every 12 or 15 minutes to get up steam. He made a second carriage, of which several successful trials were made in the streets of Paris, but this, having upset while going at the rate of about 3 miles an hour, was considered as dangerous, and locked up in the arsenal. It is still to be seen in the Conservatoire des Arts et Métiers at Paris. Cugnot was born in 1729, and died in 1804.

In 1769, Moore, a London linen-draper, patented an invention of this kind; and in 1772, Oliver Evans obtained an exclusive right from the State of Maryland for the use of a steam-carriage devised by him.

In 1786, William Symington constructed a model of a steam-carriage, but afterward devoted his attention to steam-navigation.

In 1784, Murdoch, an assistant of Watt, invented a steam-carriage, which he tested on a road in Cornwall; and in 1789, Thomas Allen, of London, proposed a plan for constructing steam-carriages.

Trevethick and Vivian, engineers of Cornwall, patented a high-pressure steam-carriage in 1802. It was a four-wheeled carriage, the wheels of the fore-carriage being small and having a narrower track than the large driving-wheels which sustained the body.

The cylinder was horizontal, and in the rear of the hind axle. The piston-rod was forked to admit the crank, which turned a shaft having a spur-wheel gearing into a similar wheel on the driving-wheel axle. A fly-wheel was placed on the crank-shaft. The boiler was below the cylinder, and fed from the rear.

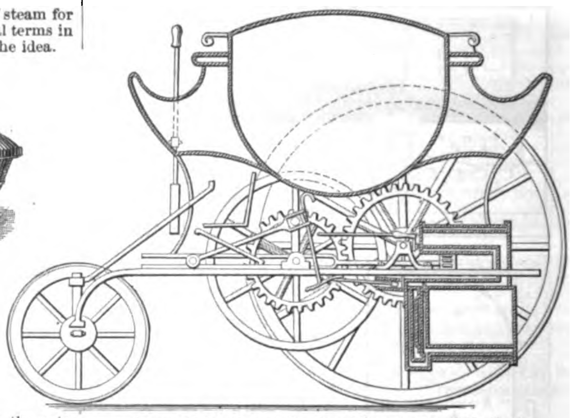
The specification cites bellows for the fire and a feed-water pump for the boiler, with divers accessories, showing a careful attention to the requirements of the case.

A steam-carriage of this description was publicly used for a considerable time previous to the introduction of railways, in the neighborhood of Euston Square, London, the terminus in after years of the London and Birmingham Railway.

Trevethick was a very ingenious and skillful engineer, and is known as the predecessor of Brunel in the construction of a tunnel under the Thames, which he had nearly succeeded in completing when the work was terminated by an irruption of water; as the inventor of a locomotive railway-engine employed in the vicinity of Merthyr Tydvil in 1804; of mining-engines and machinery and coining apparatus for the silver regions of Peru; of ore-refining furnaces; and of various improvements in steam-engines, hydraulic engines, propelling and towing vessels, discharging and stowing ships' cargoes, floating-docks, construction of docks, buoys, steam-boilers, heating apartments, etc.

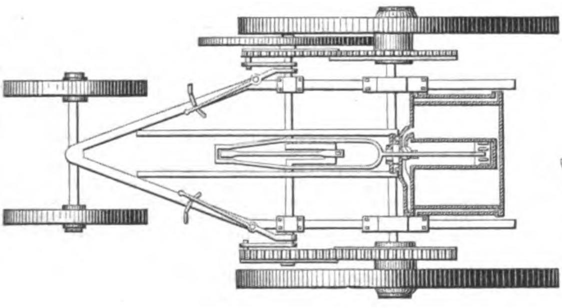
See LOCOMOTIVE.

Fig. 5646.



Trevethick's Steam-Carriage (Longitudinal Section).

Fig. 5645.



Trevethick's Steam-Carriage (Plan of Machinery).

Griffith's steam-carriage, patented 1821. The engine part of the carriage was supported on two driving-wheels. The boiler consisted of tiers of water-tubes arranged in the fire-box. The upper row of tubes, being filled with steam and exposed to the furnace heat, may be compared to some of the modern superheaters. The connection from the piston to the driving-axle was by sweep-rods, the lower ends of which were provided with driving pinions and detents operating upon toothed gear attached to the driving-wheel axle. The engine was suspended by slings inside the frame.

The machine was one of a chain of inventions, but was not otherwise practically useful.

Burstall and Hill's steam-carriage, 1824. This machine bears some resemblance to the former, having the engine and boiler behind the carriage, and applying the power to the hind wheels.

The engine had two double-acting vertical cylinders, and the pistons were connected to working-beams, whose other ends were attached to rocking-standards, which became inclined toward the cylinders as the pistons rose, and allowed the latter to move in a vertical line. At a point on each working-beam, between its connections to the piston and rock-post respectively, was attached the connecting-rod, which was keyed to the crank on the driving-axle. The cranks were at an angle of 90°, and dispensed with a fly-wheel. The machine was not successful.

James, of Birmingham, England, from 1824 to 1832, appears to have constructed several steam-carriages. He caused the engines and their framework to oscillate upon an axis, and connected these engines to the induction and eduction steam-pipes by means of hollow axles moving in stuffing-boxes, which, together with the body of the carriage, were suspended on springs bolted to the axle-trees.

The cylinders were 4 in number, and the crank was a 4-throw, the cranks being arranged at angles of 90°.

The machine was a mechanical success, but was commercially a failure.

Gordon's steam-carriage, 1824, had feet which were dropped, propelled, and lifted in regular succession.

Gurney's steam-carriage of 1825 employed legs or crutches which were operated in a similar manner to the preceding. In his patent of 1831 he abandoned the legs, and substituted horizontal steam-cylinders below the body of the carriage and act-

Fig. 5647.

Gurney's Steam-Carriage.

ing upon cranks on the hind axle. The boiler and furnace were behind the carriage, with the fireman's seat in the rear. The carriage was steered by a wheel in front, the shaft of which acted by gearing upon the fifth wheel of the fore-carriage.

Mr. Gurney seems to have been more persevering and successful than most of his predecessors, and had the benefit of their experience. He built several carriages on his plan, which ran regularly on the Cheltenham and Gloucester road for some months.

Hancock's steam-carriage, 1827, had 3 wheels, and the power was applied through the medium of 2 oscillating engines, whose piston-rods were connected to the crank-axle of the fore-wheel There were several other details that might be mentioned, did space permit. The third engine built by Hancock seems to have been well constructed, and ran for hire in the neighborhood of London. It was called the "Infant."

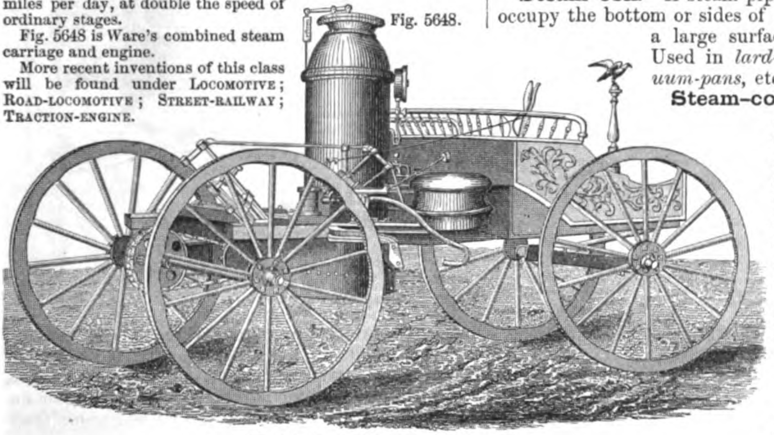
In following the record chronologically, we find the names of Gough, Summers and Ogle, Bosse and Rawe, Heaton, Napier, Palmer, Gibbs and Applegath, Church, Redmund, Squire and Macaroni, and Hills. This brings us down to 1833.

Hills seems to have been the most successful of the whole series of inventors. He traversed many of the roads leading out of London, traveling as much as 128 miles per day, at double the speed of ordinary stages.

Fig. 5648 is Ware's combined steam carriage and engine.

More recent inventions of this class will be found under LOCOMOTIVE; ROAD-LOCOMOTIVE; STREET-RAILWAY; TRACTION-ENGINE.

Fig. 5648.

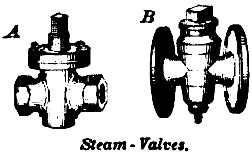


Ware's Steam Engine and Carriage.

ing-box for the valve-stem being made of one piece, or rigidly connected as usual; the nut, instead of being provided on its outer surface with a screw-thread, is turned off smooth, and fitted in the socket of the shell, where it is held by a cap, the relaxation of which cap permits the nut to revolve, with the stem, to grind the valve to its seat.

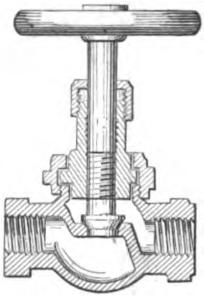
Fig. 5649.

A B



Steam-Valves.

Fig. 5650.



Globe-Valve.

Steam-coil. A steam-pipe bent into a shape to occupy the bottom or sides of a boiler, so as to have a large surface in compact space. Used in *lard-tanks, malt-vats, vacuum-pans*, etc. (which see).

Steam-col'ors. A style of calico-printing in which a mixture of dye extracts and mordants is topically applied to cloth, while the chemical reaction which fixes the colors to the fiber is produced by steam. (URE.)

The different descriptions of apparatus used in the steam process are,—

1. The *column*.
2. The *lantern*.
3. The *cask*.
4. The *steam-chest*.
5. The *chamber* (which see).

Steam-cook'ing Ap'pa-ra'tus. That in which the heat of steam in pipes or jackets is made to cook the food, without the direct action of fire by radiation, conduction, or convection. See STEAMER.

Steam-case. See STEAM-CASING; STEAM-CHEST.

Steam-cas'ing. (*Steam-engine.*) A steam-jacket around a cylinder or other object to keep in the warmth. Invented by Watt, to prevent the radiation of heat from the cylinder.

Steam-cham'ber. 1. The *steam-room* in a boiler; the space for the collection of steam, above the water-line. A *steam-dome.*

2. A chest or chamber in an apparatus in which the object is subjected to the wet heat of steam.

Steam-chest. 1. (*Steam-engine.*) A box or chamber above the boiler to form a reservoir for the steam, and from whence it passes to the engine.

2. The *steam-chest* or *box* is one form of steam-apparatus in which steam is applied to cloths, in order to fix the colors; called *steam-colors* from this mode of treatment.

The cloths are wound upon blanket-covered rollers and laid in rows in the tight chest, to which steam is then applied for about 45 minutes.

3. A steam-chest is also used for softening timber which is to be bent to a curved form, as ships' planking. See STEAM-TANK.

Steam-chim'ney. (*Steam-engine.*) An annular chamber around the chimney of a boiler-furnace for superheating steam.

Steam-cock. A valve or faucet in a steam-pipe.

In Fig. 5649, *A* is a *gland* stop-cock; *B*, a stop-cock with flanges, by which it is attached to tanks, chests, or boilers.

Fig. 5650 is a globe steam-valve, so constructed as to facilitate the grinding of a globe-valve down in its seat, the nut and stuff-

Steam-crane. A crane worked by a steam-engine; frequently carries the engine upon the same frame.

The railway portable crane (Fig 5651) has two cylinders fitted with link motion for reversing; single and double purchase gearing; and the radiating motion can be given in either direction without stopping or reversing the engine. The lifting and radiating motion may both be in action at the same time.

The locomotive steam-crane is designed to do the ordinary heavy lifting at a railway-station, and is also adapted to take itself from station to station along the line of rails.

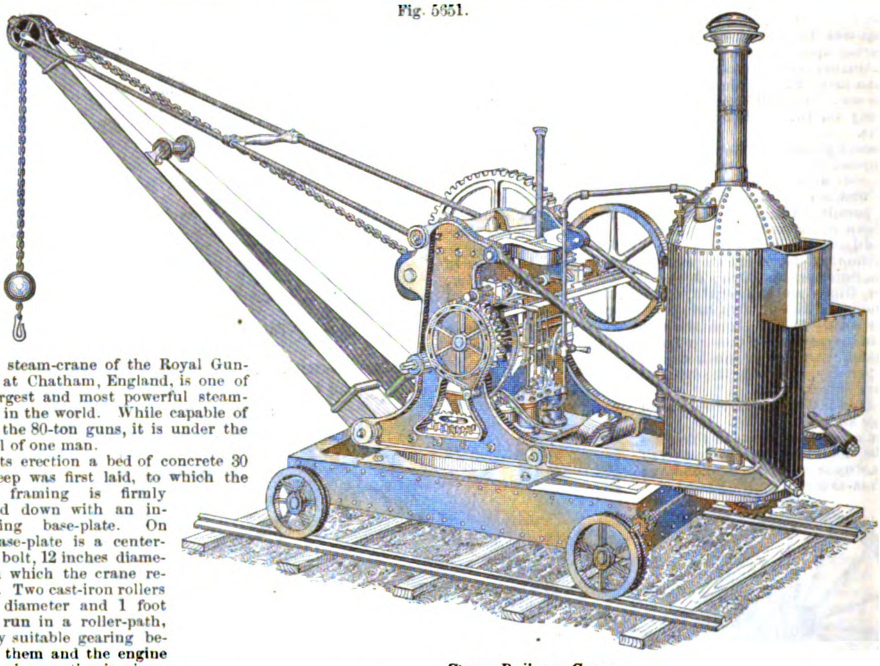
The illustration (Fig 5652) shows the crane at the Middlesborough Docks, England.

The traveling-stage or *gantry* on which it is mounted is composed of timber uprights braced and strengthened by cast-iron brackets, and two wrought-iron plate girders connected to the timber uprights by four plate-iron brackets, strengthened with angle-irons. The girders are planked over, and the traverse-circle on which the crane revolves is bolted to their ends. The stage has a hight of 17 feet 6 inches in the clear, and the rails on which it traverses are 23 feet from center to center, affording ample room for two lines of cars between them.

It is moved by gearing and shafts, which transmit the motion of the engine to the traveling-wheels; warping-drums or capstans are fitted on a countershaft on the inner side of each frame, which may be worked independently of the traveling-wheels for towing the trucks into position beneath the crane for loading and unloading. The arrangement may be modified by making the crane movable on its gantry, to adapt it to the case of a jetty to which vessels are moored on each side, or it may be fixed on an overhead traveling gantry.

The works of the crane (Fig. 5653) are carried on a flat-bottomed boat, which may be towed from place to place and moored by attachment to piles. The pile or other object to which the end of the boat opposite the derrick is fastened serves as a fulcrum to resist the strain of heavy weights, as well as to hold the boat in place.

Fig. 5651.



Steam Railway-Crane.

The steam-crane of the Royal Gun-wharf at Chatham, England, is one of the largest and most powerful steam-cranes in the world. While capable of lifting the 80-ton guns, it is under the control of one man.

In its erection a bed of concrete 30 feet deep was first laid, to which the main framing is firmly screwed down with an intervening base-plate. On this base-plate is a center-pin or bolt, 12 inches diameter, on which the crane revolves. Two cast-iron rollers 3 feet diameter and 1 foot broad run in a roller-path, and by suitable gearing between them and the engine the slewing motion is given to the crane. The top of the jib rises 36 feet above the wharf level, a circle 208 feet in circumference being described by the apparatus when being swung round. The crane is worked by a pair of reversing engines, which are supplied with steam from a vertical multitubular boiler, which, with the engines, is fitted on the main plate. The framing is of cast-iron; the jib is of two rolled girders 40 feet long, well stayed together, and secured by two tension-rods of similar length. Distance-pieces are placed between the jib and the tension-rods, which carry the chain-rollers. See also OVERHEAD-CRANE; TRAVELING-CRANE.

Steam-cyl'in-der. (*Steam-engine.*) The chamber within which the piston reciprocates. The invention of Dr. Papin, of Blois, in France. The first steam-engine with reciprocating motion. The water-raising devices of Worcester and Savary, like the toys of Baptista Porta, Leonardo da Vinci, and De Caus, were steam-pressure apparatus, approximating to pumps, not engines. The pump-cylinder, however, was much earlier, used either for water or for air. See the "Spiritalia Heronis."

Steam-dome. (*Steam-engine.*) A chamber on top of the boiler forming a steam-chest, from which the steam is conducted to the cylinder.

Steam-en'gine. The original steam-engine is the Æolipile of Hero, exhibited in the Serapeum of Alexandria, 150 B. C. It is a true rotary steam-engine, and there are quite a number of late patents in which the same principle is maintained. Originally it was a philosopher's experiment, and late attempts to utilize it have not been successful from some cause. The principle is the same as that of the turbine or reaction water-wheel, which is a very effective mode of applying the power of a head of water. (See Barker's mill, page 231.) In the Æolipile a pressure of steam is maintained internally, and the rotation is due to the recoil of the wheel in a direction opposite to that of the issuing steam. The same description will answer for the turbine, substituting water for steam in the description. The agencies differ in this respect: the steam is elastic, and the water otherwise. Whether that will account sufficiently for the success of the latter and the want of success of the former the writer is not able to state. In each it is a case of positive internal pressure and recoil, and modern inventors are loath to give it up, as the records of the Patent-Office show yearly, not understanding why a given pressure per square inch in a rotary engine on the Æolipile principle should yield a less result than the same pressure in a turbine.

It has been the fashion to call the Æolipile a "mere toy." The directness and positiveness of the invention can hardly be exaggerated. All that followed it for more than eighteen centuries were not *engines*, and had no means for running machinery directly. They were fountains or water-elevators, not even pumps in the ordinary acceptation of the word, having neither cylinder, piston, nor moving parts, except the spigots of the faucets which governed the induction and eduction of steam and water, and most of them had not even these faucets. They were neither engines, pumps, nor pumping-engines. Hero's was a true engine, and capable of work, according to its capacity, by attaching a pulley and band to the rotating shaft. Size is not an attribute but a proportion, and Hero's was a working machine of model size.

In this connection we notice that cylinders and pistons were used by Hero in his air-pumps and water-pumps (see the "Spiritalia Heronis"). They were revived again by the illustrious Papin, 1699.

Leaving steam-*engines* for a while and coming to steam water-fountains and water-elevators, commend us to the "Spiritalia" of Hero. A fine folio copy, published in France about two centuries since, is in the Patent-Office Library, Washington. It is double-column Greek and Latin, well illustrated from the original drafts, and bears the fleur-de-lis of the old French Monarque.

One great object of Hero in his devices is to surprise by accomplishing unexpected results. For this purpose he uses fire, water, and air in several scores of different machines. The air-pump is used to fill the upper part of a vessel which is partly charged with water. An eduction-pipe passes below the surface of the water, and the pressure of the air forces out the water in a fountain when the faucet is turned. In another case fire is applied, and the pressure of steam performs the same office. This is like the Baptista Porta apparatus of A. D. 1660; De Caus, 1620; Marquis of Worcester, 1655. It has been said Hero merely collected these, and probably derived much from the sublime Archimedes, with whom he was nearly contemporary. Be it as

it may, he recorded them, and we know no other author. His paternity of the Æolipile is evident from the manner in which he exhibited it to the wondering Ptolemy Philadelphus and his court, in the Serapeum of Alexandria.

"He [Hero] describes three modes in which steam is used as a mechanical power: to raise water by its elasticity; to elevate a weight by its expansive power; and to produce a rotary motion by its reaction on the atmosphere."—STUART *on the Steam-Engine*, London, 1829.

Now for a long interval, not forgetting on the way Anthemius of Lydia, one of the architects of Justinian employed on the Church of St. Sophia at Constantinople (A. D. 540). This skillful man imprisoned steam in a long pipe which proceeded from a caldron of boiling water, and caused a vibration and a roaring noise which shook the house and scared the inmates. It is not certain what the good man was after, or that anything of note resulted, unless the report be true that he was only annoying the orator Zeno, who lived next door, and there practiced his studied harangues.

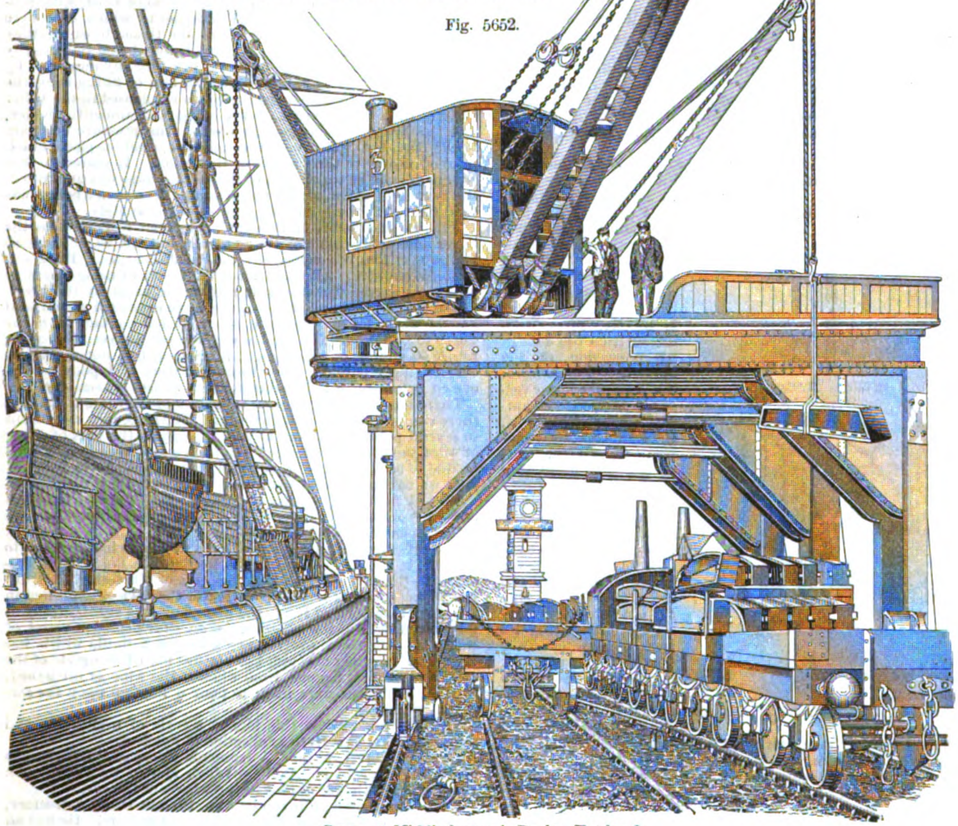
Gerbert of Rheims, A. D. 1000, had an organ played by steam: probably a blast of steam as a substitute for air; not an engine.

As Europe emerged from the transition period, called the Middle Ages, Italy took the lead in arts and sciences, as the names of Leonardo da Vinci, Baptista Porta, Galileo, and others will indicate.

Leonardo da Vinci's steam-gun (A. D 1500) is noticed under that head See STEAM-GUN.

Brancas (A. D. 1629) had a copper boiler and eduction-pipe, the steam issuing from which rotated the vanes of a shaft which worked pestles for grinding-materials, raising water by buckets, sawing timber, etc. This may be considered the first

Fig. 5652.

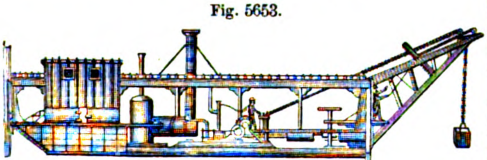


Crane at Middlesborough Docks, England.

BREAST-WHEEL STEAM-ENGINE (which see).

Baptista Porta (about A. D. 1600) contrived an apparatus for exhibiting the power of steam (*A*, Fig. 5654). Steam generated in a flask below and introduced into a water-chamber raised the

Fig. 5653.

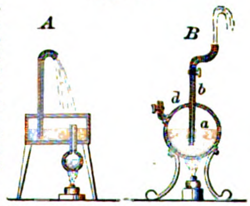


Floating Crane.

water in the discharge-pipe, as in the accompanying figure His description is too long for insertion.

Solomon De Caus, perhaps a mythical personage, about 1620, is said to have written a book, "Les Raisons des Forces Mouvantes," and to have invented an engine somewhat after the style of the annexed cut (*B*). This is like Hero's devices. The spherical vessel *a* has a nozzle and stop-cock at *b*, and another at *d* through which water may be introduced by means of a syringe. The pipe leading from nozzle *b* nearly touched the bottom of the sphere. Water is introduced as required, and the pressure of steam raises a jet of water.

Fig. 5654.



Baptista Porta's Water-Elevator. *De Caus' Water-Elevator.*

The fiction of Solomon De Caus has been used to deprive the inventors of the steam-engine of their just reputation. The romance recites how the Marquis of Worcester, at the asylum of Bicêtre, saw a miserable man in a cage, who

cried, "I am not mad! I am not mad! I have made a discovery," etc., etc. Farther, that the book of the captive, the said Solomon De Caus, was exhibited to the Marquis, who pronounced the madman the greatest genius of the age. The idea took with an imaginative people, and became a subject for painters and dramatists. Finally, grave writers on mechanics and compilers of dictionaries inserted the name of De Caus as the inventor of the steam-engine.

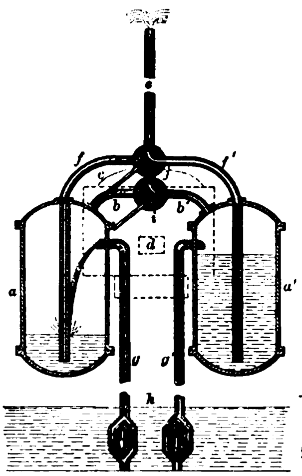
The authority for all was a letter, purporting to have been written in 1641 by Marion de Lorme to her lover, Cinq Mars. Mr Muirhead, in his life of Watt, might exclaim, "See how plain a tale shall put thee down!" There was, says he, no Marquis of Worcester in 1641. The title of Marquis was not conferred till 1642, and then upon Henry Somerset, the *father* of *the* Marquis, the author of "The Century of Inventions," and the person who was *doing* the mad-house. A French historian farther cites that Solomon De Caus could hardly have been seen at Bicêtre in 1641 in a raving condition, as he died in 1630; and farther, that Bicêtre was not a hospital in 1630 or 1641.

At all events, the device of De Caus' fountain is inferior to that of Porta, as the boiler and water-chamber are not distinct in the former.

Next in the line we behold the Marquis of Worcester, who so faithfully adhered to the faithless Charles I. and his fortunes, losing his own. Following the style of his day, he wrote in a mysterious manner, veiling his devices in superlatives, and leaving his "Century of Inventions" as a hundred "nuts to crack" for future generations. Many teeth have been ruined on them, and it is shrewdly suspected that some of them are all shell, — a stony endocarp without a kernel. Powerful jaws are still at them.

The Marquis of Worcester's "water-commanding engine," as he called it, was patented to him in 1633, and was exhibited in action at his works at Vauxhall, London. (See an elaborate but too partial digest of authorities by Dircks in his Memoir of the Marquis, London, 1865.) The accompanying cut is by Mr. Dircks, deduced from the data in his possession, of the Marquis's contrivance. $a\,a'$, two cold-water vessels; $b\ b'$, the steam-pipe; c, the boiler; d, the furnace; e, the eduction water-pipe, connected by branching pipes $f\,f'$ to the vessels; $g\,g'$, water-supply pipes; h, the well. On the steam-pipe $b\,b'$ is i, a four-way steam-cock operated by its lever handle. On the horizontal portion of pipe $f\,f'$ is a four-way water-cock j operated by its lever handle.

Fig. 5655.



Marquis of Worcester's Water-Elevator.

The four-way cock is generally credited to Watt, but this seems to anticipate him. It is the original *valve*, and still has its uses, though its glory has sadly departed.

The Worcester apparatus was in no proper sense an *engine*, but a water-raising apparatus; an expensive kind of pump. It was called by him a "water-commanding engine"; and Watt's engine was denominated by him a "fire-engine." Upon this question of names Tomlinson very justly remarks: —

"If the name 'fire-engine' had been retained, we should not have had to consider the absurd questions about 'superseding steam.' Steam is not the agent, but only the medium or instrument by or through which it acts, as our will acts by means of muscles, which it has the power of contracting. All that is required in this medium is materiality, and the property of filling more or less space by the action of fuel upon it. Steam, or rather water, is selected on account of its abundance," and other good qualities.

Air is the only other costless material: and while it probably will not produce a greater motive effect than water with a given increment of heat, it has the disadvantage of requiring a very much larger body of the medium to carry the said increment, and a corresponding increase in the capacity of the vessels in which the pressure is utilized, say the cylinder of the engine. Air also requires a more perfect packing, and lubrication of the surfaces is more imperative with dry air than with wet steam, as well as being less readily effected. Tomlinson well states that "a liquid expanding into an *air* has immense advantages over a body retaining either state unchanged. The change of state always involves a change of bulk far greater than the same change of temperature would produce on a body retaining even the aëriform or most expansible state. It seems indeed proportional, not to the change of *sensible* but of *total* heat, most of which becomes latent in the aëriform body.

"This absorption of heat is advantageous in several ways: It greatly diminishes the difficulty of retaining the heat where it is wanted, since only the sensible and not the latent heat tends to spread and equalize itself. It keeps the whole machine cooler than it must otherwise be, by the whole amount rendered latent, which in steam is near 1,000°, or enough, if sensible, to produce a *red* heat. Lastly, it leads to a most useful phenomenon which could never happen with a body retaining one constant state, such as air. Air ever so hot, and ever so cold, mixed together, would occupy nearly the same bulk as before the mixture; but steam coming in contact with such a body of water, so much colder than itself that the total heat of both is insufficient to keep both vaporous, is suddenly condensed, and the whole, becoming water, occupies some hundreds of times less space than when the steam and water were separate, although their total heat remains the same; as no time is required for the transfer of heat to surrounding bodies, the change may be made instantaneously."

Worcester's invention was a duplication of that shown as the steam-fountain of De Caus. Two boilers were used, with separate means for filling them, and branches by which they were connected with the common ejection-pipe through which they were alternately discharged. A given boiler, being temporarily shut off from the discharge-pipe, was filled by any means, — by pouring water into it, probably, for the idea of filling it by the pressure of the atmosphere as the steam condensed in the boiler had not then been devised. A fire being made under the boiler, and the branch discharge-pipe opened, the pressure of steam forced the hot water out through the ejection-pipe, which reached nearly to the bottom of the boiler. It ceased to discharge as soon as the mouth of the ejection-pipe was uncovered, the issuing of steam giving notification. The other boiler was then treated in the same way, and so on alternately.

This, as said before of De Caus', is inferior to Porta's, as the boiler and water-chamber are identical, and the water must all be brought to a boil before any can be discharged. Porta's is wasteful enough. All three missed the idea of using steam to produce a partial vacuum, and raising the water by the pressure of the atmosphere. Each of the three expended actual heat on the water by allowing the steam actual contact with the water to be raised. The time of engines was not yet. Worcester raised 40 pounds of water (hight not stated, but not much) by evaporating 1 pound. The theoretical duty of 1 pound evaporated is to elevate 1,700 pounds about 83 feet (at sea-level).

There may be many *original* inventors of the same thing, but there can only be one *first* inventor. The same idea may occur to several persons, without any knowledge on the part of either of what the other has devised. In such a case equal credit may be due to each for an original idea, but in a historic point of view we naturally insist upon the claims of the prior inventor.

Viewed in this light, that of priority, the claims of the Marquis of Worcester are reduced to a mere duplication, alternate action in each of two reservoirs.

The pressure of steam upon water, as we have had occasion to observe, in the manner contrived by Baptista Porta, 1600, Solomon De Caus (?), 1620, and the Marquis of Worcester, 1633, differs in no essential respect from one of the devices exhibited in the "Pneumatics" of Hero, 150 B. C. This was substantially as follows: A light being placed upon an altar heated a vessel of water, and the steam evolved pressed upon a liquid which was conducted by pipes through two statues placed alongside of the altar and holding flagons, from whence the wine or oil issued, so that the figures were made to pour a libation upon the sacrificial victim.

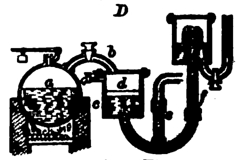
The Marquis worked this idea on a scale of usefulness, and probably never saw Hero's collection of wonders.

Father Verbrest, in his "Astronomia Europæa," 1680, speaks of driving a car by an Æolipile which ejected its steam upon wings whose axis was geared to the wheels of the car.

Next is presented an inventor who, though called a dreamer, added more to the *engine* than all his predecessors. He had an original mind, like Watt, and was fertile in resources. This was Dr. Papin, of Blois, in France (about 1695).

Papin started with one vessel (like De Caus); then separated them (like Porta); then he commenced to add items of efficiency actually new. To obviate to some extent the condensation of steam by its contact with the water to be raised, he interposed a *float*, upon whose upper surface the steam pressed, while its lower surface rested on the water, as seen in the annexed figure. The float being of wood, a good non-conductor, much of the heat would be saved, especially if the float fitted well. It was the precursor of the piston, also invented by Dr. Papin; we have, however, seen that Hero used it in water and air pumps 1,850 years before

Fig. 5656.



Papin's Water-Elevator.

Another feature may also be noticed in the apparatus of Papin. The water in contact with the float was to some extent unchanging, so that whatever warmth it acquired was

not communicated except in part to the water to be raised. *Another feature* visible in the apparatus is the safety-valve, of which Papin was the inventor.

Another feature will be detected by a description of the operation, namely, the charging of the water-chamber by atmospheric pressure incident to the condensation of steam therein. Now we begin to see sunlight in the investigation of the history of the machine.

In Papin's engine (Fig. 5656), the boiler was connected by a pipe *b* with a cylinder *c*, in which is a float *d*, resting on the surface of the water. The supply-pipe *e* has a valve opening downward, and the discharge-pipe *f* has a valve opening upward. Steam from the boiler being admitted to the cylinder *c*, the water is ejected therefrom, and passes by pipe *f* to the tank to be filled. Communication between the boiler and cylinder being closed by the faucet or pipe *b*, the steam in *c* condenses, and the pressure of the atmosphere forces water by pipe *e* to fill up the vacancy; the valve in pipe *f* closing by gravity. A repetition of the process need not be detailed.

Another feature is the air-chamber at the summit of discharge-pipe *f*. The air therein, being condensed during the entrance of the water, assists by its elasticity in discharging the water through a second ascending pipe in a continuous instead of an intermittent stream.

Dr. Papin is also the inventor of the *atmospheric steam-engine*, though his form is somewhat crude as he left it. A smooth cylinder was fitted with a piston, which was raised by the vaporization of a small body of water below it, and depressed by the pressure of the atmosphere when the steam condensed. Fire was applied directly to the lower end of the cylinder, and the downward stroke of the piston was the effective one. This was the *first* true engine since Hero.

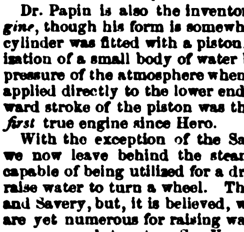
With the exception of the Savery engine, yet to be noticed, we now leave behind the steam-fountains, which were only capable of being utilized for a driving power by setting them to raise water to turn a wheel. This was proposed by both Papin and Savery, but, it is believed, was never put in practice. They are yet numerous for raising water for boiler supply, for ordinary pump duty, etc. See VACUUM STEAM-PUMP.

Papin, we see, has furnished us with a reciprocating piston-rod, and we shall see what Newcomen and Watt will do with it. The latter studied hard to convert the motion thus acquired into a rotary, and applied the crank, — he did not invent it. The crank had been used on foot-lathes for 2,000 years. Hero's engine had the rotary motion all ready to hand.

Dr. Papin has introduced us to so many improvements that it seems like going back, to consider the original Savery engine; but while we were enumerating the Doctor's services, it seemed well to complete the list, and it must be recollected that he and Savery were contemporary. It is even claimed that the idea of lifting water into a chamber by atmospheric pressure against a partial vacuum is Savery's invention. It appears to be otherwise, but was adopted by the latter in his patent of 1698, and in his joint patent with Newcomen, of whom we shall have to speak after Savery's first apparatus is described.

Savery's apparatus (Fig. 5657) is illustrated in the 21st volume of "Philosophical Transactions," A. D. 1700, the patent being granted by the astute William III. in 1698. It is stated to be "for raising water by the help of fire." The illustration shows a double apparatus, the respective portions of which are used alternately. The steam from the boiler *a*, being admitted into chamber *b*, expels the air therefrom. The cock *c* being then turned, so as to isolate the chamber *b* from the boiler, the condensation of the steam makes a partial vacuum, into which the water from the well is driven up, lifting the valve *v*. Steam from the boiler is then admitted into chamber *b*, expelling the water below and causing it to pass valve *v'* and to rise in the stand-pipe, which discharges into a tank above. The water *injection*-pipe *d* is then opened, to condense the steam, the cock *c* being turned for this purpose, simultaneously closing the steam supply and admitting water, which issues in a spray from the rose at the end of the pipe *d*.

Fig. 5657.



Savery's Water-Elevator.

Savery's engine was employed with good results in the drainage of mines in Cornwall and Devonshire, though at an expense for fuel that we should consider terribly wasteful. His was perhaps the first valuable working machine.

Hero, Leonardo da Vinci, and Papin excepted, all the preceding would read just as well as a prelude to the history of "devices for raising water"; and, with the exceptions noted, all down to and including Savery, made the raising of water their object and end. Their intention is indicated plainly in the names they bestowed on their devices: Worcester's "water-commanding engine"; Savery's "engine for raising water and occasioning motion to all sorts of mill-work by the impelling force of fire." The mill-work, as we have stated, was to be driven by water raised by the engine, and not directly by the engine. This was not yet; but Savery joined with others, and together, with what they borrowed from Papin, they made an engine capable of giving motion directly to machinery.

A controversy has arisen in regard to the respective claims of the Marquis of Worcester and Savery, and it has been much embittered by the ungenerous remarks of Dr. Desaguliers, in his "Experimental Philosophy" (1734).

While the respective engines agreed in the feature that the direct pressure of steam on the surface of water in a chamber forced the water thence and up a stand-pipe to an elevated tank, there are yet two special points to be noted in the Savery apparatus which distinguish it from Worcester's.

Savery separates the heating-chamber from the water-chamber. Worcester does not. Savery may have derived the idea from Porta or Papin, but that does not concern the matter as between him and Worcester.

Savery charges his water-chambers from a lower level by atmospheric pressure induced by a partial vacuum produced in the chambers by the condensation of steam therein. Worcester does not. Savery may have derived this from Papin, but that is nothing to Worcester.

Savery stands between Worcester and Newcomen thus: —

Worcester raises water by direct pressure of steam only.

Savery raises water by direct pressure of steam, alternating with atmospheric pressure.

Newcomen raises water by atmospheric pressure alone; steam being only used to make a vacuum.

By way of bringing another disturbing element into the inquisition, Solomon De Caus, already referred to, has been cited, and the erudite Arago had declared him the author of the modern steam-engine; but the same argument that would exalt the Frenchman De Caus over the English Marquis of Worcester would exalt the Italian Baptista Porta over the Frenchman.

Again: —

The same argument that Desaguliers uses to exalt Worcester over Savery would place the Italian Porta over the Englishmen. But Desaguliers misses the point. Papin and Savery had carried the work beyond all previous attainments, and then came Newcomen, who, as Tomlinson remarks, brought the "steam-engine to the general form and properties it has retained to this day, insomuch that there is not a single change introduced by him which has not been permanent, nor a single part or feature of his engine but continues essential in all future engines, merely improved in detail, but identical in name and principle." This is presumed to refer to engines of its class.

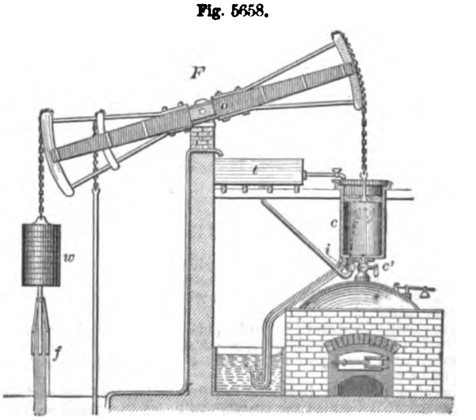
Newcomen's engine (Fig. 5658), which followed Savery's, was introduced in 1705, and perfected the principle which was initiated by Papin. It differed from Savery's in several respects. One difference has been noted. It is this: —

Savery raised water partly by the pressure of the atmosphere, and partly by the pressure of steam, the actions being alternate. Newcomen raised water by the pressure of the atmosphere, steam being employed alternately to create a vacuum. Another: —

Savery allowed the direct pressure of steam on the surface of the water. Newcomen had the pressure of the steam and air alternately on the respective sides of the piston, that of the water on a pump-piston which was attached to the other end of the walking-beam from that to which the steam-piston rod or chain is attached. The walking-beam is Newcomen's.

Newcomen separated the boiler from the cylinder; Papin, we have seen, *generated* and *condensed* his steam in the cylinder beneath the piston, which consumed much time in the alternate heating and cooling. The boiler had already been separated from the cylinder, in Papin's apparatus, and also from the reservoir in Savery's apparatus, so that it is singular that Papin should have missed this point, which gave value to the idea of the atmospheric engine.

Fig. 5658.



Newcomen's Engine.

In Newcomen's engine, the piston depended from one end of the walking-beam *a*, and the pump-rod from the other end. The pump-rod was heavy enough to sink it in the shaft and raise the steam-piston, or else a weight *w* was added. The periphery of the piston was covered with leather, and kept air-tight by water above it from a tank *t*. The cylinder *c* was placed above the boiler *b*, and steam was admitted to it through the cock *c'*, which was tended by hand, the strokes being slow. At starting, the air from the cylinder, displaced by the steam, passed down the pipe which proceeds from the bottom of the cylinder, and issued at the valve *s*, which opened upwardly. This is the *blow-valve* or *snifting-valve* of the engine. The cock *c'*, being then opened, shuts off the steam, and the cock *i*, being opened, allows injection water to enter the cylinder from the tank *t*. The water, being condensed into $^1/_{1700}$ of its bulk, formed a nearly perfect vacuum, and the atmospheric pressure of 14 pounds to the square inch bearing upon the piston depressed the latter, and consequently raised the pump-rod, the weight *w* (if any there be), and the load of water. The downward stroke only of the piston was used effectively. The pump-rod *f* was to lift water to supply the tank *t*. The water of injection and condensation passed by the pipe leading from the bottom of the cylinder to the hot-well, issuing at the valve *s*, and was used to feed the boiler.

It will be observed that the piston and pump-rod are merely suspended by chains; the action of each is to pull, — not push, — and a stiff connection was not necessary.

At first Newcomen adopted Savery's plan of external condensation, but a faulty cylinder having admitted water internally, the condensation was more rapid, with increased effect from the engine. Since that accidental discovery, internal injection has been generally adopted.

The beam, pump, internal condensation, and self-action were important additions to the previous steam-engines, earning for Newcomen and Cawley a well-deserved fame.

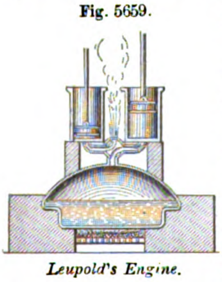
The taps which answered as valves in the Newcomen engine required the most unremitting attention of the person in charge, to introduce steam into the cylinder to lift the piston, or the shower of cold water which was to condense the steam and cause the depression of the piston by the atmospheric pressure above it. A Cornish boy, named Potter, in order to have some time for play, conceived and put in execution the idea of connecting the beam to the handle of the taps, so as to work them automatically. Hence the valve motion. For the first time, the engine worked by itself.

With the exception of Smeaton's improvements in details, the Newcomen engine remained in the state to which its inventor had brought it, from 1710 to 1764, about which time Watt appeared.

Desaguliers' steam-engine, invented about 1716, was substantially similar to Savery's. The steam pressed directly upon the water to drive it up the eduction-pipe. Cutting off the steam caused the steam in the water-chamber to condense, and atmospheric pressure again filled the chamber from the well.

Leupold, 1720 (Fig. 5659), invented an engine in which two vertical cylinders were placed parallel, their pistons being raised by the direct pressure of the steam, necessitating the use of piston-rods. A four-way cock of ingenious construction made the necessary changes of induction and eduction. The steam was used at full power, and then exhausted into the atmosphere. This latter feature was novel. The positive pressure of steam was not. Papin had used it 25 years before. The two coacting, alternate cylinders was a novel feature. The engine never had any practical importance.

Fig. 5659.



Leupold's Engine.

In 1756, Blakey took out a patent for a water-raising apparatus, as an improvement on Savery's, to avoid the condensation of steam incident to its contact with the water. To avoid this he interposed a stratum of oil or air between the water and the steam.

Smeaton devoted himself to the details of the Newcomen engine, laid down some rules for proportions, and determined a mode of measuring the power. It was formed upon the data: —

Rate of the piston.
Area of the piston.
Pressure of the steam.

The number by which he denoted the power was obtained by multiplying together, —

1. The number of feet which the piston traveled in a minute.
2. The square of its diameter in inches
3. The number of feet of water to which the pressure driving it was equivalent.

The calculations and the subject may be pursued in treatises devoted to this subject, but the result may be stated: Smeaton's dynamic unit was a power that lifts ¼ of a pound 1 foot high per minute.

Smeaton probably invented the flue-boiler, and by various improvements doubled the effective value of the steam-engine. (See DUTY.) Smeaton also invented the CATARACT (which see).

James Watt was born in Glasgow, in Scotland, January, 1737.

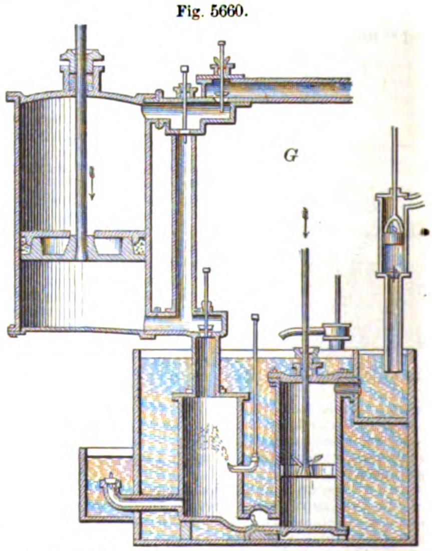
" His attention seems to have been directed to the steam-engine by a model of Newcomen's engine, which was sent him to repair. He set about repairing it as a mere mechanic; and when it was repaired and put in operation, he was surprised to find that the boiler belonging to it could not furnish a sufficient supply of steam, although apparently large enough for this purpose, for the cylinder of the model was only 2 inches in diameter and 6 inches stroke, while the boiler was about 9 inches in diameter. By blowing the fire the machine was made to effect a few strokes, but it required an enormous quantity of injection-water, although it was very lightly loaded with the column of water in the pump. It soon occurred to him that this was caused by the fact that the cylinders of small engines expose a greater surface to the condensation of their steam than the cylinders of large engines, in proportion to their capacity. He seems to have been well aware of the mathematical principles, that solids are to one another as the *cubes* of their dimensions, but that their surfaces are to one another only as the *squares* of their dimensions. He found, by shortening the column of water in the pump, the boiler could be made to supply the cylinder with steam, and that the machine would work regularly with a moderate quantity of injection-water. He also found that the cylinder of the model, being made of brass, conducted heat much faster than the cast-iron cylinders of large engines, and that considerable advantage would be gained by making the cylinders of some substance that would conduct heat slowly. Wood seemed most likely to answer this purpose, provided it were found sufficiently durable. Accordingly he made a small engine, of 6 inches diameter and 12 inches stroke, of wood, soaked in linseed oil and baked to dryness. With this engine he made many experiments; but he soon found that the wooden cylinder would not prove durable enough, and that the steam condensed in filling it still exceeded the proportion of that required for large cylinders, according to the statements concerning them, given by Dr. Desaguliers. He found, also, that all attempts to produce a better state of exhaustion, by throwing in more injection-water, occasioned a disproportionate waste of the steam. Meditating on the cause of this, he attributed it to the fact that water boiled *in vacuo* at low heats (100° Fah.), — a discovery made by Dr. Cullen, the predecessor of Dr. Black in the University of Glasgow, — and he naturally inferred that at greater heats the water in the cylinder would produce a vapor which would partially resist the pressure of the atmosphere. We now know that the vapor of water at 180° is equal to half the pressure of the atmosphere."

Watt made experiments on the power of steam by means of Papin's digester.

See also Muirhead's " Mechanical Inventions of James Watt," London, 1854.

The single-acting steam-engine of Watt is shown at Fig. 5660.

Fig. 5660.



Watt's Single-Acting Steam-Engine.

Watt, after the invention of the separate condenser and *air-pump*, which go together (see CONDENSER), devoted himself to farther improvements.

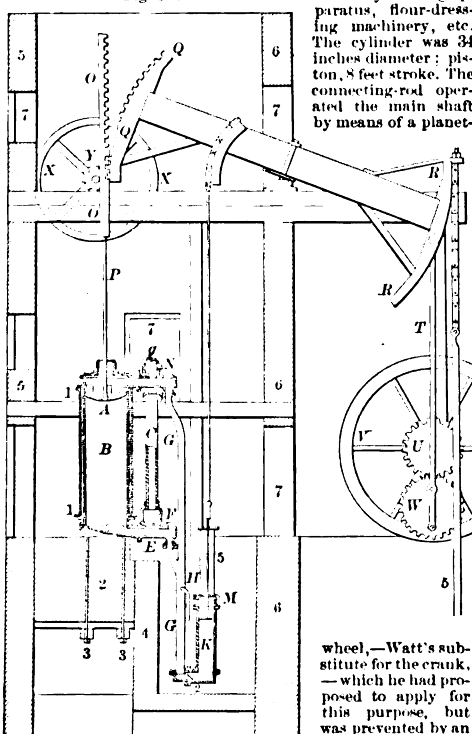
He added a *jacket* to the cylinder, and surrounded the latter with an envelope of steam to prevent its cooling.

He substituted for the open cylinder of the Newcomen engine and the piston covered with water a *cover to the cylinder* and a *greasy packing*.

He next sought for a means of excluding the air from the cylinder above the piston, in order that the heat of the cylinder might be maintained. For this purpose he admitted a body of steam above the piston, merely to occupy the space at first, but afterward he substituted *pressure of steam* for the *pressure of the atmosphere;* and finding that he could obtain a pressure greater than that due to the atmosphere when the space below was nearly a vacuum, he constructed that form of engine, the *double-acting* In doing this he adopted the *stuffing-box*, the invention of Sir Samuel Morland.

Watt made double-acting engines in 1782, and soon after that date put up two of them, of 50 horse-power each, at the Albion Flour Mills, Blackfriar's, London. They jointly drove 20 pair of mill-stones with the necessary hoisting apparatus, flour-dressing machinery, etc. The cylinder was 34 inches diameter; piston, 8 feet stroke. The connecting-rod operated the main shaft by means of a planet-wheel,—Watt's substitute for the crank,—which he had proposed to apply for this purpose, but was prevented by an interloper, who stole his idea and patented it See Fig 1692, page 722, Vol. I.

Fig. 5661.



James Watt's Double-Acting Steam-Engine (from original sources).

The following is from the inscription on the original drawing:—

"Fig. 12th [it is one of a number of figures on a broad sheet] Represents the New Improved Engine the Piston of which is pressed forcibly both Upwards and Downwards by the Powers of Steam.

A. The Piston.
B. The cylinder or Steam Vessel.
C. A Pipe which brings Steam from the Boiler to a lower Regulator box or Nozle.
D. The place of a Regulating Valve, which admits Steam into the upper end of the Steam Vessel.
E The place of the Regulator which admits Steam below the Piston.
F. The place of a Regulator which lets Steam go out from below the Piston into the Condenser.
N. Place of a Regulator which discharges the Steam from above the Piston.
G G. The Eduction or Condenser Pipe.
H. The Injection Pipe.
J. The Hot-water Pipe.
K. The Air Pump
L. A Valve at the Eduction Pipe foot.
M. A passage from the Air Pump to the Hot-water Pump.
O O. A Toothed Rack which connects the Piston Rod and the Working Beam.
P. The Piston Rod.
Q Q. A Toothed Sector or Arch which also serves to assist the Piston in its descent.
Q R. The Working Beam.
S S. The Pump Rod which is made double when the Rotative Machinery is used.
T. The Connecting Rod of the Rotative Machinery.
V. The Wheel fixed upon an Axis.
W. The Wheel fixed to the Connecting Rod.
V V. The Fly.
X X. The Fly of the Reciprocating Rotative Motion.
Y. The Pinion by means of which it acts is acted upon by the Working Beam.
g. The pipe which brings Steam from the Boiler.
1. The steam case which surrounds the cylinders.
2. The platform on which the cylinder stands.
3. Beams which support it.
4. Wall of the Condenser Cistern.
5. Back wall of the Engine house.
6. The Lever wall.
7. Doors and Windows."

It will be perceived that the fly-wheel is connected to the working-beam by a "sun and planet" motion. This was adopted as a substitute for connecting-rod and crank; a motion which was well known to Watt, and which he had designed using, but which was surreptitiously patented by another party, with the result of depriving the Boulton and Watt engines of its use. It was used on the "Charlotte Dundas" steamboat, built by Symington. This, by various modifications, made the Cornish engine substantially as we know it, but the actual improvements in detail of construction and excellence of workmanship have been vast. Watt never saw a good power-lathe or a planing-machine of any kind.

Watt next proposed, in certain cases where cold water was scarce, to abandon the condenser and allow the steam to exhaust into the atmosphere, thus reviving Leupold's idea of 1720. This is one feature of the ordinary high-pressure engine, but Watt was always afraid of high-pressure, and though he included a steam-carriage in one of his patents, it was not a success until Trevethick and Vivian built their steam-carriage, in 1802. See Steam-carriage.

Thirteen years after Watt's first patent, that is, in 1782, he obtained another patent, in which he describes and claims the working of steam expansively; that is, cutting off the supply of steam from the boiler to the cylinder after the latter has been partly filled, and allowing the steam to expand during the remainder of the stroke. See Cut-off.

The conversion of a reciprocating into a rotary motion was long a puzzle to mechanicians.

Papin tried to avoid the problem, suggesting the direct action of the steam on a kind of wheel. A rotary engine. Watt repeated this 70 years afterward, and included it in his first patent, but neither he nor Papin accomplished anything in that line.

Papin suggested another plan, which was adopted a century afterward, but was abandoned more than half a century since. It consisted of a pair of pistons acting alternately on a wheel or axle, each pulling it round, while the other was being drawn back to its starting-place by a weight disconnected with the revolving parts. The alternate reciprocating motion was used upon a number of carriages and boats before the crank was generally adopted.

Hulls, in 1737, used an arrangement of cords and pulleys, involving the use of a ratchet. This was repeated by Symington in 1789.

The Newcomen engine, which was doing the heavy work from 1705 to 1770, or thereabouts, had no rotary motions, but employed a walking-beam, with arcs upon the ends, from which the piston and pump-rod were respectively suspended by flexible connections. No parallel motion as yet, and no rotation.

Watt applied the crank Such men are not impostors; and this meek, earnest man says:—

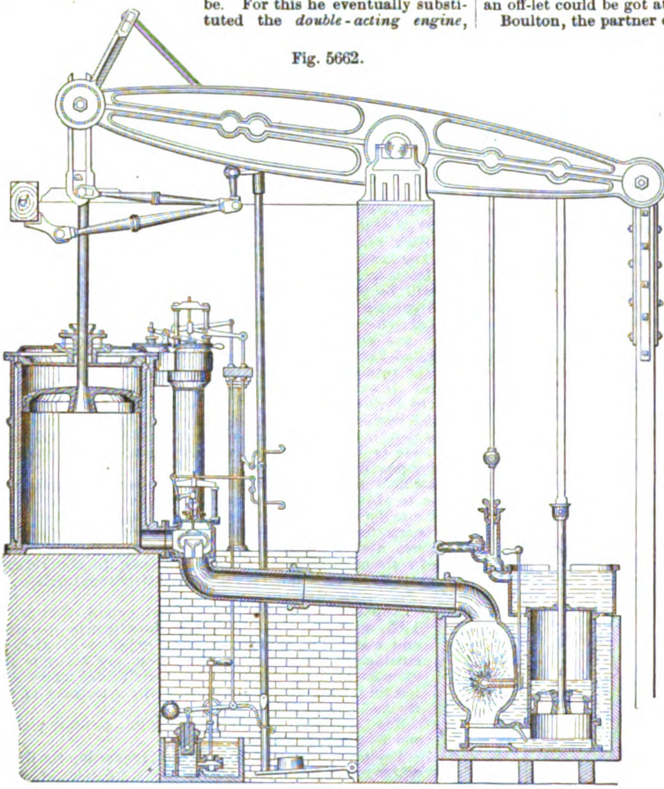
"The true inventor of the crank rotative motion was the man, whose name unfortunately has not been preserved, who first invented the common foot-lathe. The applying to the steam-engine was merely taking a knife to cut cheese which had been used to cut bread." The device designed to be applied by Watt was pirated by a man who overlooked a sketch of the machine, and, rushing to London, patented it. It would be a pity to embalm the name of a scoundrel by recording it.

The use of a crank to change a rotary to a reciprocating motion, the inverse of the Watt proposition, was not new at the date. A 4-throw crank was employed on each end of the wallower or lantern-wheel which was driven by the water-wheel under the north end of London Bridge, as described by Beighton, 1731. The water-wheel was first placed there by Morice in 1582, but the mode of driving the pump-piston from the rotary-shaft is not known to the writer.

To make the rotary motion continuous, passing the dead points was the next problem, and various suggestions seem to have been entertained. The crank, receiving an impulse in one direction, might then be abandoned to the momentum of a counter-weight which was raised the previous stroke. This weight might be placed on a wheel, and constitute a fly-wheel. Better still, a positive motion might be given to the crank in each direction. For this purpose, Watt arranged 2 or 3 engines acting

on as many different cranks on the same shaft, and arranged at 180° or 120° apart, as the case would be. For this he eventually substituted the *double-acting engine*,

Fig. 5662.



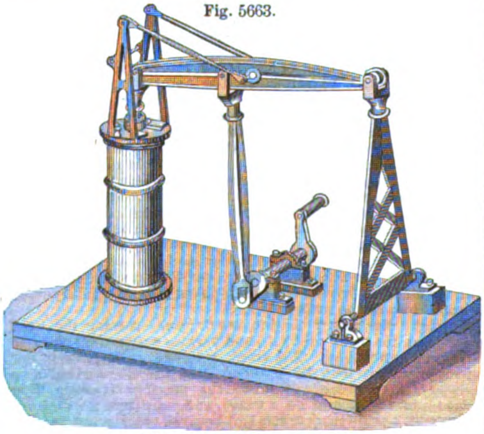
Cornish Steam-Engine.

which served the purpose of two, acting alternately, within the compass of a single cylinder and piston.

For the purpose of communicating a vertical motion to the pump-rods and plug-rod from an engine-beam which oscillated on a horizontal axis and described arcs, Watt contrived the PARALLEL MOTION (which see).

Watt's governor was adopted from an ancient device in windmills. A pair of balls are suspended by jointed rods from a collar on a rotating axis. According to the speed of the latter such is the lateral extension of the balls, that their divergence under the centrifugal effect of the rotation is made to operate through certain devices upon the throttle-valve, by which steam passes from the boiler to the cylinder. See GOVERNOR.

Fig. 5663.



Oliver Evans' Steam-Engine.

He also devised the mode, since adopted, of removing the water, which, he says, might be run off by a descending pipe if an off-let could be got at a depth of 30 or 35 feet.

Boulton, the partner of Watt, who, by business tact and sterling sense, smoothed the asperities of the road for his studious and previously desponding friend, was proud of his vocation, and is described by Boswell as "*an iron chieftain, with 700 work-people, and the father of his tribe.*" The works of Boulton — afterward Boulton and Watt — were established in Birmingham, 1764. Steam-engines were made there in 1774.

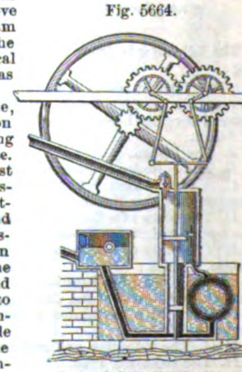
The first trial of the "Watt engine" took place in Cornwall under the inventor's supervision. The sea had broken into a copper-mine in that county, and the owners were unable to cope with the waters. Boulton, with his accustomed enterprise, announced that he had an engine which would retrieve the disaster. To back his own statements, he offered to supply the engine for a royalty of one third of the proved saving of coal as compared with the Newcomen engine. The offer was accepted. Watt toiled and ran the engine, making a register to mark the number of strokes, so that the duty performed might be positively ascertained. The saving of coal, for a given number of hogsheads raised, was found to be 75 per cent over the Chacewater engine on the Newcomen principle, which amounted to £7,200 per annum. The economy and effectiveness of the Watt engine were then fully admitted, and orders for the "fire-engine," as Watt called it, flowed into Soho.

Pirates commenced work immediately, and law expenses gobbled up the money of these men, of whom the world was not worthy. The separate condenser, which gave especial character to the "Watt condensing-engine," was a boon to the Cornish miners, and as such they appropriated it. The studious and conscientious Watt hated a lawsuit, with its lies and vexations, and retired on a moderate competence due to the extension of his patents to the year 1800.

The Spanish cinnabar-mine of Almaden is one of the last places where one would expect to find one of Boulton and Watt's original engines, but it appears that one was erected there in 1799, and has been at work ever since.

Fig. 5663 illustrates the parallel motion invented by Oliver Evans. The working-beam, also known as the *grasshopper-beam*, connected at one end to the piston-rod, was pivoted at the other in a rocking frame; it was connected near its mid-length with two standards secured to the cylinder head by two rods which were pivoted to these standards and to the beam; the effect being that while the rocking-frame, the crank connecting-rod attached to the piston near its center, the two rods above named, and the working-beam itself, vibrated freely as the crank revolved, the vertical movement of the piston-rod was not interfered with.

Fig. 5664.



Cartwright's Engine.

Cartwright's steam-engine, 1797, had a long piston-rod, on which were two pistons working in two cylinders of varying size. It is said to have been the first engine in which a metallic piston was used. Steam is admitted by the pipe to the upper end of the upper cylinder, depressing both pistons; as the piston reaches its lowest position, the valve in the piston is lifted and allows the steam to escape to the condenser, which is an annular cylinder with water inside and outside. The contact of the cross-bar closes the steam-valve. The force of the fly-wheel raises the pistons, and as the upper one rises it closes the valve in the piston and opens the steam-valve in the cylinder-head. Another stroke is then made. The descent of the lower piston forces the water and air into the pipe leading to the reservoir on the left, a foot-valve preventing it from running back toward the condenser. The

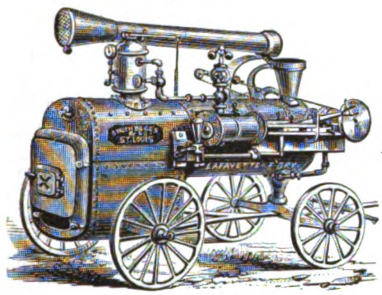
boiler is fed from the reservoir, and superfluous water and air escape therefrom.

Hornblower's steam-engine was an expansive engine, having two cylinders. His patents were 1781, 98, 1805. The steam was worked expansively in a second and larger cylinder, after a previous use in a primary cylinder.

Woolf very much improved this idea about 1804. See DOUBLE ENGINE; COMPOUND ENGINE; DUPLEX ENGINE.

The oscillating-cylinder engine was patented in England in 1813, by Witty.

Fig. 5665.



Portable Engine.

For notices of portable and traveling engines, see PORTABLE ENGINE; LOCOMOTIVE.

In the Corliss engine (Fig. 5666), the steam-valves, which are of peculiar form, their acting portions forming a segment of a cylinder, are oscillated by connection with a wrist-plate journaled on a shaft at the side of the cylinder, and vibrated by a lever and connecting-rods, operated by the movement of the fly-wheel eccentric. They are so arranged as to cut off at any required part of the stroke by rods, which cause the connection between the wrist-plate and the valve-stems to be completed and released when the rods are brought into action by or freed from the action of the governor, which merely performs the function of connecting and disconnecting the levers which work the valves, without being called on to exert any force in opening and closing them. The exhaust-valves have also circular acting faces, and are similarly actuated by connection with the wrist-plate before referred to, this connection, however, being permanent. The area of the exhaust-ports is about four times that of the steam-ports, to obviate any risk of back pressure, and the eduction-pipe is made proportionately large. The induction-valves are at the top and the eduction-valves at the bottom of the cylinder, which is thereby kept free from water of condensation, and are in immediate proximity to the bore of the cylinder, having no long passages to be filled with live steam.

Fig. 5667 illustrates the Eickemeyer steam-engine. *A* is a perspective; *B*, sections in parallel planes through the steam-cylinder *a* and crank-wheel *b*; *C*, transverse section of the cylinder; and *D*, sectional plan, showing the connection of the piston-rod *c* and crank-wheel.

The piston *d* is hollowed at the ends, and its sides have grooved passages *e f* which communicate with the cavities, and, alternately, with the steam induction and eduction passages *g h*.

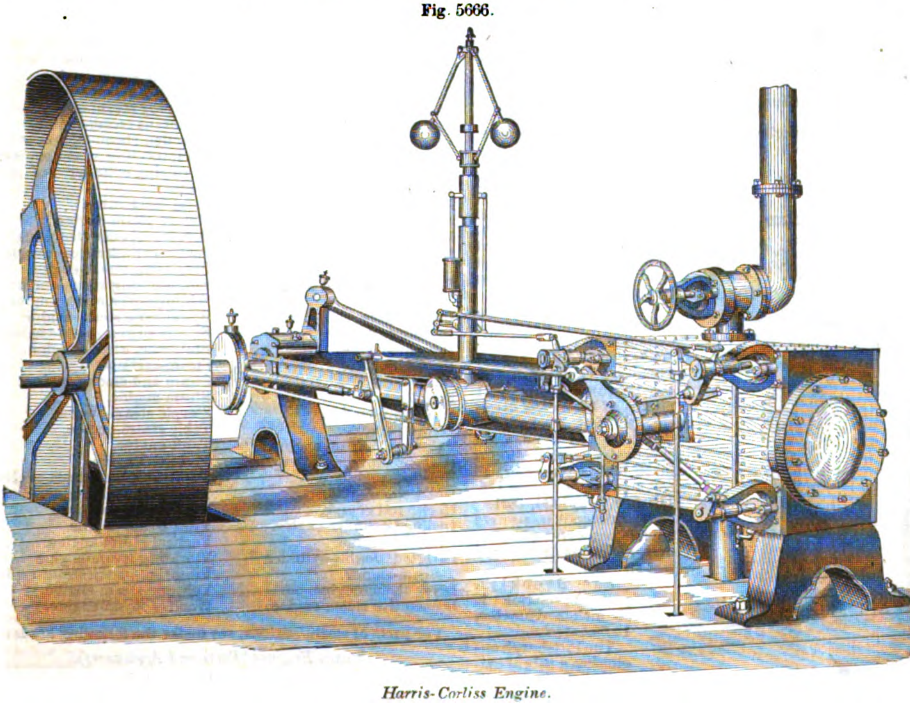
A compound lug *i* on the piston-rod, secured by set-screws, receives a wrist-pin *k* having a ball on the end, which enters the lug and forms the axis of an eccentric roller *m* entering a groove in the side of the crank-wheel and causing it to rotate at each reciprocation of the piston.

Root's double-reciprocating engine has a square piston, which reciprocates in one direction while a piston inside the former reciprocates in a direction at right angles thereto.

The inner piston is connected to the wrist, and communicates both its motions thereto, — its own vertical motion *in* the outer piston, and its horizontal motion *with* the outer piston. The resultant is a rotary motion of the crank without dead-centers. See Fig. 1710, page 728.

A steam-engine driven by the heat of the sun has been made at Tours, France, by Professor Mouchot. A silver-plated concave reflector abou t five feet in diameter collects and throws the heat in the solar rays upon a copper boiler which, in from fifteen to forty minutes, gets so hot that the heat must be moderated to prevent it from bursting by the conversion of all the water into steam. The reflector turns with the sun by clock-

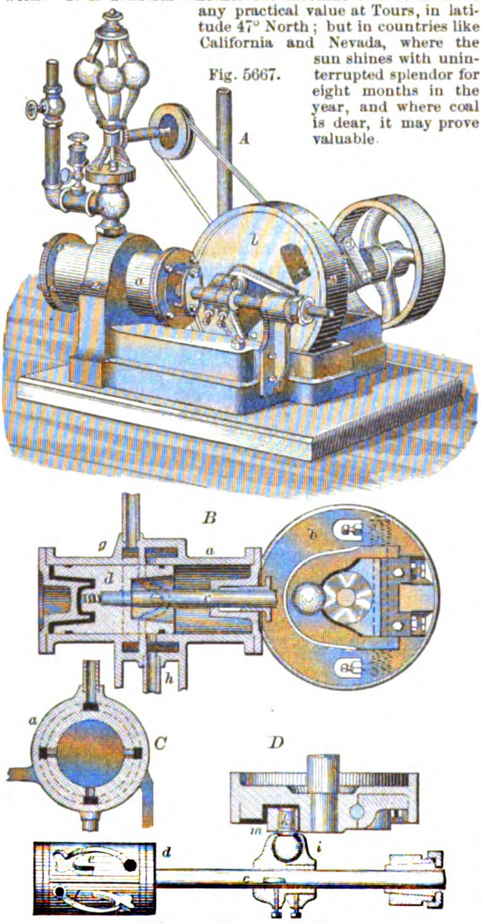
Fig. 5666.



Harris-Corliss Engine.

work. It is doubtful whether the machine can be made of any practical value at Tours, in latitude 47° North; but in countries like California and Nevada, where the sun shines with uninterrupted splendor for eight months in the year, and where coal is dear, it may prove valuable.

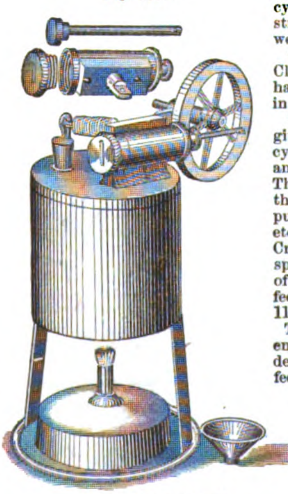
Fig. 5667.



Eickemeyer's Steam-Engine.

The dollar steam-engine is a working toy. It is a reciprocating steam-engine, with cylinder, piston, fly-wheel, boiler, and patent safety-valve, taking steam at both ends of the cylinder, with half-inch stroke. All complete it weighs less than 4 ounces.

Fig. 5668.



Dollar Steam-Engine.

The engines of the "Lord Clyde" British iron-clad have cylinders 116 inches in diameter, 4 feet stroke.

The Haarlem Mere engines have annular outer cylinders of 112 inches diameter, 15 feet stroke. There are three of them: the Leeghwater works 11 pumps of 63 inches diameter, 10 feet stroke; the Cruquius and Lynden respectively work 8 pumps of 73 inches diameter, 10 feet stroke. See pages 115, 116, 739, 740, 1830, 1831.

The Chicago Water-works engine has a pair of cylinders 44 inches diameter, 8 feet stroke.

The Brooklyn pumping-engine is 85 inches diameter, 10 feet stroke.

The Pittsburgh engine has a pair of cylinders 64 inches diameter, 14 feet stroke.

The Lehigh zinc-works, 110½ inches diameter, 10 feet stroke.

The Providence Sound steamers' cylinders, 110 inches diameter, 12 feet stroke.

The Baxter steam-engine, described and pictured on page 1770, has the following sizes and prices: —

Horse-power.	Revolutions to the minute.	Price.
2	300	$ 400
4	266	600
6	240	800
8	200	1,000
10	170	1,200

The Maxim steam-engine is also vertical, the engine being above the boiler, and not sunk within it, as in the Baxter engine.

Small steam-engines are coming much into favor to relieve hand and horse work in establishments where but a moderate amount of power is required. Many of these are attached to their boilers, the bed-plate being common to both. The upright form of boiler and engine has the preference, partly for compactness, and partly on account of the evenness of wear. The rate is usually quite rapid. The Washburn engine, used some years since at the Massachusetts State Fair at Worcester, was not larger than an ordinary ice-cream freezer, and its proportions and work are reported as follows in a Worcester paper: "It has two cylinders, 3 7-10th inches bore by 1 85-100th inches stroke; runs about 370 revolutions per minute, and drove all the machinery in the hall. The machinery is as follows: one loom, one carding-machine, one 20-shuttle tape-loom, one cloth-loom, one spinner, twenty spindles, envelope-machine, six fine wire blocks, three hoop-skirt covering machines, one 8-foot planer, one 16-inch engine-lathe, one 15-inch engine-lathe, one card and two small printing presses."

One or two very small engines are described under MODEL, page 1457.

The several forms of engines are considered under the specific heads. The Cornish, pages 626 and 1828; the Haarlem Mere engines, pages 1830, 1831; Portable, pages 1769, 1770; Worthington Duplex, Plate XV., opposite page 763; etc.

See under the following heads: —

Steam-Engines (Varieties).

Æolipile.
Aëro steam-engine.
Agricultural steam-engine.
Annular-cylinder steam-engine.
Assistant steam-engine.
Atmospheric steam-engine.
Auxiliary steam-engine.
Ballast-engine.
Beam steam-engine.
Bisulphide-of-carbon engine.
Bogie-engine.
Breast-wheel steam-engine.
Compound steam-engine.
Concentric steam-engine.
Condensing steam-engine.
Corliss steam-engine.
Cornish steam-engine.
Cut-off.
Direct-action steam-engine.
Disk steam-engine.
Doctor steam-engine.
Donkey steam-engine.
Double steam-engine.
Double-acting steam-engine.
Double-cylinder steam-engine.
Double-expansion steam-engine.
Double piston-rod steam-engine.
Draft-engine.
Draining-engine.
Dummy-engine.
Duplex engine.
Duty.
Eolipile.
Fan steam-engine.
Feeding-engine.
"Gorgon" steam-engine.
High-pressure steam-engine.
Hoisting-engine.
Hot-water engine.
Horizontal engine.
Inclined-cylinder engine.
Inverted engine.
Inverted double-cylinder steam-engine.
Lever steam-engine.
Locomotive steam-engine.
Low-pressure steam-engine.
Man-engine.
Marine steam-engine.
Mining-locomotive.
Nigger steam-engine.
Non-conducting steam-engine.
Oscillating-cylinder steam-engine.
Oscillating-piston steam-engine.
Overhead steam-engine.
Pendulous-cylinder steam-engine.
Pilot steam-engine.
Pony steam-engine.
Portable steam-engine.
Propeller steam-engine.
Pumping steam-engine.
Quadrant steam-engine.
Reaction steam-engine.
Reciprocating steam-engine.
Revolving-cylinder steam-engine.
Road-locomotive.
Rotary steam-engine.
Screw-propeller steam-engine.
Sector-cylinder steam-engine.
Side-beam steam-engine.
Single-acting steam-engine.
Sliding-cover steam-engine.
Spiral-vane steam-engine.
Square-piston steam-engine.
Stationary steam-engine.
Steam-carriage.
Steam and smoke engine.
Steam-engine.
Steeple steam-engine.
Table steam-engine.
Tank-engine.
Traction-engine.
Treble-cylinder steam-engine.
Triple-cylinder engine.
Trunk steam-engine.
Twin steam-engine.
Vertical steam-engine.
Vibrating steam-engine.
Vibrating-piston steam-engine.
Volcanic steam-engine.
Woolf's steam-engine.

For parts of steam-engines, see under the following heads: —

Steam-Engines (Parts and Appliances).

Back-balance.
Back-link.
Balance-bob.
Balanced valve.

Banking-up.
Beam.
Beam-center.
Bedding.
Belly-brace.
Bisulphide-of-carbon engine.
Blast-pipe.
Blower
Blow-off pipe.
Blow-through valve.
Blow-valve.
Bob.
Boiler.
Boiler-feeder.
Boiler-float.
Boiler-prover.
Boiler-stay.
Boiler-tube.
Bridge.
Brine-pump.
Brine-valve.
Bucket-valve.
Cataract.
Check-valve.
Cinder-frame.
Circulating-pump.
Cistern.
Clack-box.
Cleading.
Clinker-bar.
Clothing.
Cold-water pump.
Condenser.
Condenser-gage.
Condensing-engine.
Contra-vapeur.
Counter.
Cover.
Crank-axle.
Cross-head.
Cross-head block.
Cross-tail.
Cut-off.
Cut-off valve-gear.
Cylinder.
Damper.
Dash-pot.
Deading.
Delivery-valve.
Detector. Low-water
Diagonal framing and stays.
Distribution.
Dome.
Draining-engine.
Drip-pipe.
Driver.
Drop-flue.
Dry-pipe.
Dumb-plate.
Eccentric.
Eduction-passage.
Ejector-condenser.
Entablature.
Equilibrium-valve.
Escape.
Exhaust-pipe.
Exhaust-port.
Exhaust-regulator.
Exhaust-valve.
Expansion-gear.
Expansion-valve.
Feeder. Boiler
Feed-head.
Feed-pipe.
Feed-pump.
Feed-water apparatus.
Feed-water pump.
Ferrule.
Fire-bar.
Fire-box.
Fire-bucket.
Fire-guard.
Fire-regulator.
Fire-surface.
Fire-tube.
Float.
Flue.
Flue-brush.
Flue-cleaner.
Flue-surface.
Foam-collector.
Fork-head.
Foot-plate.
Foot-valve.
Fusible plug.
Gab-hook.
Gab-lifter.
Gage-cock.
Gage-glass.
Gallows-frame.
Gasket.
Generator. Steam
Giffard injector.
Gland.
Globe-valve.
Governor.
Governor cut-off.
Governor-valve.
Grate-surface.
Grease-cock.
Grease-cup.
Guide-blocks.
Guides.
Hand-gear.
Hand-pump.
Hanging-bridge.
Heating surface.
High-pressure alarm.
Holding-down bolt.
Hot-water pump.
Hot-well.
Hydraulic governor.
Incrustation in boilers. Removing
Indicator.
Induction-pipe.
Induction-valve.
Injection-cock.
Injection-condenser.
Injection-pipe.
Injection-valve.
Injector.
Inside cylinder.
Instantaneous generator.
Intermediate shaft.
Jacket.
Junk-ring.
Kingston's valve.
Lag.
Lagging.
Lap.
Lead.
Lifter.
Lifting-gear.
Lifting-rod.
Link motion.
Lock-up safety-valve.
Locomotive valve-gear.
Low-water alarm.
Low-water detector.
Low-water indicator.
Lubricator.
Main center.
Main links.
Man-hole.
Manometer.
Marine governor.
Metallic packing.
Mid-feather.
Mud-collector.
Mud-hole.
Mud-plug.
Mud-valve.
Nozzle.
Nozzle-plate.
Packing.
Packing-box.
Packing-ring.
Parallel bar.
Parallel motion.
Pet-cock.
Pinching-pin.
Piston.
Piston-packing.
Piston-rod.
Piston-rod packing.
Pitman.
Pitman-box.
Pitman-coupling.
Pitman-head.
Plug-rod.
Pressure-gage.
Priming-valve.
Prop-stay.
Radius-bar.
Radius-rod.
Recording gage.
Refrigerator.
Regulator.
Relief-valve.
Reverse valve.
Rising-rod.
Rocking-shaft.
Rose.
Safety-plug.
Safety-tube.
Safety-valve.
Safety-valve lever.
Salinometer.
Scale-borer.
Sectional steam-boiler.
Sediment collector.
Shunt.
Side-lever.
Side-rods.
Skimmer.
Slide-case.
Sludge-hole.
Sluice.
Smoke-box.
Smoke-pipe.
Sole-plate.
Spark-arrester.
Spring-balance.
Spring-hook.
Spring pins.
Spring-valve.
Starting-valve.
Stay.
Stay-bolt.
Stay-rod.
Stay-wedge.
Steam.
Steam. Applications of
Steam-blower.
Steamboat.
Steam-boiler.
Steam-boiler alarm.
Steam-boiler furnace.
Steam-brake.
Steam-car.
Steam-carriage.
Steam-chest.
Steam-cock.
Steam-coil.
Steam-crane.
Steam-cylinder.
Steam-engine. (Parts of)
Steam-engine. (Varieties.)
Steam-engine indicator.
Steamer.
Steam fire-engine.
Steam-fountain.
Steam-furnace.
Steam-gage.
Steam-generator.
Steam-governor.
Steam-gun.
Steam-hammer.
Steam heating-apparatus.
Steam-hoist.
Steam-indicator.
Steam-jacket.
Steam-jet.
Steam-jet pump.
Steam-navigation.
Steam pile-driver.
Steam-pipe covering.
Steam-plow.
Steam-port.
Steam-power meter.
Steam-pressure gage.
Steam-pump.
Steam regulation-valve.
Steam riveting-machine.
Steam-room.
Steam-sled.
Steam steering-apparatus.
Steam-tank.
Steam-trap.
Steam-valve.
Steam-vessel.
Steam water-elevator.
Steam-whistle.
Steam-winch.
Stop-motion.
Strap.
Stuffing-box.
Surface-condenser.
Tail-valve.
Take-up.
Tank.
Tappet.
Tappet-motion.
Test-cock.
Throttle-valve.
Trailing-spring.
Trailing-wheel.
Travel.
Trunk.
Trunnion.
Tube.
Tube-brush.
Tube-cleaner.
Tube-cutter.
Tube-door.
Tube-expander.
Tube-fastener.
Tube-ferrule.
Tube-flue.
Tube-plate.
Tube-plate stay.
Tube-plug.
Tube-scaler.
Tube-sheet.
Tubular boiler.
Tubulous boiler.
Unit.
Uptake.
Vacuum-pump.
Vacuum-valve.
Valve.
Valve-gear.
Valve-motion.
Variable cut-off.
V-bob.
Waste-steam pipe.
Waste-water.
Water-bridge.
Water-gage.
Water-heater.
Water-indicator.
Water-injector.
Water-leg.
Weigh-shaft.
Whistle.
Working-beam.

Steam-en'gine In'di-ca'tor. A contrivance to make a record of the pressure of steam at all points of the motion of the piston. See also STEAM-GAGE; PRESSURE-GAGE; INDICATOR, etc.

In the indicator (Fig. 5669), a pencil or tracer is fixed centrally in the middle one of three connected levers forming the parallel motion. The two end members of the series are jointed to two opposite arms *b* near the top of the indicator-cylinder *c*. The cylinder is attached to a convenient part of the boiler, and steam admitted to the piston, whose rod is connected to the lever *d*, causing a vertical upward movement of the tracer, which is opposed by a weight suspended from the hook *e*. As the cylinder *f* is rotated by appropriate mechanism, the pencil traces a continuous line upon a sheet of paper secured thereon, varying in hight according to the steam-pressure. The use of the parallel motion is to prevent the wabbling of the stem of the piston-rod, preserving it directly in line during its vertical excursions.

Steam'er. 1. A steam-vessel. See STEAMBOAT.

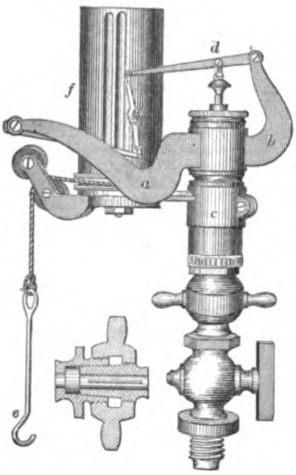
2. A steam fire-engine. See FIRE-ENGINE.

3. (*Domestic.*) A culinary vessel with a perforated bottom, placed upon a cook-pot and having a lid to keep in the steam.

In Fig. 5670, the steam passes up through a central channel

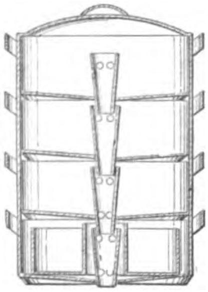
composed of frusto-conical sections of pipe, one of which is attached to each steamer. The lower smaller end of each section enters the top of the one below, and the drip which flows from the close bottoms of the steamers into the pipe is carried off without contaminating any matters in the steamer beneath.

Fig. 5669.



Parallel-Motion Indicator.

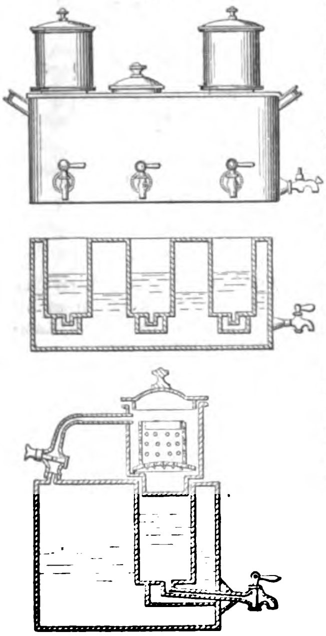
Fig. 5670.



Steamer for Cooking.

A primitive mode of cooking in use among several savage nations is called "stone-boiling," and is as follows: A hole is dug in the earth, dry wood is placed in it, and on that a number of stones. When the stones become red-hot the unconsumed fuel is removed, wet, green leaves placed upon the stones, and upon the leaves the food to be cooked. More leaves are placed on the food, and a mat over all. Then some water is poured on the mat, and finally earth as an outside coating; thus the food is cooked by a combined baking and steaming process. But a simpler method of stone-boiling than this of the New-Zealanders was probably practiced by the pit-dwellers. Stones made red-hot in the fire were thrown one after another into a vessel of water containing the food to be cooked. This is the plan adopted by certain North-American Indians, and traces of it still survive on the Continent of Europe.

Fig. 5671.



Coffee and Tea Steamer.

Fig. 5671 is a tea and coffee steamer for hotel purposes, with double walls extending nearly to the bottom, placed in the boiler so as to allow the water to pass all around them, while upon them set vessels with perforated bottoms and containing each a strainer in which the coffee is placed.

4. *a.* An apparatus in which wood (for instance) is placed within a chamber, in order to expel the natural juices, inject preservative compositions, or merely soften the wood so that it may be readily bent.

b. A vessel in which paper stock or other fiber is treated in order to soften it, to facilitate the removal of siliceous matters.

Fig. 5672 is an apparatus for steaming paper-stock. See also PULP-DIGESTER.

5. (*Milling.*) An apparatus for steaming wheat preparatory to grinding.

Fig. 5673 shows Hunt's apparatus for steaming wheat. The grain flows from the hopper *a* down through the passage *b*, which is larger at the bottom than at the top; in its progress downward steam is admitted to it from the perforated chamber *c*, which receives steam from the pipe *d*, and it is then dried by coming in contact with the walls of the chamber *e*, supplied with steam by the pipe *f*. By means of the cock *g* the steam may be shut off from the upper chamber if the grain does not require steaming; or it can be cut off entirely by the globe-valve *h*. The water of condensation is drawn off by the pipe *i*.

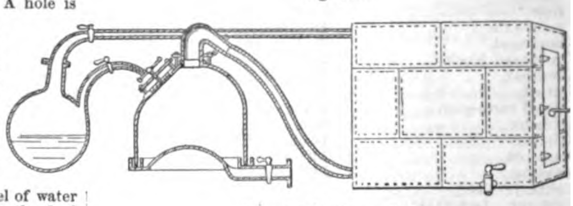
Steam Fire-en'gine. Mr. Braithwaite's fire-engine, used in London, was described in Partington's "British Cyclopedia," published in 1833. It is there described as a portable steam-engine, to move the pump-rod, the steam being prepared during the passage of the fire-engine to its destination. See FIRE-ENGINE.

Steam-foun'tain. A jet or body of water raised by the pressure of steam upon the surface of the water in a reservoir.

This is shown in the "Spiritalia" of Hero, 150 B. C., in several forms. The device was a part of the priestly jugglery of the temple. The fire, being lighted on an altar, heated water in an adjoining chamber; the steam evolved pressed upon the surface of a liquid, oil or wine, and ejected the same by means of pipes hidden within a statue, so as to run out of a flagon in the hand of the figure, and thus pour a libation upon the altar.

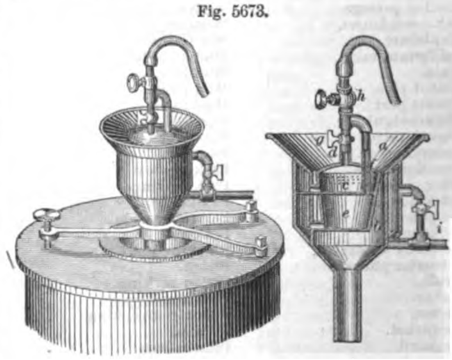
The idea of Hero was revived by Baptista Porta in 1600; De Caus (?), in 1620; the Marquis of Worcester in 1633; Savery, in 1698. See STEAM-ENGINE.

Fig. 5672.



Steamer for Paper Stock.

Fig. 5673.



Steamer.

Steam-gage. (*Steam.*) An attachment to a boiler to indicate the pressure of steam.

a b c d e, in Fig. 5674, are forms of mercurial gages; the pressure of the steam rising in the longer leg of the tube is read against the graduated plate.

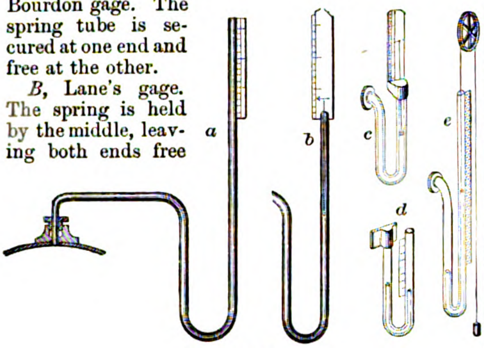
Fig. 5675 represents piston-gages. The cylinder has a solid plug, turned and ground, the pressure of

the steam elevating the plug against the force of the spring.

A (Fig. 5676), Bourdon gage. The spring tube is secured at one end and free at the other.

B, Lane's gage. The spring is held by the middle, leaving both ends free

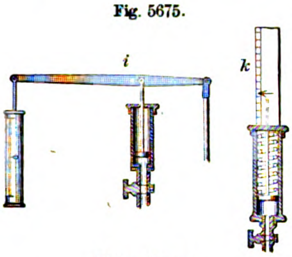
Fig. 5674.



Mercurial Gages.

and pointing upward, so as to prevent water from the siphon which transmits the steam pressure collecting in the tube and freezing in cold weather. Both ends of the tube are connected by a lever to the index, and vibration of the latter is prevented.

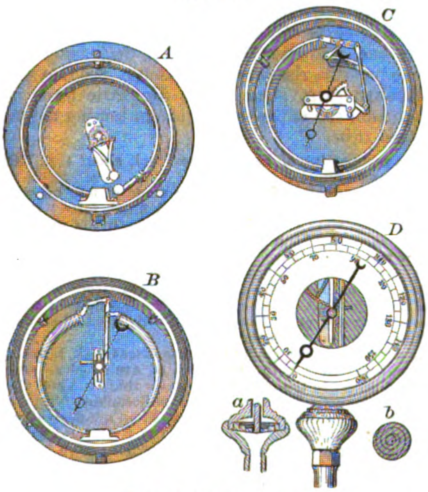
Fig. 5675.



Piston-Gages.

C, Crosby's gage. The spring-tube is arranged in a manner similar to the last; three connected levers are employed for transmitting motion to the index, and it is claimed that a stronger and heavier tube may be used, obviating danger of straining or bursting under high steam-pressures.

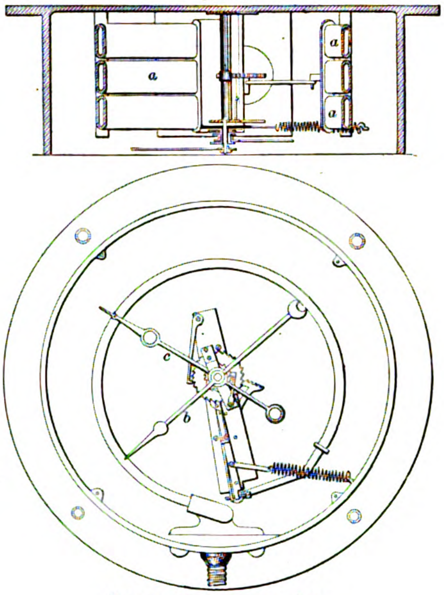
Fig. 5676.



Bourdon Steam-Gages.

D, Allen's gage. This is a box or diaphragm gage, on the principle of the aneroid barometer. *a* is a section through the box, and *b* a plan of the diaphragm. See also PRESSURE-GAGE; INDICATOR, etc.

Fig 5677.



Bourdon Tube Pressure-Gage.

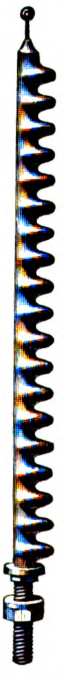
Fig. 5677 represents a steam-pressure gage on the principle of the Bourdon barometer (see page 347). The views are respectively a front elevation and a horizontal section, the upper part of the casing being removed.

A series of spiral tubes *a a a* communicate at one end with a common opening connected with the steam-chamber, and at the other are joined by a T-piece, which, by means of a connecting-rod, is attached to a lever operating a segment-rack that engages a pinion on the shaft of the index-hand *b*, which shows the pressure on a dial

A second index *c* has a projection on its under side, which is struck by the index *b* when the steam pressure exceeds a limit to which it has been previously set, carrying it forward till the extreme amount of pressure has been reached; and a ratchet-wheel and pawl prevent it from receding from this point.

A third and shorter index, also controlled by a ratchet and pawl arrangement, is caused to advance a step, and is prevented from returning each time that the limited amount of pressure has been exceeded, so that the gage is caused to register both the maximum pressure and the number of times that the engineer has allowed the pressure to exceed the proper amount.

Fig. 5678.



Matthews' Pressure-Gage.

Fig. 5678 is a view of Matthews' tube for pressure-gages. It is made without seam, by electro-deposition of metal upon a core of some fusible material, such as stearine or wax. The tube has offsets on one side, in the form of hollow plates. The lower part is fused to the dial-plate, and has a screw coupling for the steam or carbonic-acid gas pipe. The effect of elastic pressure in the tube is to press apart the horizontal portions of the offsets and elongate that side of the tube, which becomes bent thereby; the upper end being attached to a short lever or rack, which moves the pointer on the dial.

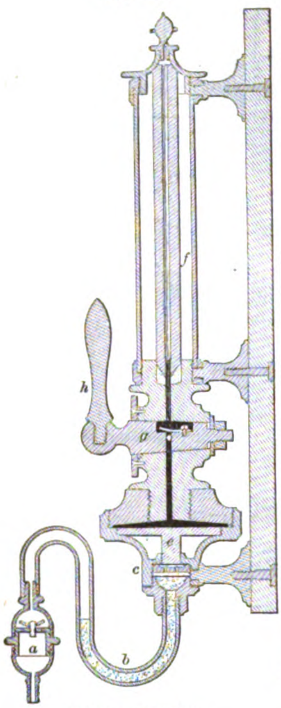
Shaw's (Fig. 5679) is also particularly designed to measure the pressure of elastic gases generated by explosive substances. The pressure from the chamber *a* is transmitted through the curved pipe *b*, which is partially filled with glycerine, and the perforated disk *c* to the foot of the plunger *e*, the top of which forms the bottom of a mercurial reservoir; the plunger rising causes a thin column of the fluid to ascend the tube *f*, where it is retained by a valve *g* until its hight can be conveniently noted. On partially turning the cock *h*, the pressure having been removed, the mercury falls to its normal hight.

In Fig. 5680, steam pressure acting from within upon the curved metallic diaphragm *a*, causes it, through the medium of a series of interposed levers and a segment-rack, to turn the spindle *b*, carrying

an index-hand, by which the pressure is indicated on a dial; the mechanism employed gives a much larger amount of motion to the index than that originally imparted to the first of the series of levers by the expansion of the diaphragm. As the pressure diminishes, the motion of the index is reversed by a spiral spring surrounding its shaft.

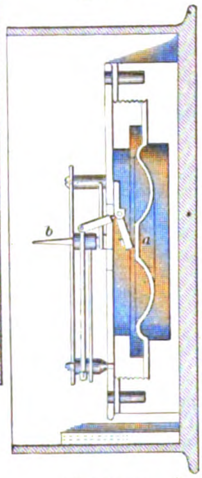
In Fig. 5681, the steam admitted within the box of the gage expands its elastic corrugated top, forcing up a rod, which, through interposed mechanism, moves the dial index. As the pressure falls, the course of the index is reversed by a conical spiral spring, which reverses the movement of the rod.

Fig. 5679.



Differential Piston Pressure-Gage.

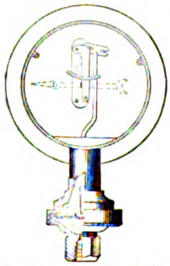
Fig. 5680.



Diaphragm Pressure-Gage.

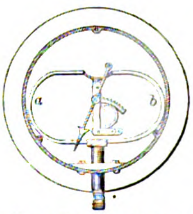
In Fig. 5682, the two tubes *a b* have a common base, to which steam is admitted, and their free ends are connected by a flat, bent spring. A link and rod, centrally connected to the spring, actuate the segment-rack, which gears with a pinion on the index-shaft in the usual manner.

Fig. 5681.



Diaphragm Pressure-Gage.

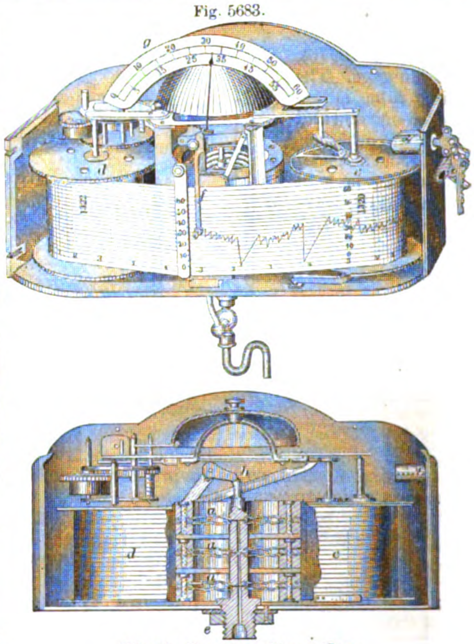
Fig. 5682.



Duplicate Tube Pressure-Gage.

Edson's recording steam-gage (Fig. 5683) consists of a case, secured by a lock and key, and having several connected air and steam tight drums *a a a* of thin flexible metal. A rod *b* on the upper one of these is attached to a segment which directly, or through intermediate gearing, actuates a rack-bar provided with a pawl, which rotates the cylinder *c* to the right, causing it to take up some of the paper from the cylinder *d*, on which a roll is wound, as the gage is expanded by steam from the boiler entering the apparatus through a pipe *e* in the bottom compartment. An opposite pawl prevents the paper-carrying cylinders from turning backward as the boxes *a a a* collapse under a diminished pressure of steam. By means of suitable gearing the arm *f*, carrying a pencil or tracing-point at its lower extremity, is caused to rise and fall, impressing a zigzag line on the paper as the steam pressure varies. By means of clockwork mechanism, actuated by the engine or otherwise, the motion of the cylinders *c d* may be made uniform and continuous, so as to leave a permanent record of the variations of pressure for 12, 24, or a greater number of hours, the paper having been previously ruled with a system of horizontal lines indicating the pressure in pounds and vertical lines for the hours. A scale and pointer *g* enable the pressure at any moment to be more readily ascertained by inspection.

Fig. 5683.



Edson's Recording Steam-Gage.

The handle of the inlet steam-cock enters the gage, and is so secured that it cannot be withdrawn until the gage-door is unlocked, thus preventing tampering with the record.

Steam-gas. Superheated steam.

Steam-gov'ern-or. A regulator which determines the passage of steam, and thus its pressure in a chamber or cylinder beyond.

Usually a device placed between the boiler and the valve-chest of a steam-engine, which operates a valve and graduates the opening, decreasing its area as the pressure rises and conversely. See GOVERNOR.

Steam-gun. One whose projectile force is derived from the expansion of steam issuing through a shotted tube.

In a manuscript of Leonardo da Vinci, about A. D. 1500, occurs the following: —

"The *architonnere* is a machine made of fine brass, which throws iron balls with great noise and much force. One third of this instrument consists of a great quantity of fire and fuel. When the water is properly heated, the screw on the vessel where the water is must be turned; at that moment the water will escape below, will descend into the heated part of the machine, and be immediately converted into steam so abundant and powerful that the effects of its force and its noise will strike one with amazement. This machine will propel a ball weighing rather more than a talent."

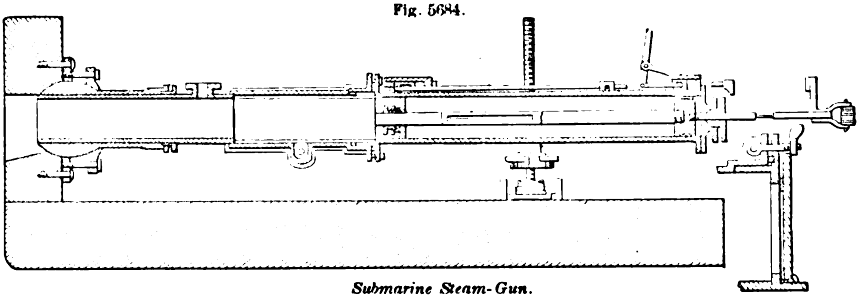
L. da Vinci, in describing this gun, uses Greek terms, and it is surmised that it is the invention of Archimedes. One who has had access to the manuscript states that Da Vinci gives the credit of the invention to the Greek philosopher.

A steam-gun is described in Van Etten's "Recreations Mathematique," 1629, 83d Problem. It is a very clumsy contrivance, but used steam acting on a wooden piston or sabot to expel the ball.

Perkins exhibited a steam-gun in England before the Duke of Wellington, 1824. It was very effective, but the "Iron Duke" considered that a steam-boiler that threw away balls as fast as that did would be out of place in an army, and would waste ammunition. The same objection has been until lately urged against the use of breech-loading fire-arms. "The men shoot too fast."

Mr. Henry Bessemer's idea is to have a steam fire-engine to throw bullets instead of water. He calculates that it will throw

Fig. 5684.



Submarine Steam-Gun.

181¾ pounds, representing 2,540 rifle-bullets per minute, to a distance of 1 mile, with a consumption of 5 pounds of coal and 3 gallons of water. "An increase in the weight of the projectile would increase both its range and force, and 2-ounce bullets might be used for a long range, being propelled at the rate of 1,000 a minute. A machine with three parallel barrels could throw 2-ounce shot at long range from the center barrel, and 1-ounce shot (2,000 a minute) at short range from the side barrels."

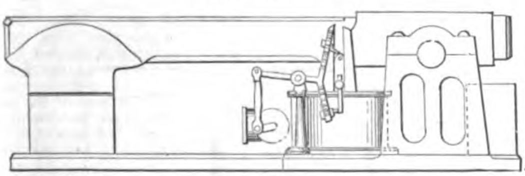
The calculation for steam at 150 pounds pressure is that it would escape at an initial velocity of 1,900 feet per second, and, acting upon a 2-ounce leaden ball, presenting an area of .6 of an inch, would exert a force upon it of 90 pounds. 1,100 to 1,200 feet per second is the initial velocity of the Armstrong gun projectile. Mr. Bessemer suggests a universal joint tube for delivering a sweeping fire; and a mantlet to shield the gunners.

Fig. 5684 shows the Wood and Lay submarine steam-gun. The side of the ship, below the water-line, has an aperture, which is closed by a ball and socket joint. This joint has connected with it a tube, which extends inward, and terminates in a box in which is a trunk with two compartments for containing the shells. This trunk is capable of being moved in the box, so that while one shell is being discharged another can be placed therein. To the rear end of this box a steam cylinder is placed, having a piston therein, which, when the shell is placed in the trunk, has steam admitted in the rear by means of suitable valves, and is pressed forward with such force as to eject the shell and force it to a considerable distance. The piston-rod is hollow, and a cord is passed through it, and is wound around a spool upon its outer end. The opposite end of this cord is secured to the shell, and thus, when the shell has traveled any determined distance, the cord is made to discharge it.

Steam-ham'mer. (*Forging.*) Properly, a steam-operated hammer. The term is usually, however, restricted to one working vertically by the attachment of its rod to a piston in an upright cylinder above.

The first application of steam to the hammer was to the tilt, which was worked by *wipers* or cams on a rotating shaft driven by the usual steam-engine. A more direct application of steam to the tilt-hammer is shown in Fig. 5685, which has a T-shaped lever, having adjustable dogs on its lower and upper

Fig. 5685.



Steam Tilt-Hammer.

arms so arranged with reference to the tappet placed upon the cross-head of the engine that, by moving dogs up or down upon the arms, the stroke of the piston, and consequently the force of the blow of the hammer, may be varied at pleasure.

See also Atmospheric Hammer, pages 178, 179, and list under Hammer.

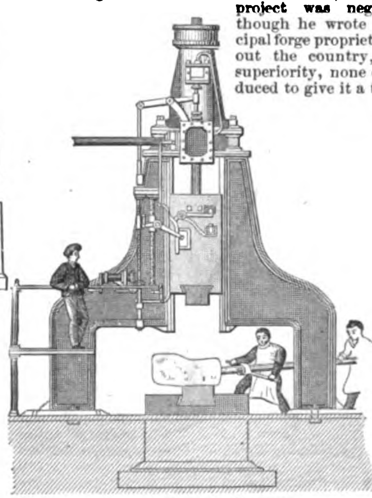
Hague, in 1827 (English patent), raised the hammer by atmospheric pressure below a piston, whose rod is attached to the hammer. The pressure is obtained by a partial vacuum above the piston, obtained by an air-pump or other means. The same idea is applied to cranes. See Fig. 409.

In Watt's proposed steam-hammer, in 1784, the steam-cylinder was at one end of a wooden beam, while the hammer was at the other; the shaft being journaled like the old tilt-hammer, and the hammer moving in the arc of a circle.

William Deverell, of London, June 6, 1806, obtained a patent for "improvements in the mode of giving motion to hammers," etc. The inventor says: "I raise steam in a boiler or steam-vessel as in the common way. I have a steam-cylinder with a piston and rod in it; at the end of the rod that comes out of the steam-cylinder is a hammer, either made fast to the rod by welding, or in any other proper way. The steam from the boiler or steam-vessel is let in underneath the piston by means of opening a cock or valve, or cocks or valves; the air at the top of the piston will be then compressed by the superior pressure of the steam underneath the piston. After the piston has been raised to a given hight, there will be an opening made from the under side of the piston to a vacuum formed as in the common way, or otherwise the steam may be let out into the common air. The compressed air on the top of the piston will then drive down the hammer with a velocity equal to what it may be compressed." It does not appear that any valuable practical result followed.

In November, 1838, Mr. Humphries, who was superintending the construction of the machinery for the "Great Britain," the largest steamship which had, up to that time, ever been built, wrote to Mr. Nasmyth (who was a workman in Maudslay's shop) that there was not a forge-hammer in England or Scotland powerful enough to forge a paddle-shaft for that vessel, and requesting his advice. Mr. Nasmyth immediately went to work and designed an apparatus embracing the essential and distinctive features of the steam-hammer now in use. It consisted of an inverted cylinder, to whose piston the block of iron forming the hammer-head was attached. Steam entering below the piston raised the hammer, and the escape of steam allowed the hammer to fall. The sketch was shown to Brunel and other experts, by whom it was highly approved. About this time the screw-propeller was brought prominently forward, and it was determined to adopt this means of propulsion for the "Great Britain"; the forgings required for this were within the capacity of the appliances then in use, and Nasymth's project was neglected; and though he wrote to the principal forge proprietors throughout the country, urging its superiority, none could be induced to give it a trial.

Fig. 5686.



Nasmyth Hammer.

Some time afterward, M. Schreider, the celebrated French ironmaster, with M. Bourdon, his superintendent, being on a visit to

the Patricroft works, were shown the sketch made by Nasmyth, and Bourdon was so favorably impressed that on his return home he constructed and put in operation the first steam-hammer. In April, 1840, Mr. Nasmyth, then on a visit to France, in passing through the works at Creusat, observed a crank-shaft of unusual dimensions forged in the piece and punched, which he was informed by M. Bourdon had been forged by his (Nasmyth's) steam-hammer. On his return he constructed a 30-cwt. hammer for the Patricroft works, and in December, 1842, obtained a patent for the invention.

The steam pile-driver was soon afterward invented by Nasmyth. See Holtzapffel, ii. 961.

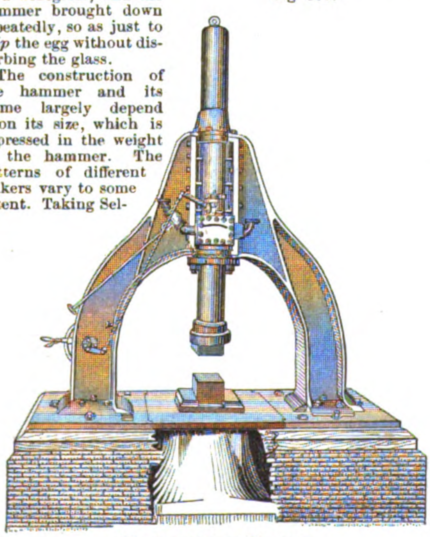
The Nasmyth was the first steam-hammer of the modern type, and the works, as well as name, are noted throughout the world; but the machine-tool has been much modified and enlarged. The first idea was to simply lift the hammer and let it drop; the force of the blow was afterward very much increased by making the engine double-acting, that is, by allowing steam under pressure to pass above the piston and add its force to the weight of the falling hammer. Condie made the piston stationary, the cylinder moving in guides. Morrison made the hammer of one long bar of wrought-iron, the piston being welded thereto, and forming part of it, and he then dispensed with the guides on the frame, and guided the bar by the top and bottom cylinder-heads only. This left the entire space below the cylinder free for the use of the workman in handling his work.

In the automatic hammer the motion to work the valves has been obtained from inclined grooves, diametrically opposite to each other, and made to work a brass yoke, whose line of vibration is through the central axis of the bar. A supplemental valve is used to throttle the exhaust below the piston, without impeding the free exhaust above the piston. This enables the hammer to strike quick, light blows for finishing; in other words, the hammer can go up as quickly, but in coming down its force may be gaged by the steam cushion upon which it descends, which steam, thus condensed in bulk, re-expands in the up-stroke, economizing steam.

As an illustration of the capacity for adjustment and command of the steam-hammer, an experiment may be cited in which an egg was placed in a wineglass, and the hammer brought down repeatedly, so as just to *chip* the egg without disturbing the glass.

The construction of the hammer and its frame largely depend upon its size, which is expressed in the weight of the hammer. The patterns of different makers vary to some extent. Taking Sellers', it may be stated that the piston-rod or hammer-bar is of solid wrought-iron, passing through both heads of cylinder; the piston-head forged solid with piston-rod. The hammer-head is adjustable on the lower end of the bar, which is prevented from turning by the upper cylinder-head. The slide-valve is balanced

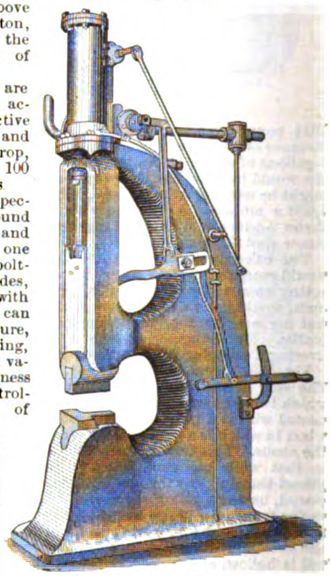
Fig. 5687.



Morrison Steam-Hammer.

Hammers of 2,500 pounds weight, and under, have one upright only, are double-acting, taking steam above and below the piston, with self-acting valve-gear and hand-motion operated by the same lever; these can be changed, at will, while in operation, thus affording complete control over the length, rapidity, and force of blow, also enabling the hammer to be used as a vise or squeezer. Hammers of 1,000 pounds and under have anvil blocks passing through the base of the upright. Double upright hammers are hand-working only, taking steam above and below the piston, thereby increasing the force and rapidity of blows.

Fig. 5688.



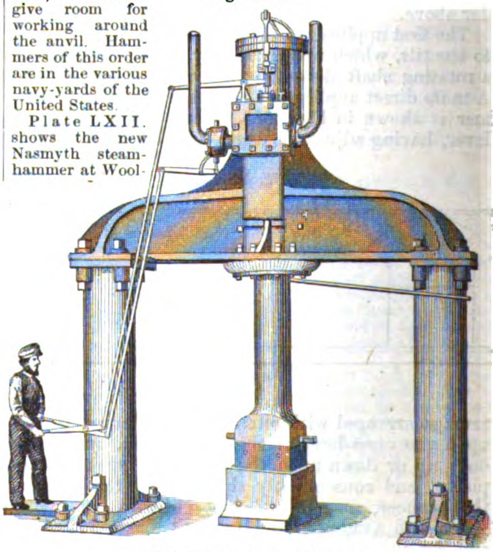
500-Pound Steam-Hammer.

Steam-hammers are rated or classified according to the effective weight of the piston and hammer-head or drop, and range from 100 pounds up to 80 tons

Fig 5688 is a perspective view of a 500-pound hammer, whose anvil and frame are cast in one piece, to which are bolted the cylinder, guides, etc. It is fitted with valve motion, which can be worked at pleasure, single or double acting, adjusting itself to all variations in the thickness of the forging, controlling the admission of steam so as to produce at will a short and quick or a long and slow stroke, and graduating from the light-cushioned blow to the dead blow, in which no steam is admitted beneath the piston until after the blow is struck, thus utilizing the *vis viva* of the falling weight impelled by the top steam. It can also be used as an ordinary hand-working hammer, without altering the setting of the gear.

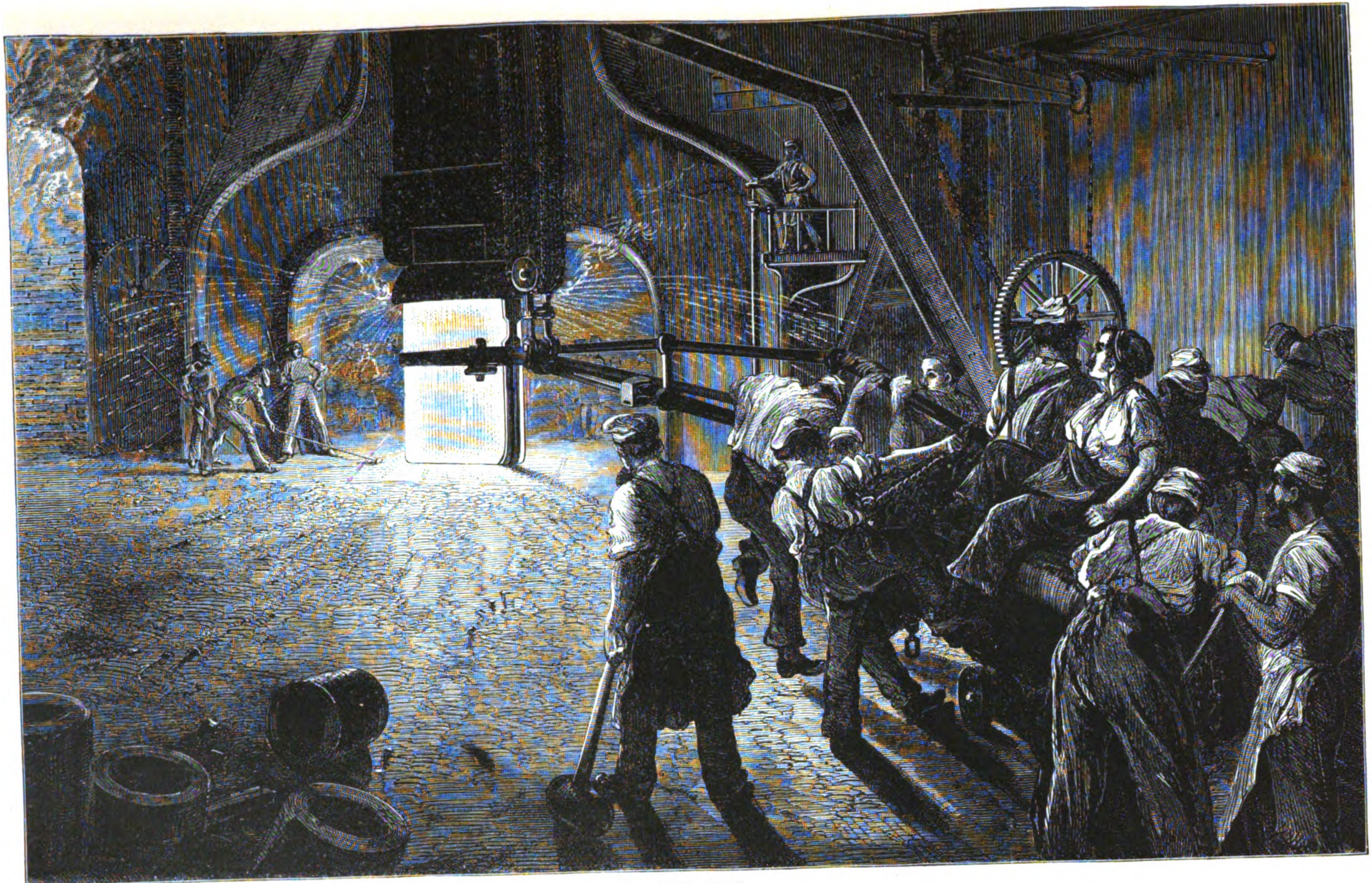
Fig. 5689 is a view of a hammer in which the frame is high and its pillars distant, in order to give room for working around the anvil. Hammers of this order are in the various navy-yards of the United States.

Fig. 5689.



High-Frame Steam-Hammer.

Plate LXII. shows the new Nasmyth steam-hammer at Woolwich, England. It is at present the largest and most powerful in the world, but it is understood that Krupp of Essen is now building one to work a mass of steel of 100 tons (of 2,240 lbs.)



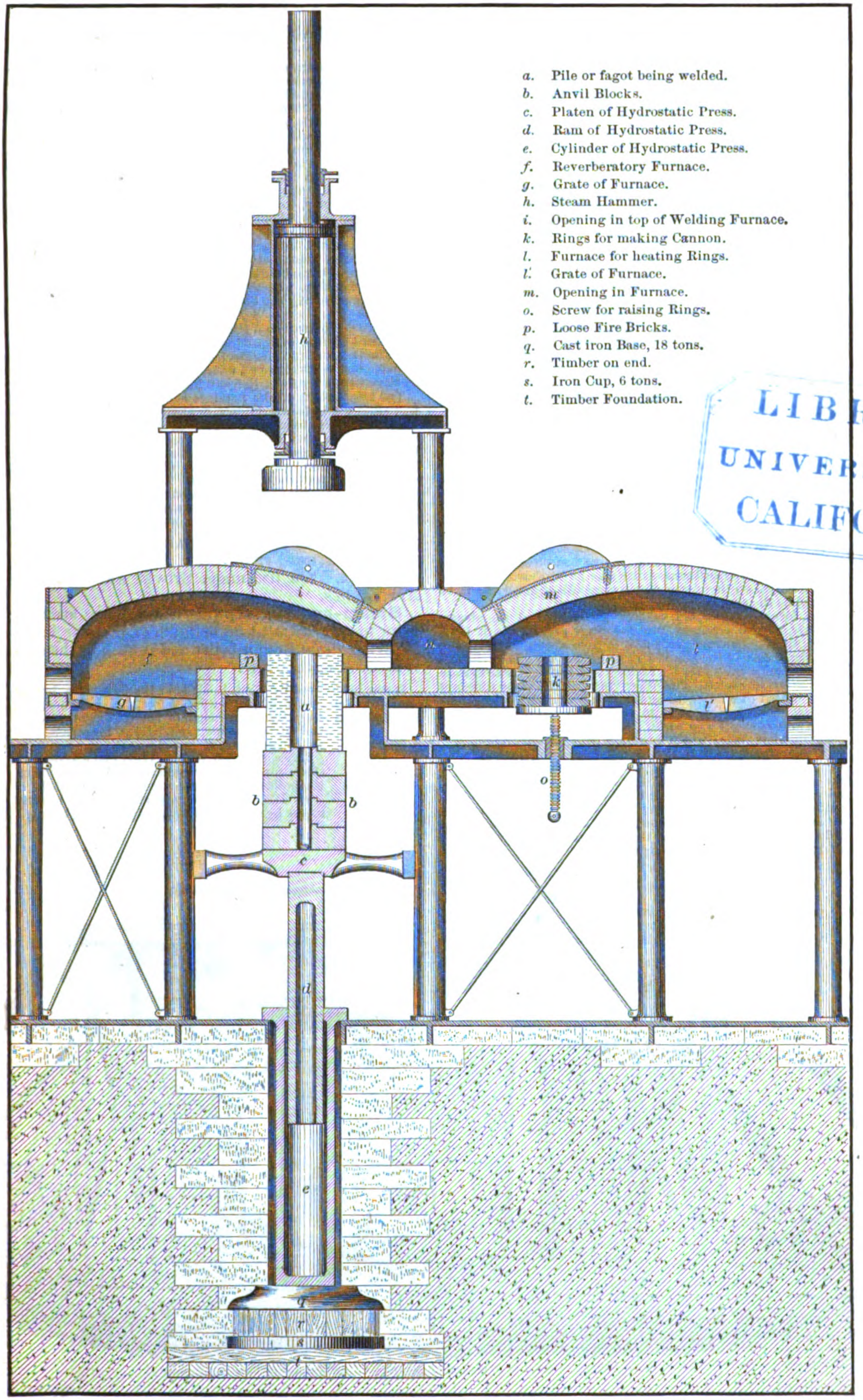
STEAM HAMMER.

WOOLWICH ARSENAL, ENGLAND.

[*For forging the 80-ton guns for the " Inflexible," and sister vessels.*]

See page 2348.

PLATE LXII.



ALONZO HITCHCOCK'S CANNON-FORGING STEAM-HAMMER AND FURNACE.

PLATE LXIII. *(Springfield, U. S. A. Arsenal.)* See page 2350.

weight, and which is expected to cost $ 1,000,000. The weight of the falling portion of the Woolwich hammer is 40 tons, and the force of the falling weight is accelerated many times by the use of steam to drive it down from the top. It is four times as powerful as the present "Krupp" hammer. It is estimated that the use of top steam is equal to allowing the hammer to fall of its own weight 80 feet. It has been allowed a striking fall of 15 feet 3 inches, and the force of the blow is estimated as equal to a weight of 800 tons. The hammer is 45 feet in hight, and covers, with its supports, a base of about 120 feet square. Above the ground it weighs 500 tons, and the iron in the foundations below weighs 655 tons. It cost $ 250,000.

In making the foundations, an excavation was made 45 feet square and 20 feet deep, then 100 piles were driven 20 feet into the solid gravel, and the intèrstices filled up with concrete; on these was placed a block of iron 30 feet broad and 11 inches thick, weighing 160 tons, and on this two layers of oak balks. On this timber was next placed another iron plate, 10 inches thick and 27 feet square, weighing 121 tons, and then followed a number of oak balks as before, standing vertically and bound together with wrought-iron bands. Two more iron plates, weighing together 214 tons, were lowered upon the oak balks, and one heavier than any yet followed upon these. Upon this the anvil block, weighing 102 tons, was placed, and it, in turn, was crowned by the anvil face, which was 12 feet in diameter, and weighed 60 tons.

The new steam-hammer in the Bessemer Steel Works, at Harrisburg, Pa., weighs 35,000 pounds, and cost $ 92,000, and is said to be the largest in the United States.

Plate LXIII. illustrates the system of Mr. Alonzo Hitchcock, of New York, for forging cannon, hollow shafting, hydraulic cylinders, and other large masses of iron, particularly those of tubular form.

The metal is heated in a reverberatory furnace to avoid its contact with sulphur and other impurities of coal. The gun is formed of rings of wrought-iron, or low steel made without welds. The rings are so formed as to be united first in the center, that the superfluous cinder may be squeezed out. The anvil is seated on the piston of a hydrostatic press, so as to be lowered as the successive rings are added.

The furnace is situated between the anvil and the steam-hammer, and so arranged that the rings project into it from below, and the hammer drops into it from above. The ring to form the muzzle of the gun is laid upon the movable anvil, and projected sufficiently into the furnace to allow the flame to raise it to the welding heat. The other rings at the same time are being heated to welding in another part of the furnace; the dampers being so adjusted as to proportion the degree of heat to the masses in the two parts. Without being removed from an atmosphere which contains little, if any, oxygen, one of the rings is transferred to that upon the anvil, and the two welded together by a few strokes of the steam-hammer. The anvil is then lowered by the thickness of another ring, and the same process is repeated. Although the gun may be of any size, the parts actually united at one operation may be made so light by reducing their thickness that the pressure of a hammer of moderate weight will be adequate.

Fig. 5690 illustrates a large steam-hammer at the Alexandrowski Steel Works, St Petersburg, Russia. This was originally a 35-ton hammer, the arched standards springing from the ground line. They were subsequently mounted on vertical stands 12 feet high, giving a clear hight below the cylinder of 28 feet 8 inches, and guides for the hammer added; the hight of the whole apparatus is 46 feet. The guides consist of two cast-iron columns 20 feet high, and 4 feet 6 inches in diameter, weighing each 25 tons, resting upon cast-iron girders 40 feet long, level with the floor line. These are connected by 8 wrought-iron bars, 4 on each side, 20 feet long, 16 inches deep, and 7 inches thick. Four vertical steel bars 14 inches wide and 7 inches thick serve as guides for the hammer. They are not rigidly connected to the cross-bars, but are kept up to their work by oaken beams between them and the cast-iron columns. There are 6 of these beams on each side of the hammer, arranged in pairs, between which are cast-iron shoes with interposed wedges for adjusting the beams. The whole weight of this part is 97 tons.

The guide columns and the anvil have each foundations independent of that of the standards. The hammer weighs 42 tons, its face, of Bessemer steel, 3 tons, the piston, 6 feet 6 inches in diameter, weighs 2 tons 1 cwt., the total falling weight being 51 tons, with a stroke of 12 feet 6 inches.

The total weight of the hammer above the ground line, not including the bed-plate, girders, or anvil-block, is 402 tons. The anvil-block was cast in situ. It is in 3 tiers, each of smaller diameter than that below it, weighing in all 240 tons. It is bedded upon concrete and wooden piles inclosed in a wrought-iron casing 73 feet deep by 25 feet in diameter, the foundation extending down to the solid ground. The hammer and its four 60-ton cranes are supported on a masonry platform resting upon timbers supported by piles. The steam-valve is of the equilibrium kind, and the hammer is easily worked by one man.

Steam-heat'er. See STEAM-HEATING APPARATUS; HEATING-APPARATUS; HYPOCAUST; FURNACE, etc. See list under STOVES AND HEATING APPLIANCES.

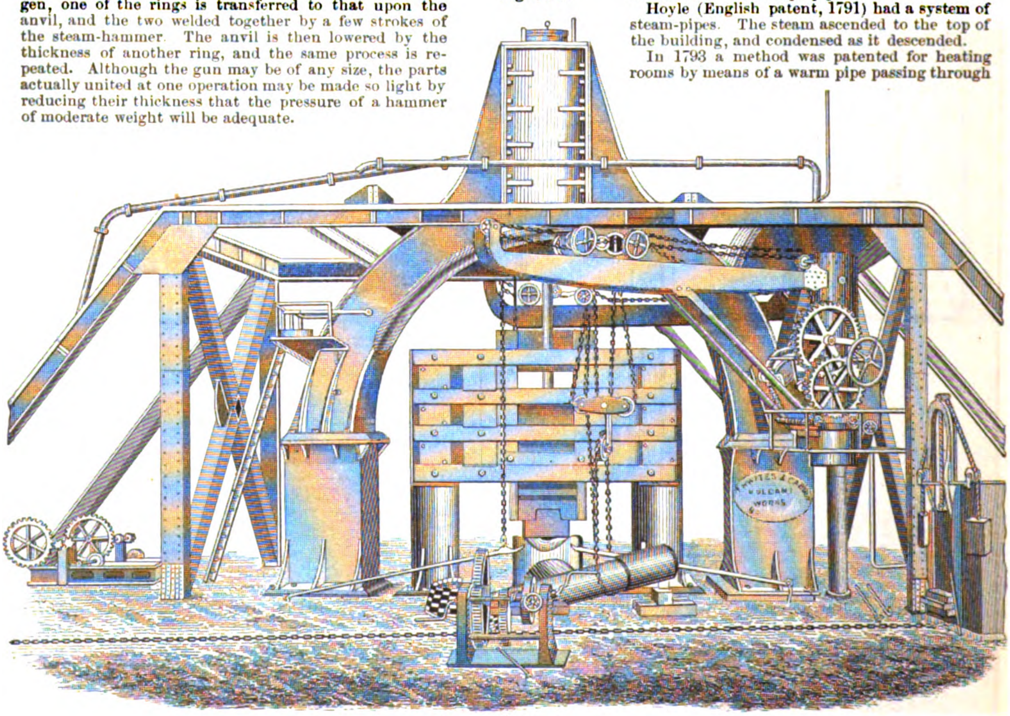
Steam-heat'ing Ap'pa-ra'tus. An arrangement in an apartment or building of pipes or boxes receiving steam from a boiler and returning the condensed steam thereinto.

It was introduced by Watt, in 1784, in the form of a hollow sheet-iron box, made of plates $2\frac{1}{3} \times 3\frac{1}{4}$ feet, and 1 inch apart, supplied with steam from the boiler of the establishment. It had an air-escape cock, steam induction, and condensed-water escape-pipe.

Hoyle (English patent, 1791) had a system of steam-pipes. The steam ascended to the top of the building, and condensed as it descended.

In 1793 a method was patented for heating rooms by means of a warm pipe passing through

Fig. 5690.



Steam-Hammer.

a boiler containing hot water or steam, on its way to the apartment to be warmed.

By another method pipes from a steam-boiler were inclosed in other pipes, and the air heated during its passage between them.

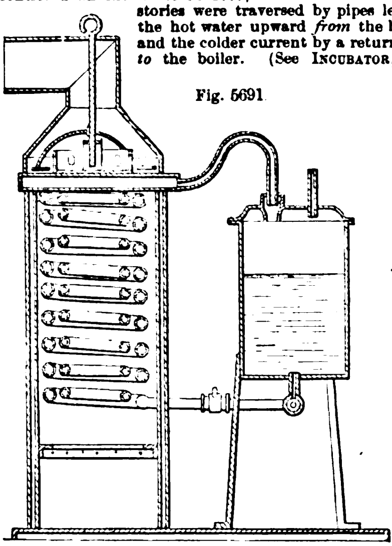
About this time steam was applied to heating hot-houses by being discharged directly into them, thus raising the temperature and affording a greatly increased supply of moisture, which was said to have the effect of causing the plants to vegetate luxuriantly and of destroying insects.

In 1799, Boulton and Watt constructed a heating apparatus, in Lee's factory, Manchester, in which the steam was conducted through cast-iron pipes, which also served as supports to the floor. See also HEATING-APPARATUS, pages 1088-1091.

One of the first buildings heated by steam is said to have been a silk-mill at Waterford, in Hertfordshire. It was 106 × 33 feet, 4 stories high. A furnace was built on the outside, and from the boiler rose a stand-pipe which had branches suspended from the ceiling of each story. The lower story had a pipe 5 inches in diameter; the 2d and 3d stories, pipes of 4 inches; the 4th story, one of 3 inches. The hight of the stories decreased upwardly. The pipes had a slight inclination to allow the water of condensation to run off, and valves at each story governed the admission of steam to the heating-pipe of the said story.

Heating by heated air conveyed in caliducts is much older, being found in the hypocaust of the ancient Romans, and the palaces of the Spanish Saracens. Heating by hot water is older than steam-heating, and probably originated with Bonnemain, who contrived an incubator in 1777, in which the different stories were traversed by pipes leading the hot water upward *from* the boiler, and the colder current by a return pipe *to* the boiler. (See INCUBATOR, Fig. 2666.) He also had an automatic heat-regulator. See Fig. 2476.

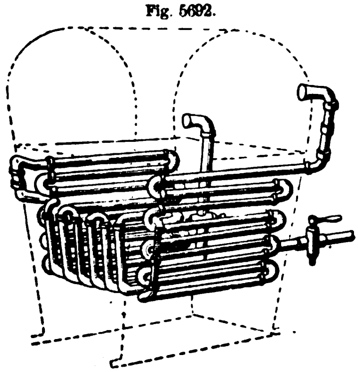
Fig. 5691.



Steam-Generator for Heating Buildings.

Fig. 5691 is a simple form of apparatus, having concentric series of heating coils in the furnace, and a supply reservoir at the side where the condensed water from the various pipes in the building is gathered to resupply the coils. The water passes to the lower ends of the coils, and the upper ends of the latter communicate with the steam space in the reservoir, and form an injector to supply the reservoir with waste water from the heaters. Dampers above the coils regulate the circulation within the furnace.

Fig. 5692.

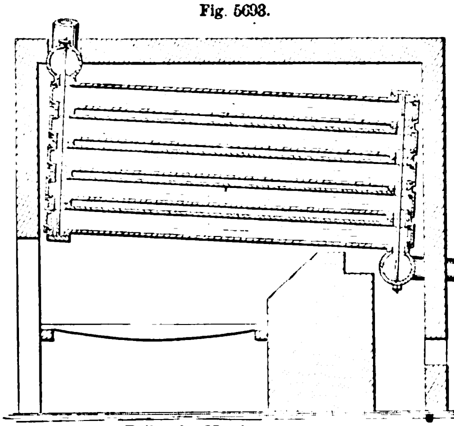


Basket-Grate for Steam-Heater.

Fig. 5692 shows a basket-grate made up of pipes, in which water is converted into steam, which rises in pipes to the rooms of the house.

Fig. 5693 is a sectional boiler for steam-heaters, having several series of inclined pipes which connect in front and rear. Each one in the vertical series of pipes has an upper and lower thimble at each end, communicating with the pipes immediately above and below. The pipes are held together by stay-rods traversing all the thimbles. The pipes from the heaters receive steam from the higher ends of the pipes, while the water of condensation from the heaters above is returned to the boiler at the lower level.

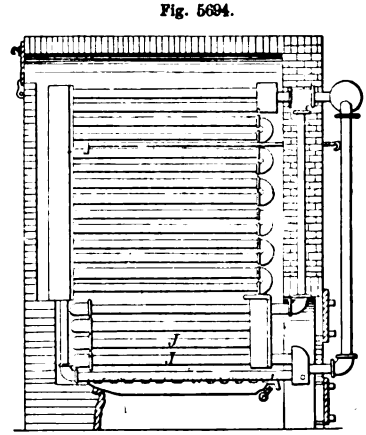
Fig. 5693.



Boiler for Heating-Apparatus.

Fig. 5694 has a series of pipes J J which line the furnace and form the sides of a basket-grate; also an upper series of convolved pipes in which steam is generated. The grate-bars have longitudinal agitation by a ribbed rocking-bar on which their fore ends rest. The furnace is lined and the fire space traversed by horizontal pipes, the current through which is supplied by vertical pipes and headers. From the receiver in front of the furnace the condensed steam is carried to the lower part of the generator.

Fig. 5694.



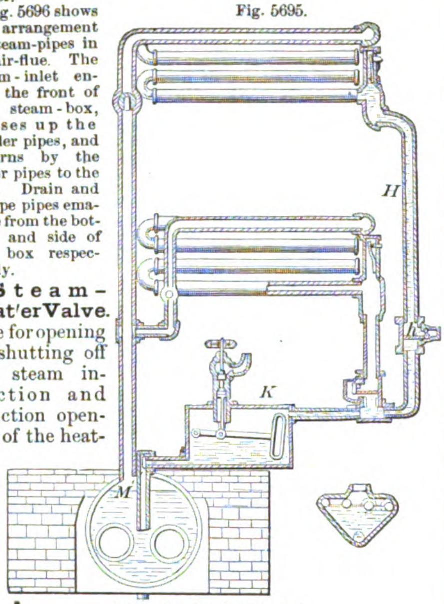
Steam-Generator for Heating-Apparatus.

Fig. 5695 shows the arrangement of circulating pipes on several stories. The steam rises by the pipe M to the heat radiator-pipes, which have automatic air-vents; the water of condensation descends by pipes H, which have valves h which open and close automatically by the alternate action of the back pressure of the steam and the downward pressure of the water of condensation. This as it accumulates passes to a tank K, and thence through another automatic valve to the boiler. In the tank is an elongated float combined with an air-discharge

valve and ventage-pipe, to regulate the flow of water into the boiler.

Fig. 5696 shows an arrangement of steam-pipes in an air-flue. The steam-inlet enters the front of the steam-box, passes up the hinder pipes, and returns by the other pipes to the box. Drain and escape pipes emanate from the bottom and side of the box respectively.

Fig. 5695.

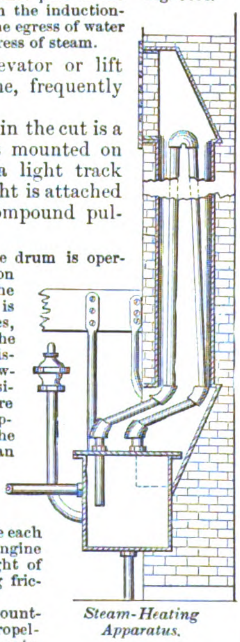


Steam-Heater Circulation.

Steam-heat'er Valve. One for opening or shutting off the steam induction and eduction opening of the heater.

In the example (Fig. 5697), the induction and eduction valves are in one case, both being opened and closed simultaneously by the turning of the same wheel. The screw-threaded pipe connecting the double-valve case and heater is provided with a partition, and that part of the pipe which communicates with the induction-valve is extended to facilitate the egress of water from the heater during the ingress of steam.

Fig. 5696.



Steam-Heating Apparatus.

Steam-hoist. An elevator or lift worked by a steam-engine, frequently portable.

The steam-hoist shown in the cut is a small engine and windlass mounted on a truck which runs on a light track along the wharf. The weight is attached to the lower block of a compound pulley.

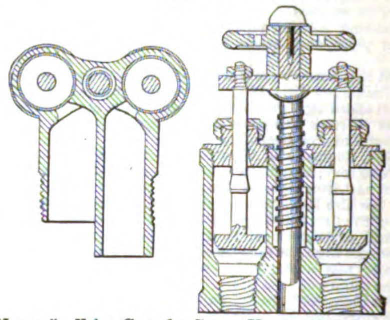
In Otis's hoist (Fig. 5699), the drum is operated by gearing receiving motion directly from the pistons of the double-cylinder engine; it is grooved, and receives two ropes, one of which winds off while the other winds on, so that the raising of one platform and the lowering of another are effected simultaneously. The platforms are stopped automatically at the upper and lower landings, and the apparatus is provided with an automatic brake, which is brought into action at the moment of shutting off steam.

The platforms counterbalance each other, so that the work of the engine is confined to lifting the weight of their contents and overcoming friction.

Montgomery's (Fig. 5700) is mounted on a carriage, and is self-propelling; its arrangements are such as to enable it to be used for hoisting, pumping, etc., and also as a traction-engine. In use, the driving-wheels may be lifted from the ground so as to act as fly-wheels, or they may be unclutched. The rope drum is thrown into gear with the engine, the piston being driven forward or reversed to wind or unwind the rope from the drum, or the rope may be lowered while a friction-brake is applied to the drum.

Fig. 5701 shows a hoisting-machine for a warehouse-elevator. See also ELEVATOR; ROPE-ELEVATOR.

Fig. 5697.



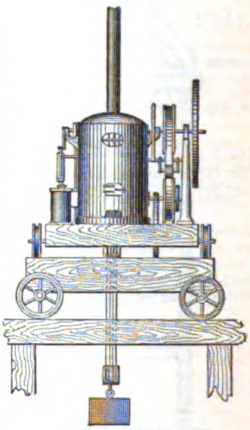
Howard's Valve-Gear for Steam-Heating Apparatus.

Steam-in'di-ca'tor. A device to record the pressure of steam. It was invented by James Watt. See INDICATOR, Fig. 2668; PRESSURE-GAGE, Figs. 3039–3043; STEAM-GAGE.

Steam'ing-ap'pa-ra'tus. An arrangement for exposing material to the softening influence of steam as preliminary to wood-bending; or for cooking food (Fig. 5702); or digesting stock for paper pulp; or as a disinfector or feather-renovator. See STEAMER; STEAM-TANK.

Steaming is used in many trades. Fig. 5703 is an apparatus for steaming on hat-bodies, exposing them to a wet heat, which expands them into shape. The hat-body is placed upon the pyramidal assemblage of levers, to which it is held by clamps with corrugated faces. The size of the frustum being then enlarged, a hat-block is elevated centrally, impinging against the crown of the hat and stretching it into shape. See HAT.

Fig. 5698.



Steam-Hoist.

Steam-jack'et. A steam-tight casing around a cylinder, boiler, or other object, to prevent the cooling of the object so enveloped.

Watt, in 1769, after contriving the separate condenser, in which the injection-water was applied to condense the vaporous contents of the cylinder of the Newcomen atmospheric engine, added to the cylinder a steam-jacket to prevent the radiation of heat from the cylinder and the consequent loss of steam and time in warming up the cylinder after the effective stroke. See also CLEADING; LAGGING.

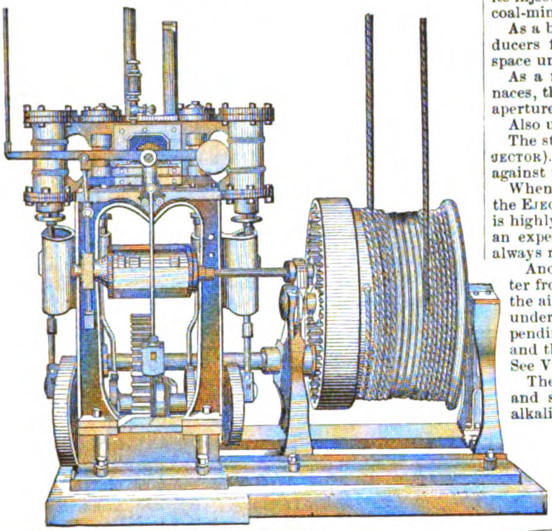
Vacuum-pans, agricultural boilers, evaporating-pans, and many other objects are steam-jacketed.

Steam-jet. A blast of steam emitted from a nozzle.

The steam-jet is used as an air-pump for exhausting one of the pneumatic dispatch-tubes employed at the Central Telegraph Station, in London, for conveying the carriers containing telegraphic dispatches from one station to another. The result of a comparative trial made with the steam-jet and with a good steam-engine and exhausting-pump has been found to be that the expenditure of steam is about the same in the two cases in doing the same work, the advantages of the steam-jet being its very low first cost in comparison with that of the engine and pump, and also its great simplicity, and the small space occupied as compared with an engine and pump.

A very thin annular jet of steam, in the form of a hollow cylindrical column, is discharged from an annular nozzle. The air to be propelled by the steam-jet is admitted through an exterior annular orifice surrounding the jet, and also through the center of the hollow jet, the area of the air-passages being gradually contracted on approaching the jet. The combined jet of steam and air is discharged through an expanding delivery pipe of considerable length, in which its velocity is gradually reduced. See PNEUMATIC TUBE; ATMOSPHERIC RAILWAY.

Fig. 5699.



Otis's Steam-Hoist.

For ventilation, by causing a draft of air in the direction of its injection. It was first used by Mr. Goldsworthy Gurney in coal-mines.

As a blower for accelerating the distillation of fuel in gas producers for heating purposes, the jet being admitted into the space underneath the fire-grate, which is inclosed by doors.

As a means of feeding hydrocarbon liquids and air to furnaces, the steam, air, and petroleum being ejected at concentric apertures in regulated quantities.

Also used as an alarm. See STEAM-WHISTLE; SIREN; etc.

The steam-jet is also used as a water-pump (see GIFFARD INJECTOR). In this case it is used to drive the water into a boiler against the pressure of the steam therein.

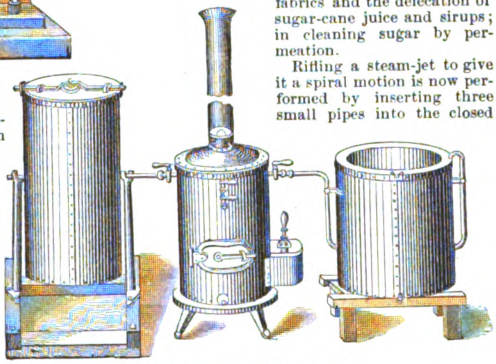
When used as a lift-pump, the device assumes the form of the EJECTOR (which see; see also AIR AS A WATER-ELEVATOR). It is highly recommended as a bilge-water pump, for although it is an expensive form of pump, it involves no machinery, and is always ready in an emergency.

Another application of the steam-jet is to the lifting of water from a moderate depth, by employing the jet to exhaust the air from a closed vessel, into which the water then rises under the pressure of the atmosphere, the hight of lift depending upon the size of the jet and the pressure of steam, and the consequent degree of vacuum obtained in the vessel. See VACUUM STEAM-PUMP.

The steam-jet is also used as a spray in damping sawdust and shavings, to lessen danger from fire; in distributing alkaline liquids upon hemp, flax, or paper stock; as a vehicle in disseminating sulphuric-acid gas in the bleaching of fabrics and the defecation of sugar-cane juice and sirups; in cleaning sugar by permeation.

Rifling a steam-jet to give it a spiral motion is now performed by inserting three small pipes into the closed head of a delivery-pipe. These pipes are then given half a turn each, and the ends brought together. In cleaning flues, this triple nozzle gives three jets, each having a spiral or twisting motion that causes them to strike the walls of the flue, and effectually sweep them clean.

Fig. 5702.

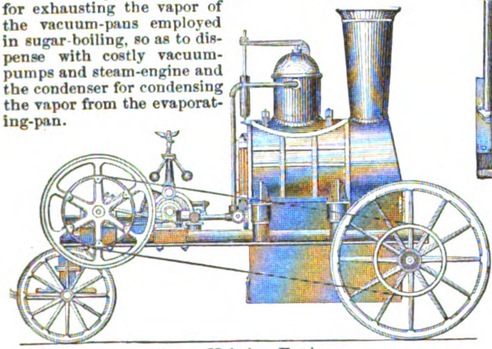


Steaming-Apparatus.

The pneumatic tube is also used for conveying messages between the various apartments of the Western Union Telegraph building, New York.

The steam-jet is also used for exhausting the vapor of the vacuum-pans employed in sugar-boiling, so as to dispense with costly vacuum-pumps and steam-engine and the condenser for condensing the vapor from the evaporating-pan.

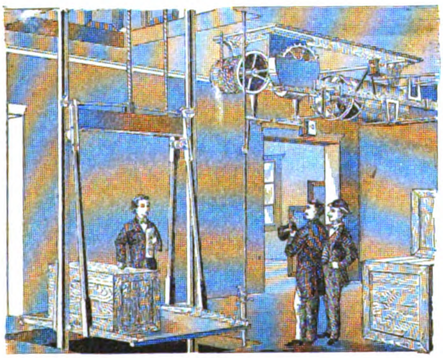
Fig. 5700.



Steam Hoisting-Engine.

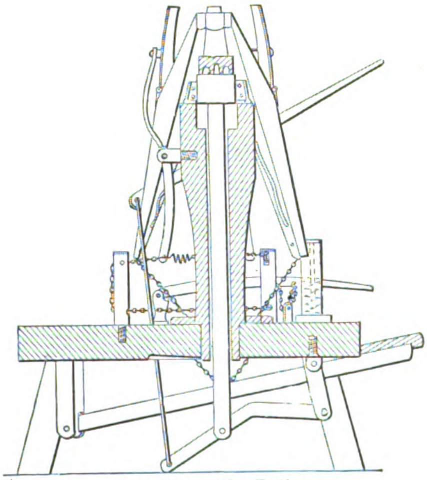
For draining the molasses from the sugar, by exhausting the air from below the perforated bottom of a strainer containing the undrained sugar, superseding the mode of draining by gravitation or by centrifugal strainers.

Fig. 5701.



Hoisting-Machine for Warehouse-Elevator.

Fig. 5703.

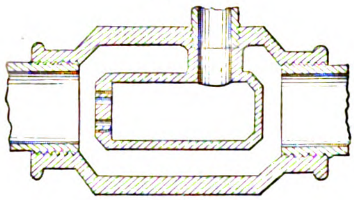


Steaming on Hat-Bodies.

Steam-jet Pump. A form of injector or ejector in which the body of water is put in motion by a steam-jet. See INJECTOR; EJECTOR; AIR AS WATER-ELEVATOR; etc.

In the example, jets of steam are delivered from a nozzle fixed concentrically in the water passage, so as to act within a cylinder of water.

Fig. 5704.

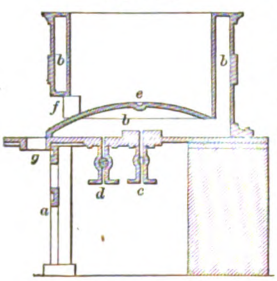


Steam-Jet Pump.

Steam-ket'tle. A pan heated by steam, used for many purposes. See OIL-MILL; LARD-TANK; MALT-VAT; etc. Specifically, —

1. A pan in which bruised flaxseed is heated, previous to pressure. Hallette's (Fig. 5705) is supported on a wall of masonry and pillars *a*; it is surrounded by a jacket, steam being admitted into the space *b b b* at its sides and bottom through the induction-pipe *c*; *d* is the eduction-pipe, serving also to run off the condensed water. The spindle of a rotary stirrer is stepped into the depression *e*; *f* is an opening for discharging the heated seed, and *g* an orifice for the mouth of the bag in which they are received.

Fig. 5705.



Steam-Kettle.

2. An agricultural boiler for cooking food for stock.

Steam-launch. A large man-of-war's boat with a propeller-engine.

The details of one made as a tender to a sailing yacht for use on the fiords of Norway may afford an instance. The boat is 14 feet long by 4 feet 3 inches beam, and is to be carried at the ordinary davits; the total weight, including the machinery, being only 800 lbs. The hull is built entirely of mahogany, and it contains a vertical boiler with engine attached, the arrangement being such that the machinery can be detached from the hull in a few minutes, and hoisted out complete, and the launch then used as an ordinary boat, it being provided with oars and rowlocks. The boiler, which is worked at a pressure of 75 lbs. to 80 lbs. per square inch, is welded up throughout, there being no riveted seams. The boat will carry four persons and a good supply of coal. See also YACHT.

Steam-pack'et. A steamer carrying mails. See STEAMBOAT.

Steam-pan. A vessel with a double bottom, forming a steam-chamber. Used as a hot table, and otherwise. See VACUUM-PAN; LARD-TANK; etc.

Steam Pile-driv'er. Invented by Nasmyth, the inventor of the steam-hammer. See PILE-DRIVER. See also Holtzapffel, ii. 961.

Steam-pipe. Any pipe conveying steam. Notably, —

1. The pipe leading from a boiler to an engine, pan, tank, and what not; or from the same to a condenser or to the open air, as the case may be. Known as *induction* and *exhaust* respectively.

The loss of steam from condensation in a well-protected steam-pipe may be taken approximately as 1 lb. of steam per indicated horse-power per hour for each 100 feet of steam-pipe. In such a case, a stuffing-box expansion-joint should be provided in the steam-pipe allowing an expansion of 2¼ inches for each 100 feet in length.

2. One of the supply-pipes in a system of steam heating or drying.

Steam-plow. A plow, or gang of plows, drawn by portable steam-engines. By the same means, cultivators, harrows, and other agricultural implements are drawn.

The varieties of systems of steam-plowing may be said to be five.

1. *Engines upon a track and plows moving at right angles thereto; the engine advancing between each course of the plows.*

The first steam-plow patented in England was the invention of Clarke, Freeman, & Varley, 1846. This system used a track for a locomotive on each side of the piece to be cultivated, and the plows were drawn back and forth by ropes from the engines.

Osborn, the same year, patented a somewhat similar contrivance of tracks, engines, and plows.

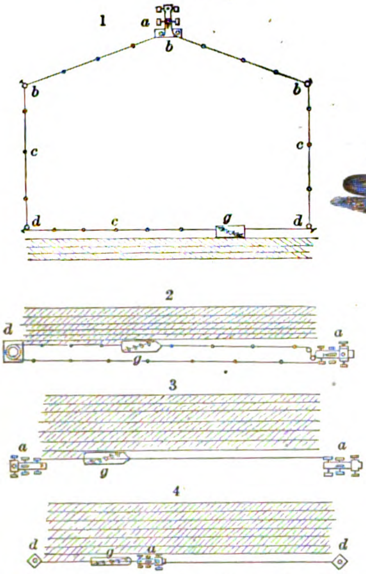
In 1850, Lord Willoughby de Eresby introduced his system of steam-plowing. The machinery consisted of the "California" locomotive-engine, designed by Sir Daniel Gooch, which weighed 3½ tons, and was 26 horse-power. The engine was fitted with a double capstan, which could readily be removed when the engine was required for other purposes. It was intended by the inventor of this system that the engine should be moved "across the center of the field on a light portable railway. The plows advance and recede on either side of the railway at right angles to it." The plows or other implements of culture are intended to be worked by "an endless chain 150 yards in length, which will be put in motion by the capstan of the engine. Provision is made at the moving anchor for taking up the slack or letting out fresh chain"; and by this arrangement the chains could be varied a length of 40 feet to suit the varying length of irregular-shaped fields. The plows that were intended to be

Fig. 5706.

Fowler's Steam-Plow.

used consisted of "four ordinary plows and the like number of subsoil plows fixed in a frame," which were to be guided "by a person standing on a small platform" attached to the frame. Two such sets of plows were intended to be worked, "one on either side of the railway."

Fig. 5707.



Diagrams showing Manner of Using various Steam-Plows.

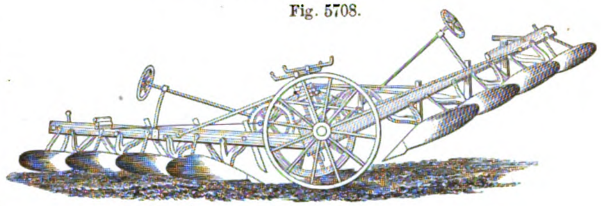
Fowler's engines and plows are used in the manner shown in diagrams 2, 3. In Fig. 5707, 2, if only one engine is used, a snatch-block at the other side of the field turns the rope, and is moved along after each furrow, as is also the engine where two engines are employed, as in Fig. 5707, 3, where one rope draws the plows, and is reeled back and forth from one engine to the other as the gang-plow crosses the field. Only one engine and one gang of plows operate at a time. The engines are of 12 to 20 horse-power each. The gang or *balance* plow (Fig. 5708) is capable of turning four or six furrows, and a double-engine steam-plow will break up 20 to 25 acres per day, requiring six men to attend the plows and engines. 400 sets of these machines have been made and sent to the Pasha of Egypt, yet there are but few in this country, — one in New Jersey, and some in Louisiana and in the West. They are in use in Cuba and South America.

The Magnolia sugar plantation, in Louisiana, has one set of the Fowler steam-plow of 14 horse-power, and one of 20 horse-power. When breaking up, the mold-board is set to plow to a depth of from 15 to 20 inches, and when using the subsoiler cultivating between the cane rows to the depth of from 20 to 24 inches.

2. The "roundabout" system of Howard may use a portable engine of any approved construction, in connection with a windlass for holding the rope. A *snatch-block* is anchored at each point where the rope makes a turn. The rope is kept from sagging by *rope-porters* having anti-friction rollers, over which it passes.

Fig. 5709 shows the operation of this mode of cultivation, which is the same in effect as the diagram 1 (Fig 5707). *a* is the engine; *b* the windlass, to which both ends of the wire rope

Fig. 5708.



Gang-Plow.

are secured, and which winds one way long enough to draw the gang-plow *g* across the field, when it is reversed, and draws it back again. Snatch-blocks *d d* are moved after each furrow, while those *b b* are stationary until the plowing is complete; *c c* are rope-porters. The snatch-block with its anchors and the rope-porters are shown on a larger scale in the perspective view, Fig. 5709.

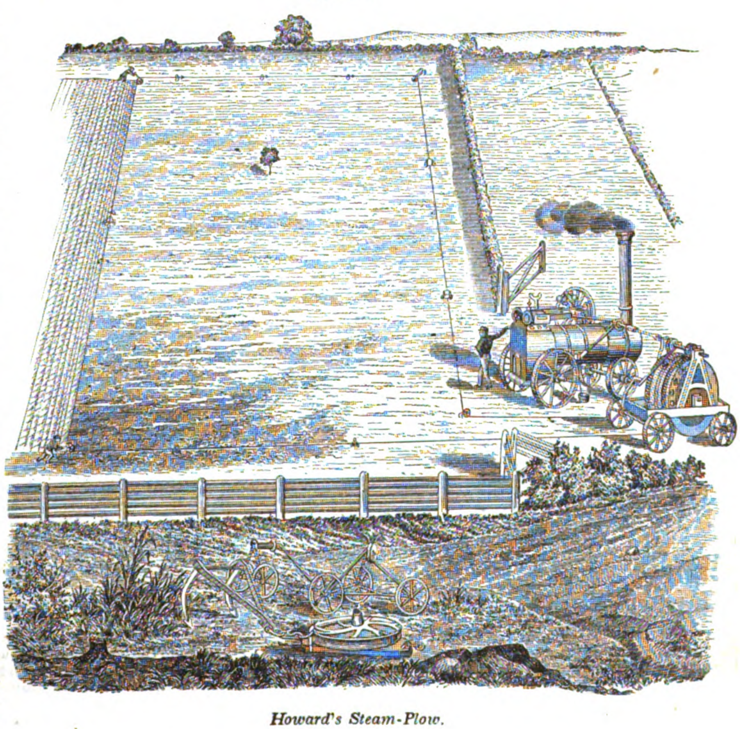
3. *The engine drawing itself and the gang of plows across the field by winding on a rope which reaches between anchors on opposite sides of the field.*

Hall's stationary rope steam-plow, operating in the manner shown at 4, Fig. 5707, is a combination of the rope and traction-engine system. The wire rope is anchored at each side of the field, and the engine travels along it, holding by a clutch or by passing the rope around a drum. The anchors at the sides of the field are moved as the work progresses. It is claimed that four men and one engine can plow 20 acres per day with this apparatus.

4. *Traction-engine drawing gang of plows.*

This has been found difficult, owing to the occasional softness and the inequalities of soils. The

Fig. 5709.

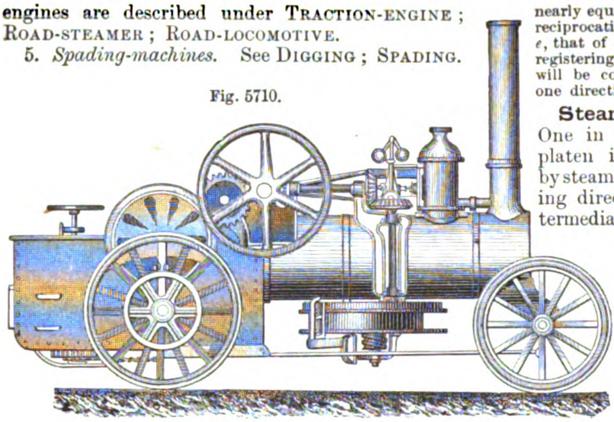


Howard's Steam-Plow.

engines are described under TRACTION-ENGINE; ROAD-STEAMER; ROAD-LOCOMOTIVE.

5. *Spading-machines.* See DIGGING; SPADING.

Fig. 5710.



Traction-Engine for Gang-Plow.

Steam-port. (*Steam.*) An opening through the valve-seat to the inside of the cylinder. Known as the *induction* (inlet) port, or the *eduction* (outlet) port, respectively, according to the course of the steam.

Steam-pow′er Me′ter. A device for ascertaining the amount of work done by a steam-engine. Fig. 5711 is that of Messrs. Ashton & Storey, of Manchester, England.

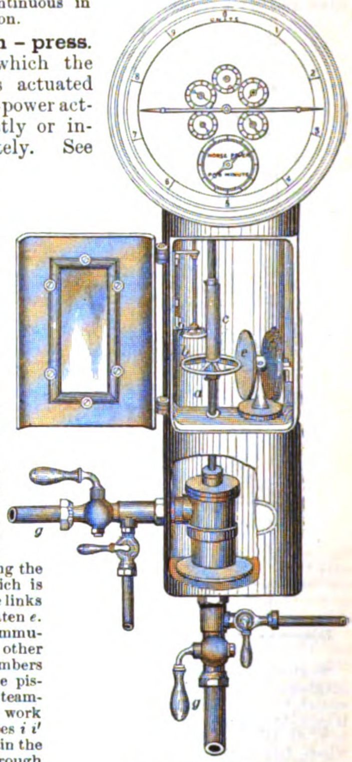
It consists of a double-acting indicator cylinder, having its ends connected with those of the engine-cylinder by pipes *g g*. The indicator piston-rod *a* carries a wheel *b* with a plain rim and a long pinion *c* gearing with the spur-wheel *d*. At the upper end of this rod is a helical spring, which resists either the upward or downward movement of the indicator piston. The wheel *d* is fixed on the lower end of a spindle having a worm at its upper end, which communicates motion to the train actuating the dial.

The wheels *e f* are of the same diameter, and on the same horizontal shaft; the first has a smooth face, which is, by means of a spring, pressed against the rim of the wheel *b*; the other *f* is grooved and connected by a band with the cross-head or other convenient reciprocating part of the engine, causing its partial rotation in one direction; its motion is reversed by a spring, thus causing an alternating reciprocating movement of the two wheels *e f* when the engine is in operation. The tension of the spring at the head of the rod *a* is so adjusted that when the pressures on each side of the piston are equal, the wheel *b* is at the center of the wheel *e*; an excess of pressure on either side causes it to rise or fall by an amount proportionate to this excess.

The principle of operation is as follows: If the wheel *f* be connected with the cross-head of the engine, so that its periphery and that of *e* move an equal distance and at an equal velocity with the cross-head, and a steam pressure of 50 pounds per inch suffices to move the wheel *b* to a point midway between the center and the circumference of the wheel *e*, the periphery of the wheel *b* will move with half the velocity of the engine-piston, and so on in proportion to its greater or less distance from the center of *e*, dependent on the effective pressure. The relation between this motion and that communicated to the gearing of the indicator is such that the dials register the amount of work done in units of 1,000 foot-pounds for each circular inch in area of the piston. The absolute work of the engine in a given time is then ascertained by multiplying the square of the diameter of the piston by the number of units indicated by the dial.

As at each up-stroke of the piston the wheel *b* will be above the center of the wheel *e*, and at each down-stroke an equal, or nearly equal, distance below it, it is evident, owing to the reciprocating motion of *e*, that of *b* and of the registering mechanism will be continuous in one direction.

Fig. 5711.



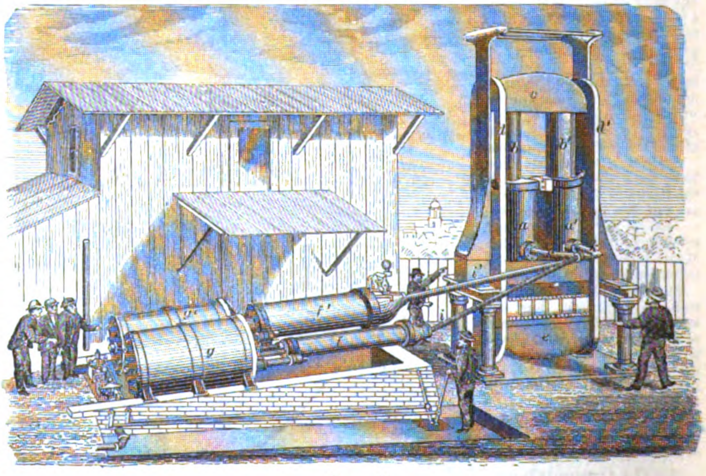
Steam-Power Meter.

Steam-press. One in which the platen is actuated by steam-power acting directly or intermediately. See list under PRESS, page 1784.

Fig. 5712 illustrates a steam and hydraulic baling-press. The cylinders *a a′* inclose the rams *b b′*, carrying the cross-head *c*, which is connected by the links *d d′* with the platen *e*. The cylinders communicate with each other and with the chambers *f f′*, in which the piston-rods of the steam-cylinders *g g′* work through the pipes *i i′ k k′*. These contain the water or oil through which the pressure is communicated.

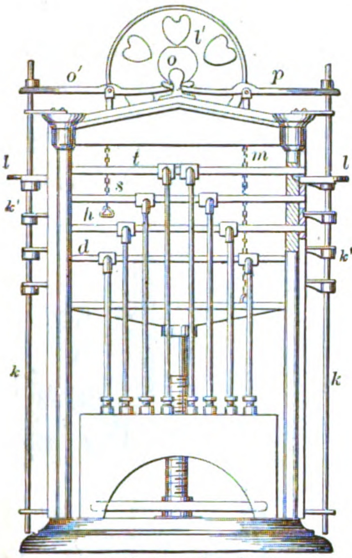
Previous to commencing operations, live steam is admitted to the cylinder *g*, forcing its piston out in opposition to the fluid pressure of the cylinders *a a′*, which, on steam being cut off, forces the piston back again, and the connecting pipe between *g* and *g′* being closed, the steam is readmitted to the other end of the cylinder *g*; by this means it is thoroughly warmed, so as to prevent condensation during the subsequent operation.

Fig. 5712.



Steam-Press.

Fig. 5713.



Press for Steaming Goods.

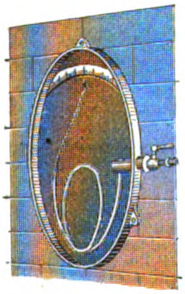
The bales are next placed on the platen, the communication valve between the cylinders g g' is opened, permitting steam to flow from one to the other, forcing the piston f' forward, and the fluid into the cylinders a a', causing the rams b b' to ascend and raising the platen. When the pressure on the two pistons is equalized, the forward motion of this piston stops, an automatically acting valve closes, a valve is opened, admitting live steam to the cylinder g, again forcing its piston forward; this is of smaller area than the piston f', and, receiving the full force of the live steam, exerts a much greater and more rapid pressure, completing the operation. The bale is then tied, and the stroke of the pistons reversed, enabling the bales to be removed and the operation repeated.

The several valves governing the admission and exhaust of steam are controlled by hand-levers.

Fig. 5713 is an apparatus for steaming goods while under pressure. The hollow pressing-plates d h s t communicate, through steam induction and eduction pipes, with a steam-chest beneath, divided into two chambers by a vertical partition. These plates have a limited vertical motion by reason of their outer edges resting upon ledges l l k' k', connected with the rods k k, which are operated by levers o' p by means of a cam o on the wheel l'. The folded goods, with layers of cardboard interposed, are placed upon the follower of the press, and then between the successive steam-plates, in ascending order, until all are filled. The follower is then raised by its screw and hand-wheel, and steam is admitted to the chest, passing through the induction-pipes into the plates, and thence out through the eduction-pipes to the eduction compartment of the chest. The steam-pipes slide in stuffing-boxes, and the plates are lowered to receive the goods by turning the wheel l' through the medium of the chain m which passes over it.

Steam-press′ure Gage. (*Steam-engine.*) An instrument for indicating the pressure of steam in a boiler, cylinder, pipe, tank, or other object to which it is attached.

Fig. 5714.



Steam-Pressure Gage.

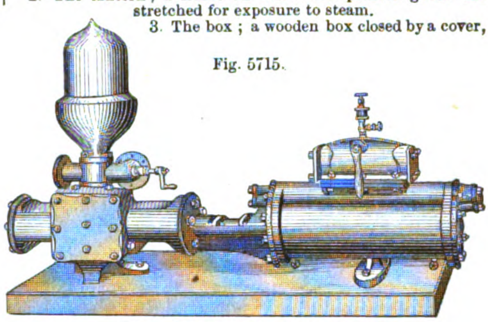
Bourdon's (Fig. 5714) consists of an elliptical copper tube bent into an arc of $1\frac{1}{2}$ circumferences, 540°. One of the extremities communicates with the boiler or reservoir of condensed gas whose pressure is to be measured, and the other carries an index which moves backward or forward on a graduated arc as the curvature of the tube is varied by changes of pressure. See PRESSURE-GAGE; STEAM-GAGE.

Steam-print′ing Ap′pa-ra′tus. An apparatus for fixing colors upon cloth by means of steam. See STEAM-PRESS.

It embraces: —

1. The column; a hollow cylinder having numerous perforations, around which the cloth is lapped, in order to steam it.
2. The lantern; a frame on which the printed goods are stretched for exposure to steam.
3. The box; a wooden box closed by a cover, which is made steam-tight at the edges by a list of felt, and has a perforated steam-pipe at the bottom.
4. A chamber into which steam is introduced through two perforated pipes.

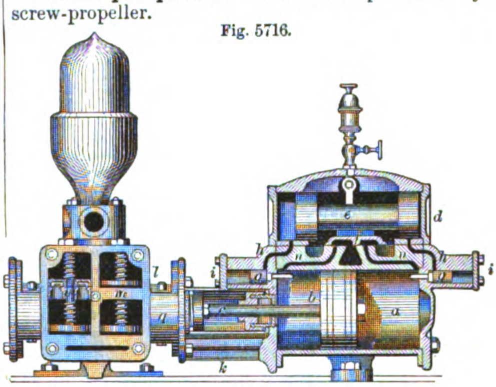
Fig. 5715.



Cameron's Steam-Pump (Elevation).

Steam-pro-pel′ler. A steam-ship driven by screw-propeller.

Fig. 5716.

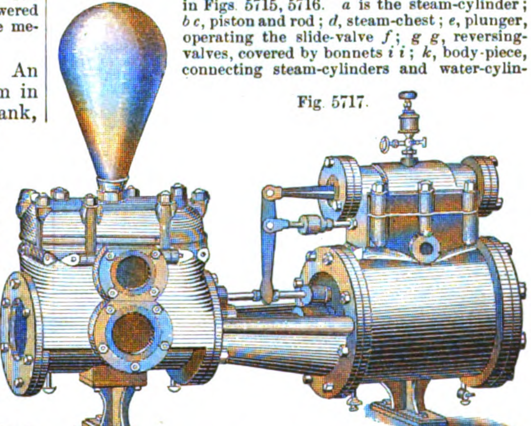


Cameron's Steam-Pump (Section).

Steam-pump. An application of the steam-engine to pumping purposes.

The steam-pump known as Cameron's special, extensively used in collieries, is shown in Figs. 5715, 5716. a is the steam-cylinder; b c, piston and rod; d, steam-chest; e, plunger, operating the slide-valve f; g g, reversing-valves, covered by bonnets i i; k, body-piece, connecting steam-cylinders and water-cylin-

Fig. 5717.

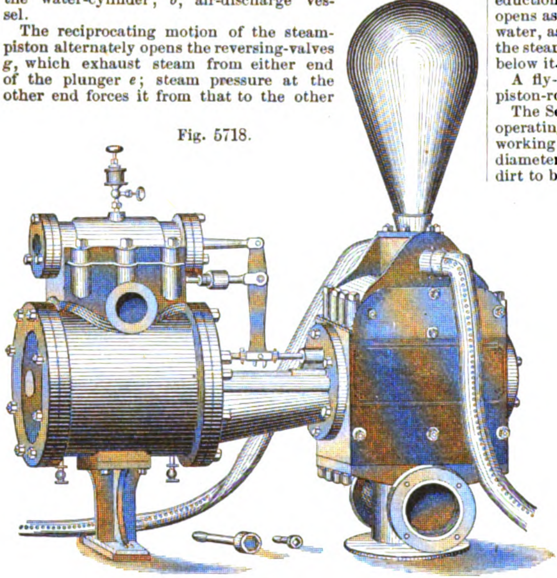


Blake's Steam-Pump.

ders q; l, valve-chest, and $m\ m$, valves of the water-cylinder; o, air-discharge vessel.

The reciprocating motion of the steam-piston alternately opens the reversing-valves g, which exhaust steam from either end of the plunger e; steam pressure at the other end forces it from that to the other

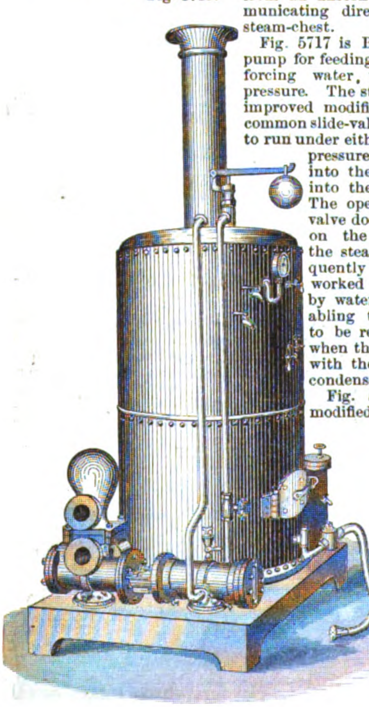
Fig. 5718.



Blake's Steam Fire-Pump.

end of its stroke, and opens or closes the steam-ports $n\ n$ controlled by the slide-valve f, which admits steam to the piston. The exhaust takes place through the ports $p\ p$, and the valves $g\ g$ are reversed by steam from an unseen passage communicating directly with the steam-chest.

Fig. 5719.



Portable Steam-Pump.

Fig. 5717 is Blake's steam-pump for feeding boilers or for forcing water, under heavy pressure. The steam-valve, an improved modification of the common slide-valve, is arranged to run under either high or low pressure, exhausting into the condenser or into the atmosphere. The operation of the valve does not depend on the elasticity of the steam, and consequently it may be worked with certainty by water-pressure, enabling the apparatus to be readily started, when the valve is filled with the cold water of condensation.

Fig. 5718 shows a modified form of this pump, specially adapted for fire-extinguishing purposes.

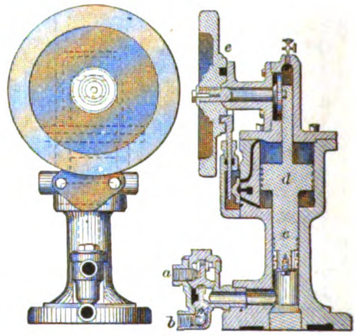
The portable pump (Fig. 5719) has an upright boiler, the pump being horizontal. The water-eduction port is connected with an air-chamber, to render the discharge continuous.

The Paragon steam-pump (Fig. 5720) has its induction and eduction orifices $a\ b$ controlled by valves, so connected that one opens as the other closes, and *vice versa*, by the action of the water, as the ram c, which is in one piece with the piston d of the steam-cylinder, rises and falls as steam is admitted above or below it.

A fly-wheel e rotated by an eccentric connected with the piston-rod regulates the velocity of the strokes.

The Selden steam-pump (Fig. 5721) has two pump-cylinders, operating by a plunger directly connected with the piston-rod, working in a cylinder between them. The cylinder is of greater diameter than the piston, enabling water containing grit and dirt to be pumped without injuring the parts by grinding.

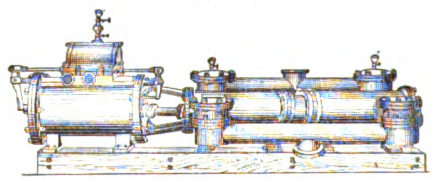
Fig. 5720.



Paragon Steam-Pump.

The steam-cylinder valve-rod projects beyond each end of the steam-chest and has a lever at each end, which is struck by a rod on the piston passing through the two cylinder heads, thus operating the valve.

Fig. 5721.

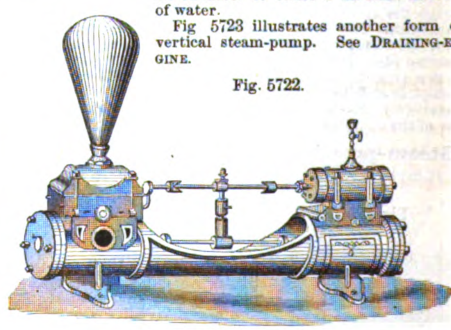


Selden Steam-Pump.

In Knowles's steam-pump (Fig. 5722), the steam and pump cylinders are both horizontal, and the latter is provided with an air-chamber to cause a uniform delivery of water.

Fig 5723 illustrates another form of vertical steam-pump. See DRAINING-ENGINE.

Fig. 5722.

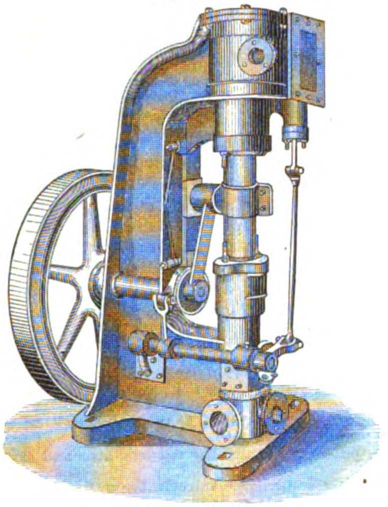


Knowles's Steam-Pump.

The pump (Fig. 5724) is particularly designed for mining purposes, and where gritty or sandy water is to be raised. It is a double-cylinder plunger-pump. The two plungers $a\ a'$ are directly connected to the piston-rod of the steam-cylinder, which does not enter the water-cylinders, but passes through guide-flanges at their sides, and is consequently not subject to the abrasive action of gritty matters contained in the water.

Fig. 5725 is what is known as an "oil line-pump," used in the petroleum regions, where an inclination is to be overcome in conveying oil from the well to a depot or other situation above ground. It has two pumping-cylinders $a\ b$, one at each

Fig. 5723



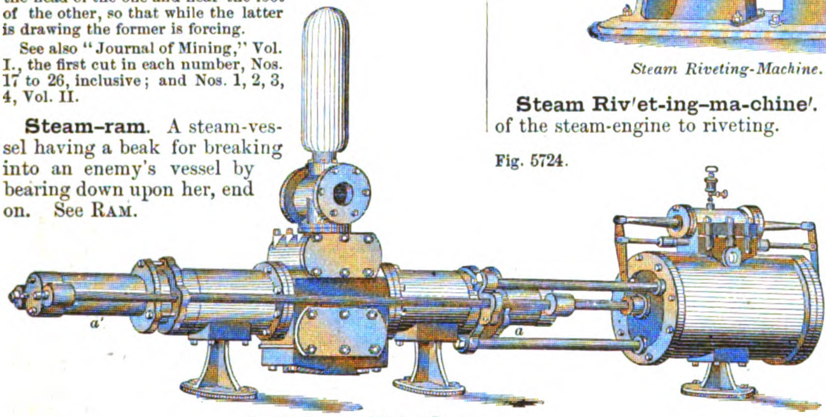
Vertical Steam-Pump.

end of the steam-cylinder *c*; one acts as a suction and the other as a forcing pump; the pipe *d* connecting the two enters near the head of the one and near the foot of the other, so that while the latter is drawing the former is forcing.

See also "Journal of Mining," Vol. I., the first cut in each number, Nos. 17 to 26, inclusive; and Nos. 1, 2, 3, 4, Vol. II.

Steam-ram. A steam-vessel having a beak for breaking into an enemy's vessel by bearing down upon her, end on. See RAM.

Fig. 5724.



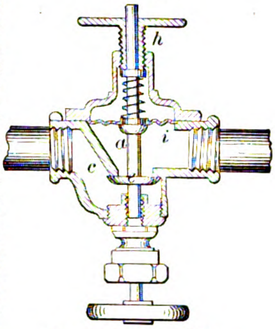
Double-Plunger Mining-Pump.

Steam-reg'u-la'tor Valve. A valve for automatically regulating the passage of steam through a pipe or opening.

In the example, the upper part of the valve-stem *a* passes through and is connected with the diaphragm *i*, the degree of compression of which is regulated by a spring whose tension may be varied by the screw *h*. The lower end of the stem is inserted in a screw operated by a hand-wheel below, by turning which the valve *e* may be forced up against its seat, to entirely close the steam opening. In ordinary operation it is allowed an indefinite amount of downward play, and the tension of the diaphragm is so adjusted that if the normal steam-supply is exceeded, the diaphragm rises and the valve cuts off the supply; but if the pressure is too small the opposite effect is produced, the tendency being in either case to cause a uniformity of steam pressure in the eduction-chamber *c*.

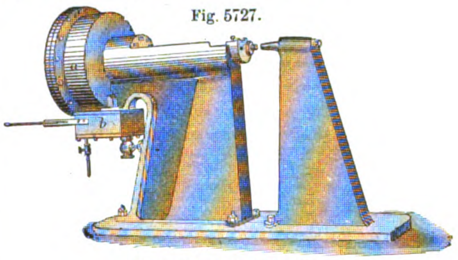
The invention is particularly designed for application to steam-blowers.

Fig. 5726.



Steam-Regulator Valve.

Fig. 5727.



Steam Riveting-Machine.

Steam Riv'et-ing-ma-chine'. An application of the steam-engine to riveting.

In Fig. 5727, the ram and piston of the cylinder *a* are made very heavy and in one piece, so as to act by momentum, and are operated by direct action of steam from the steam-chest *b*. The piston is retracted by the expansion of the steam used in riveting. See also RIVETING-MACHINE.

Steam-room. The capacity for steam over the surface of the water in the boiler.

Steam-shear. (*Metal-working.*) A machine for slitting metal plates. The plates, 20 to 30 feet long and 6 or 7 feet wide, are placed on a table provided with rollers and guides, which is advanced toward the knives until a strip of the desired width and of the whole length of the plate is severed.

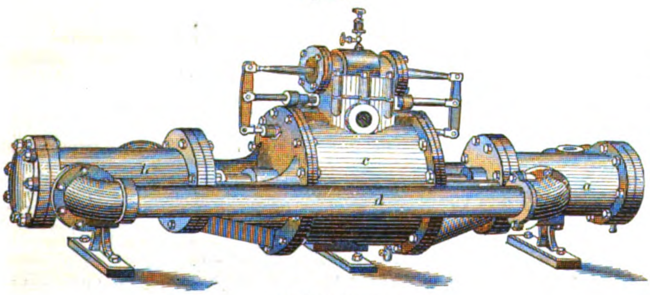
One used by the Otis Iron and Steel Company of Cleveland, O., weighs about 80,000 lbs., has knives 87 inches long, and shears $1\frac{1}{4}$-inch steel plates at a single stroke. See SHEARING-MACHINE.

Steam-ship. See STEAM-BOAT.

Steam-sled. An ice-locomotive.

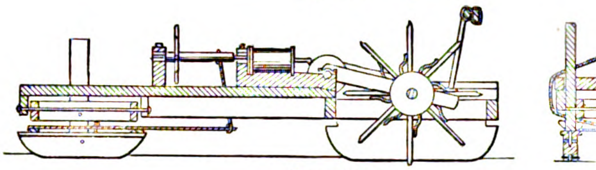
The sled is moved by point-ended radial arms on a rotating wheel, and has two pairs of runners with guide-

Fig. 5725.



Oil Line-Pump.

Fig. 5728.



Steam-Sled.

knives beneath. The forward runner-frame admits of oscillation to guide the sled. See also Fig. 2644, page 1163.

Steam-sli′cer. A steam-operated machine for slicing dried meat and fresh vegetables. See ROOT-SLICER; VEGETABLE-SLICER.

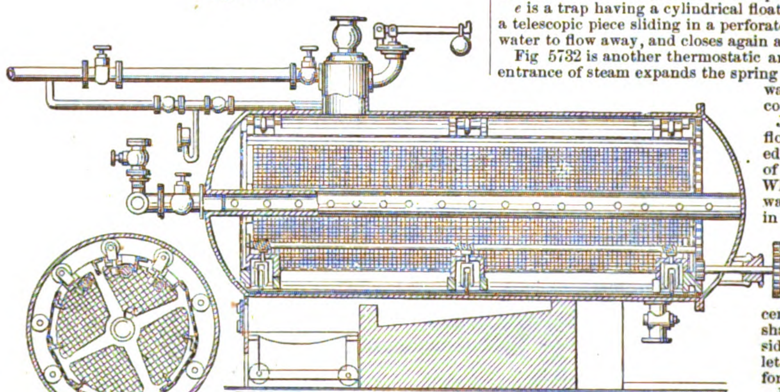
Steam Steer′ing-ap′pa-ra′tus. See STEERING-APPARATUS.

Steam-ta′ble. A hollow table heated by steam, to keep joints and other viands warm in the dining or carving rooms of hotels.

Steam-tank. A chamber heated by steam, used for various purposes in the arts, such as steaming wood, paper-stock, rendering fats, etc. See under the various heads.

Fig. 5729 shows an apparatus for treating vegetable, mineral, and animal matters with steam. The matter to be treated is

Fig. 5729.

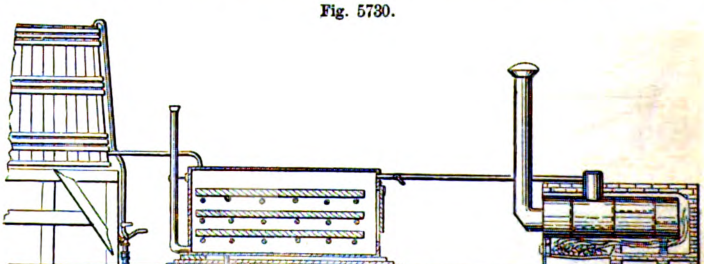


Tank for Treating Matters with Steam.

placed in the retainer, which is run into the boiler, one end of the latter being removable The retainer is a wire-work cylinder supported by a metallic frame, whose circumferential ribs carry rollers to support the retainer when rotated. Some of these rollers are fixed in casters, which are turned by a rod and worm gear to serve as supports when the retainer is run out on to the truck. A perforated pipe, axially attached to and removable with the retainer, communicates with pipes outside the boiler to allow introduction of chemicals. The grate is removable with its supporting truck.

Fig. 5730 represents a steam-chamber in which wood is treated, to preserve it. The timber-chamber is charged with superheated vapor, which is subsequently condensed, and the pores of the wood filled with an oleaginous preservative material admitted from a reservoir. See WOOD, PRESERVATION OF. See also LARD-TANK; etc.

Fig. 5730.



Apparatus for Preserving Wood.

Steam-toe. (*Steam-engine.*) An arm fastened to a lifting-rod to raise it by the contact of the cam or tappet. The toes on the lifting-rods of the inlet and exhaust are *steam* and *exhaust* toes respectively.

Steam-trap. A self-acting device for the discharge of condensed water from steam-engines or steam-pipes. Cocks are frequently applied for the purpose, as we see in the cylinders of locomotive-engines, etc., but they require strict attention.

The preferable forms of steam-traps are automatic. Some are thermostatic arrangements, in which the difference between the heat of steam and the heat of the water actuates a valve to discharge collected water; others act by the rising of a float in the water-chamber; others by the weight of the collected water.

Fig. 5731 shows several forms of steam-traps. *a* is Tredgold's. A square box is placed in such position as to collect water of condensation. When this rises to a certain hight, the float raises the valve and allows the water to flow away. As the float falls the valve closes.

In *b* is a thermostatic valve. As the chamber fills with water the rod contracts in length and opens the valve; as steam takes the place of the water the rod lengthens and closes the valve.

In *c* the water-discharge valve is below the float and the water-line. The air-valve is operated by the expansion of a copper rod.

d has a perforated sliding-tube sliding in a seat, and has a valve on each end. Steam entering at one end blows the valve forward on to its seat and opens the holes at the other end, so that the water of condensation escapes by the central pipe.

e is a trap having a cylindrical float above a valve formed of a telescopic piece sliding in a perforated tube, which allows the water to flow away, and closes again as the float descends.

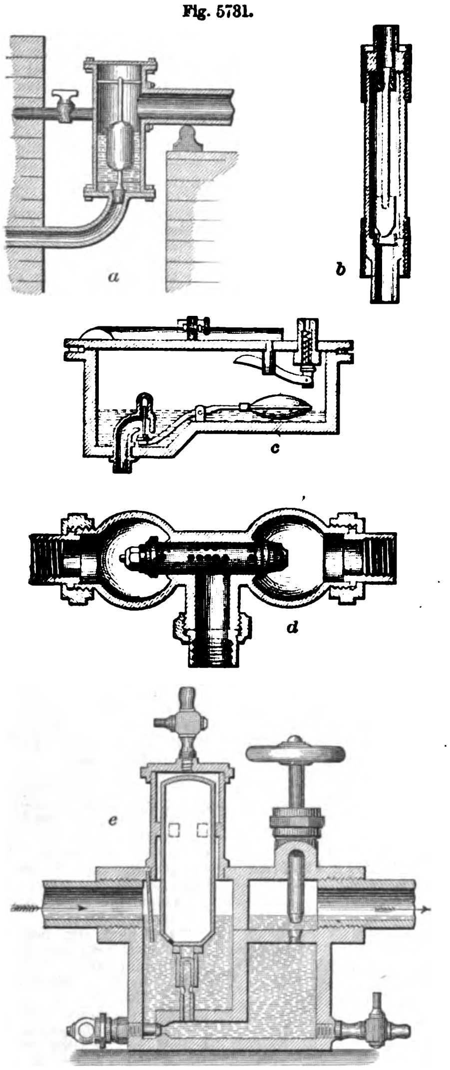
Fig 5732 is another thermostatic arrangement, in which the entrance of steam expands the spring and closes the valve. As water collects, the spring cools and the valve rises.

Jones's steam-trap has a float *a* at the end of a pivoted rod *b*, to which the stem of the valve *c* is connected. When a certain amount of water has been condensed in the trap the ball rises and lifts the valve, allowing the excess to escape into the waste-pipe *d*. The valve may also be lifted by the eccentric *e*, which turns on a shaft passing through the side of the trap. *f* is the inlet and *g* the outlet passage for steam.

Barr's elliptic steam-trap consists of two tubes *a b* united at one end by the casting *c*. *d e* are two castings attached to the free ends of the tubes, one *d* having an aperture for the admission of steam, and the other *e* an aperture for the escape of the water condensed. *f* is a globe-valve; *g*, a yoke secured to the tube *a* and to the valve-stem; *h*, a rod secured to the castings *d e*, and having a nut *i* which regulates the movement of the valve.

Steam entering the opening in *d* expands the tubes, which being prevented from extending longitudinally by the rod *h*, are caused to spread apart the tube *a*, carrying the yoke *g* and

Fig. 5731.

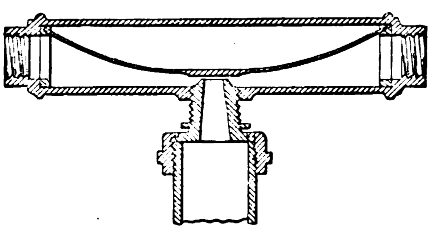


Steam-Traps.

valve-stem in one direction, and the tube *b* moving the valve *f* in the other direction, closing the valve and preventing escape of steam.

As soon as condensation takes place the tubes *a b* cool and contract, opening the valve and permitting the steam to escape.

Fig. 5732.

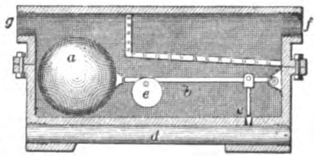


Steam-Trap.

The trap may be set to allow escape of steam at any given pressure by means of the nut *i*.

In Wilson's steam-trap, *c* is the spring, the upper leaf brass and the lower steel; the two are closely riveted together. *b*, the valve, is a plate of common solder, raised on the under side of the steel leaf of the spring.

Fig. 5733.



Jones's Steam-Trap.

Steam-tug. A small but powerful steam-vessel for towing ships in or out of harbor.

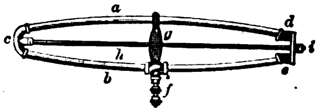
Steam Vac'u-um-pump. One for raising water by the condensation of steam in a vessel situated at such elevation above the water-supply that the atmospheric pressure will raise the water to the chamber and operate the valves. See VACUUM STEAM-PUMP.

Steam-valve. A device for opening or closing a steam pipe or port. See list under VALVE.

Steam-ves'sel. See STEAMBOAT.

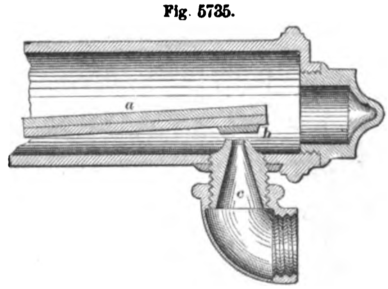
Steam Wa'ter-el'e-va'tor. A water-raising apparatus in which the pressure of steam on the water is the means of elevating it. The old idea of Savery, Worcester, and others. (See STEAM-ENGINE.) The engraving shows a locomotive whose steam-pipe *b* is temporarily connected with the chamber *a* to inject steam, by whose condensation the chamber is filled, and by whose subsequent pressure the water

Fig. 5734.



Barr's Elliptic Steam-Trap.

Fig. 5735.

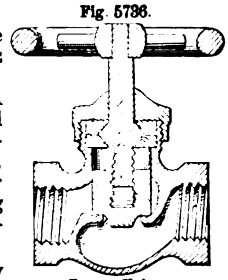


Wilson's Steam-Trap.

is driven by pipe *e'* to the tender; *e* is a valve-box; *c*, an air-chamber. See also VACUUM STEAM-PUMP.

Steam-way. A passage leading from the steam-port of a valve to the cylinder.

Fig. 5736.



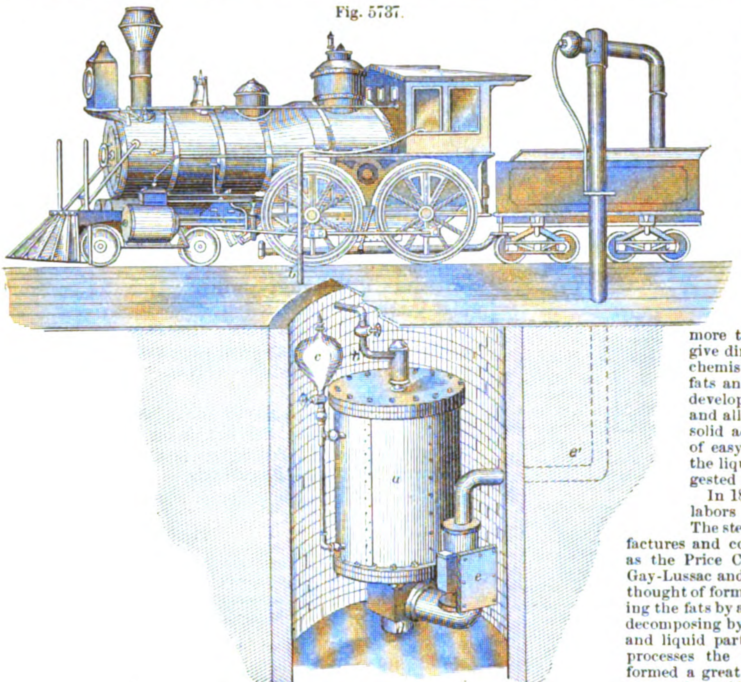
Steam-Valve.

Steam-wheel. The ROTARY STEAM-ENGINE (which see).

Steam-whis'tle. A sounding device connected with the boiler of a steam-engine, either stationary, locomotive, or marine, for the purpose of announcing the hours of work, signaling, etc.

It was invented about 1826 by Adrian Stephens, chief mechanic at Plymouth Works, England, and afterward of Merthyr Tydvil, Wales, and was designed to render clearly audible the escape of steam from the safety-valve.

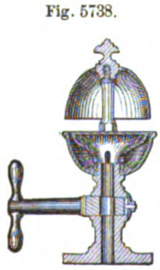
Fig. 5737.



Steam-Pressure Water-Elevator.

Fig. 5738 illustrates the whistle of a locomotive-engine. The foot is bolted on to the fire-box, has an opening for the admission of steam, and is provided with a cock, by turning which steam is permitted to rush into the hollow piece, which is provided with holes around its lower and narrower portion, through which the steam rushes into the cavity of the cup, and, passing out through the narrow annular opening, impinges against the rim of the bell, causing a shrill, piercing sound. Holes in the top of the bell permit the escape of the steam upwardly and increase the volume of sound. The quality of the tone depends on the width of the annular opening, the depth of the bell, and the distance between it and the cup.

Fig. 5738.



Steam-Whistle.

The Calliope (which see) is a series of such whistles tuned to a scale and operated by keys. See Patent 13,668 of 1855.

Steam-whistles are also made to give varying tones by graduating the length of the pipe or cup.

Patent 131,176 of 1872 has in the bell a removable piston which graduates the sound so as to play a tune.

Patent 142,166 of 1873 has a bell which consists of a fixed open cylinder and a slightly larger cylinder closed at one end and sliding over the first. This makes a telescopic sounding-tube, the length of which may be varied to produce musical notes.

Patent 141,280 of 1873 has a series of gates in the body of the pipe, which form *tompons* to vary its length, and so form musical notes.

No. 29,915 of 1860 has a series of reeds in a chamber, and movable shutters for closing all but the one required to sound a given note.

Steam-winch. A form of hoisting-apparatus in which rotary motion is imparted to the winding axle from the piston-rod of a steam-engine, directly, as at *A*, or intermediately, through bevel-gearing, as in *B*. The former is more rapid; the latter affords greater power.

It is specially used for getting freight in and out of vessels. See Crane; Steam-crane; Traversing-crane; and list under Hoisting-apparatus.

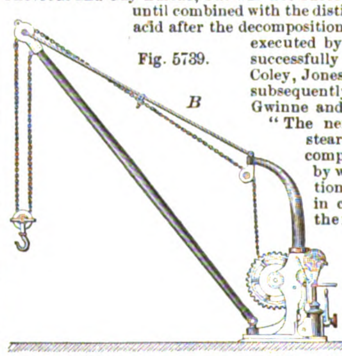
Ste'a-rine. The more solid portion of fats and oils after the fluid portion, *oleine*, has been removed.

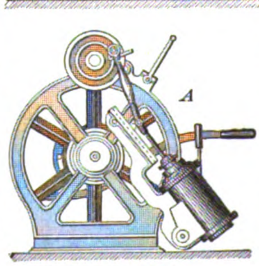
The growth of the stearine industry dates from the labors of Braconnot in 1817, in separating oleine and stearine, followed by the researches of M. Chevreul. Prof. J. Lawrence Smith observed, in his address at the Priestly Centennial of Chemistry: "M. Chevreul did not give to the world the results of his labors as a mass of isolated facts, but he systematized and classified new acids, new bases, and left to us the chemical history of facts almost as fully made out as they are at the present time; and these have contributed as much as, if not more than, any class of researches to give direction and growth to organic chemistry. The decomposition of the fats and formation of the fatty acids developed the fact that, when melted and allowed to cool slowly, the more solid acids crystallized, so as to allow of easy separation of the solid from the liquid part, which fact soon suggested a practical application."

In 1823 a complete account of the labors of M. Chevreul was published. The steps which led to the great manufactures and commercial undertakings, such as the Price Candle Factory, were made by Gay-Lussac and Chevreul in 1825. They first thought of forming the fatty acids by saponifying the fats by alkalies and the alkaline earths, decomposing by acid, and separating the solid and liquid parts by pressure. In the earlier processes the expense of potash and soda formed a great difficulty, but this was subsequently avoided by the use of lime. De Milly and Motard in 1829 in the process, and Cambaceres in the process and also in the invention of the plaited wick, put the industry upon a firm footing. To quote farther from Professor J. Lawrence Smith: —

"A second advance in this industry was the use of sulphuric acid to decompose the fats; this plan originated also with Chevreul and Gay-Lussac, but was not successfully carried out until combined with the distillation of the fatty acid after the decomposition, — a method first executed by Dubrunfaut, and successfully carried out by Coley, Jones, and Wilson, and subsequently perfected by Gwinne and Jones.

Fig. 5739.





Steam-Winch.

"The next step made in stearinery was the decomposition of the fats by water. The conception of this method, in common with all the methods of saponification of fatty bodies, is to be referred back to the author of the discovery of the true nature of fats, M. Chevreul; for in his original researches he pointed out the perfect analogy between the fats and the compound ethers, the latter class of bodies being decomposed into their two constituents, in the presence of water heated in close vessels under pressure; a reasonable deduction from which was that fats would undergo an analogous decomposition. This, however, was not undertaken at the time, but by an accident, about the time of Chevreul's researches, it was observed to take place by Faraday, when his attention was drawn to some changes in oils used by Perkins in his curious steam-engine that employed very hot water.

"No attempt was then made to draw any practical results from these observations, and we find no farther notice taken of the subject until early in the year 1854, by R. A. Tilghmann,

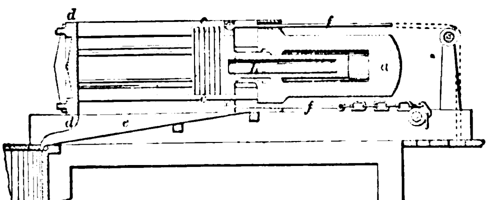
of Philadelphia, when patents were taken out by him for decomposing fats mixed with water, and superheated in vessels of a certain description. The method of Tilghmann, as originally patented, was never introduced into practice; since then, with change in the manner of operating and in the nature of the boiler, it has been successfully conducted in many factories.

"In the latter part of the same year that Tilghmann's process was patented, M. Melsens, of Belgium, took out a patent very analogous, using fats mixed with water in the proportion of 20 to 100 per cent of the latter; the water might be acidulated with from 1 to 10 per cent of sulphuric acid, or the addition of salt would suffice; the whole was heated from 180° to 200° C. for several hours. The success of Melsens's process was immediate, and it was put into operation on a large scale in Antwerp in vessels holding one ton of tallow, to which was added 50 per cent of water, and in six hours the decomposition was complete at a temperature of 180° C. (ten atmospheres). The fatty acids thus made were of a very satisfactory quality, quite as much so as those obtained by other methods of saponification.

"But this method, by superheated water, is now supplanted by a mixed method of using one or two per cent of lime with the superheated water, which addition facilitates and hastens the reaction in a manner not yet understood by chemists."

Ste'a-rine-press. A hydraulic press used for depriving stearine (stearic acid) or spermaceti of fluid oily impurities.

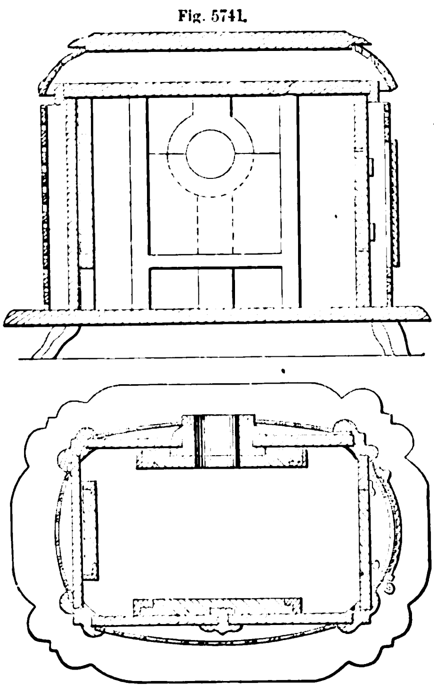
Fig. 5740.



Stearine-Press.

a is the cylinder; *b*, the ram; *c c*, iron plates previously heated, placed between every two cakes of the material, inclosed in hair or cloth bags; *d d*, a head strongly bolted to the cylinder to receive the pressure. The oil flows through a spout *e* to a reservoir. The ram is brought back to place after pressing by weights and chains connected to the rods *f f*.

Fig. 5741.



Soapstone-Stove.

Ste'a-tite-stove. A form of stove in which the sides and top are of soapstone, with iron frames and fittings.

Steel. A most valuable alloy of iron, which possesses certain peculiar characteristics.

This alloy of iron is generally understood to depend for its quality upon the possession of a certain proportion of carbon, which causes it to harden when heated and plunged into water. An expert, Mr. A. L. Holley, defines it as an alloy of iron which is cast while in a fluid state into a malleable ingot. Blister and shear steels, however, made by the usual cementation, are not cast, neither is the native steel cast by the African and Asiatic tribes. The difference between steel and iron is always structural, usually chemical also.

Another definition is, a compound or alloy of iron that will forge, harden, and temper (CROOKER). This includes iron in combination with various other elements besides carbon, as silver, tungsten, chromium, titanium, cyanogen, silicon.

Ordinary steel contains from 0.5 to 1.5 per cent of carbon. Its hardness and fusibility increase with the amount of carbon, and when this element is in excess it becomes cast-iron. When the proportion of carbon is small, the metal is termed *mild* or *low* steel; high steels are those containing a large proportion of carbon.

Steel has been produced, as an experiment, by heating the iron to be converted in contact with diamond.

The earliest discovery or invention of steel is in the remote past, but the nature of the change in the iron was not understood. It was prepared by fusion, and not by cementation.

It would seem that the distinction between qualities was known and utilized B. C. 335, as the Persian and Damascene sword-blades were then in high repute, and were formed of slips or thin rods of iron and steel, bound together with iron wire and united by welding.

The terms used in the original Scriptures are translated "iron" and "steel" according to the context. The "iron" of that day was in fact a "steel," being procured by a single or repetitive process from the ore. See IRON; MALLEABLE IRON.

"He shall flee from the iron weapon, and the bow of steel shall strike him through." — Job xx. 24.

"Shall iron break the northern iron and the steel?" — Jer. xv. 12.

Ezekiel, about 600 B. C., speaks of the "bright iron" of Javan; and Hesiod, 850 B. C., of "bright iron" and "black iron," the former probably meaning steel: it may have been a different quality, and have taken a finer polish, as steel does.

Steel was imported from the country of the Chalybes into Greece about 500 B. C., and the name *chalybs* signified steel. The description of steel-making by Aristotle shows that the process was repetitive, and that dross was eliminated. Heating several times in contact with charcoal was held to purify it. It was not understood till comparatively lately that steel is a carburet of iron.

Polybius, the friend of Scipio Africanus, states that the helmet and armor of the Roman soldier were of bronze, but that the sword was a cut and thrust blade of Spanish steel. The forgers of the latter were in Celtiberia, now New Castile and Arragon. The town of Bilbilis and the little river Salo, a tributary of the Ebro, are celebrated as the center of the iron district.

Diodorus, a Greek, who wrote about 50 B. C., describes the Celtiberians as armed with weapons of excellent temper. He states that they buried the iron till part was consumed by rust, and that the remainder made swords strong enough to cleave a shield or helmet, or cut through a bone. Some wrought bands that were recovered with the piles driven to support the abutments of old London Bridge were bought by a cutler, who became celebrated for the surpassing excellence of the blades forged from the "old scrap-pile."

Pliny gives a long description of iron and the modes of its manufacture.

The varieties of steel in modern practice are very numerous, many of them having peculiar adaptation to a certain specific purpose in the arts; among them are: —

a. Natural steel. A crude steel obtained by the finery process, i. e. by removing the impurities of cast-iron by jets of air blown into the bath of molten metal, which is covered by a layer of charcoal. It is very similar in its properties to puddled steel, and is used as a raw material for crucible cast-steel.

The *natural* steel of Germany is made directly from the ore, and sometimes from pig-iron in the Catalan forge. It is stated by Bergmann to be: —

Iron	96.84
Manganese	2.16
Carbon	1.00
	100.00

The ore is smelted, as for iron, in blast furnaces; but the blast is weaker, and is directed, not upon the metal, but in a horizontal direction above it. The metal is kept covered with slag, and is not disturbed by stirring. When the iron is judged to be sufficiently refined, it is taken out of the furnace and forged.

b. India steel, or wootz. A steel made in India by melting the crude native iron (containing a small percentage of carbon) in crucibles, in which pieces of wood or leaves are introduced. The name has been appropriated by English manufacturers to their own products, which are probably ordinary cast-steel of good quality.

The mode adopted by the native East-Indian for obtaining steel is somewhat primitive, but by the exercise of skill in manipulation an excellent article is produced. It is understood to be made from the magnetic oxide of iron. The ore is stamped to fragments, and the adhering quartz separated by washing and sifting. The smelting is effected in the most primitive way; the furnace is built of clay, and not more than four or five feet high; the bellows is formed of two goat-skins, with a bamboo nozzle, tipped with a clay tube at the end which is to be nearest the fire; the fuel is charcoal. (See SMELTING-FURNACE.) By this process the Hindoo manages to obtain a most excellent steel.

The iron is heated to a low red heat, and is beaten for a long time with stone hammers on a stone anvil; the Hindoos having an opinion that iron implements are injurious. To convert the hammered iron into steel, it is broken into small pieces, and put into small crucibles with a little dry wood; the crucibles are stopped up with clay, and are put into a furnace, where they are entirely covered with charcoal. A blast is then applied for two or three hours; the crucibles are removed, allowed to cool, broken, and the metal removed; it has changed its character from iron to steel. The lumps of steel, called *oollies*, are sorted into different sizes for knives or small tools, daggers, spear-heads, or sword-blades, and find a ready sale in most of the markets in India, at prices varying from six to eight annas, or 24 cents a pound. There is a considerable export-trade of Indian woortz steel from Hyderabad, Masulipatam, the Deccan, and Berar to Upper India, Persia, and Damascus, the *oollies* being carried on donkeys and ponies by Byraghies and wandering tribes, who live by this trade.

c. Puddled steel, or semi-steel. A steel obtained in the reverberatory furnace by conducting the puddling process in such a manner that the iron "comes to nature" and aggregates into the solid form before the carbon is entirely removed. The product is similar in structure to wrought-iron, while the residual carbon gives it hardness and the tempering property.

d. Cement steel, or blister steel. This is obtained by piling bars of wrought-iron interstratified with charcoal in a brick compartment, which is cemented tightly to prevent access of air, and subjected inside the walls of the compartment to a high temperature for several days. Carbon is absorbed in considerable quantity.

In England, the Swedish iron is used for making the best steel. It is received in bars 3 inches wide, 5/8 of an inch thick, and about 12 feet long. These are laid up evenly, in a converting furnace, which consists of two rectangular vessels, technically called *a pair of pots*, made of a refractory silicious freestone, and supported upon solid masonry, with a firebrick top, upon which the pots rest, the brick divisions forming flues underneath. The pots are $3\frac{1}{2} \times 3\frac{1}{2}$ feet, and 12 feet long, and are placed parallel to each other, but 18 inches apart, forming flues, extending up the sides and ends of the pots into the fire-brick vault which covers the whole. This vault has an arched opening at each end, for charging the pots with iron, or taking out the charge when converted into steel. During conversion, they are bricked up and plastered with clay. There is also a small opening over each pot, through which bars can be put. Out of the vault rise three chimneys on each side, opening into a large cupola. The fire-grate is under the middle flues and the whole length of the pots, with a door at each end, kept closely shut, except when being charged. Each pot has a stratum of charcoal evenly laid on the bottom, above which a layer of bars is placed, and covered half an inch deep with charcoal; bars and charcoal are thus laid alternately until the pot is nearly full, and finished off with a thicker covering of charcoal over the top. The pots when filled are covered over with five inches of *wheel swarf*, which contains iron and steel in minute particles, and, becoming partially fused when hot, perfectly protects the steel underneath from the action of the air. Each furnace has a five-inch opening through the walls and into the center of one end of the pots, through which two or three of the top bars project, the opening being filled up with fine ashes, well rammed to exclude the air. The fire, gradually raised to great intensity, is kept up for six or eight days. A furnace holds about 16 tons of iron, and is considered to be well worked if 14 to 16 heats are got out in a year. See Fig. 1197.

When the conversion is supposed to be nearly complete, a top bar is drawn, and, when cold, is broken; its condition shows the state of the whole, and the fire is regulated accordingly. A second or third bar is subsequently drawn, and when the conversion is considered to be complete, the fire is allowed to go out. In four days the man-holes are opened to hasten the cooling, and in four more the steel, still hot, can be taken out. A full furnace charge is called a *heat of steel*, and, according to the degree of carbonization required, is called a *spring* heat, a *cutler's* heat, a *shear* heat, a *file* heat, or a *melting* heat. The surfaces of the bars are now covered with thin blisters, hence the name *blister steel*. These terms do not apply to the *temper* of the steel, but to the length of time in the furnace. This steel is useful for some purposes, but is not adapted for making tools for working wood or metal. See also Fig. 1198.

Shear and spring steel. The bars are now broken and sorted by experienced workmen into the various tempers; the hardest are laid aside for melting, and the softer hammered into shear or spring steel. Those required for shear-steel are broken into lengths of about one foot; are next laid upon each other, three or four together; then heated in a furnace to *welding* heat, and drawn under the hammer or "tilted" to the size intended. It is then *single-shear* steel. If again broken, heated, and hammered, it becomes *double-shear* steel, an extra quality used for best table cutlery and other first-class purposes. Spring-steel is made from bars passed at a red heat between grooved rollers until reduced to the particular size required. Shear and spring steel are the chief, if not the only qualities manufactured direct from the converting furnace.

Mushet's process for making steel, patented in England in 1801, consists in placing malleable iron in scraps or bars in a crucible with a due proportion of powdered charcoal, pitcoal, graphite, or other carbonaceous substance, and subjecting it to intense heat.

Rich and pure iron ore may be inclosed with carbonaceous matter, and treated with heat in a similar manner.

By varying the quantity of the carbonaceous matter, steels of different quality are obtained. In employing wood charcoal from 1/70 to 1/90 of the weight of the iron is usually sufficient. From 1/60 to 1/40 produces a very fusible metal suitable for steel castings.

e. Cast-steel.

Cast-steel was invented in 1740 by Benjamin Huntsman, near Sheffield. His process was to place small fragments of blistered steel in a crucible of fine clay, place some broken green glass above, lute the cover, and then place the crucible in a furnace. When melted, the crucible was withdrawn and the contents poured into an iron mold. Huntsman was a German; born in 1704; began life for himself as a clock-maker.

This is essentially the process yet followed in producing fine cast-steel, suitable for cutlery and tools for working in metal and wood.

Previous to the successful efforts of Bessemer, various efforts had been made to produce cheap steel on a large scale.

f. Bessemer and kindred steels.

For many years it had been believed in England that Swedish iron derived its valuable steel-producing qualities from the presence of manganese.

Heath, of Sheffield, England, in 1839, devised a mode of combining carbon with manganese to produce a carburet, which converted English iron into very good steel. He obtained a patent for it. Unfortunately, he did not patent his improvement, which consisted in putting into the furnace the elements of his carburet (carbon and manganese). The Sheffield manufacturers defied him, and, after years of litigation, he died, broken-hearted, in 1850.

Macintosh, Scotland, patented a process for converting malleable iron into steel by subjecting it to a stream of carbureted hydrogen gas, evolved from coal under distillation. The iron is inclosed in a crucible in the furnace, and when it has arrived at a proper heat a stream of gas is directed upon it by a pipe.

A new method of steel-making, which has recently been patented in France, is as follows: (1) Employing ammoniac and carbonated hydrogen gases in certain proportions for the cementation of iron on a large scale, the gases acting simultaneously, and at the moment of their production, by the decomposition at a high temperature of a mixture of sal ammoniac and a substance supplying proto or carbonated hydrogen; (2) for the making of cast-steel from scraps of iron, cemented by the process above described, and melted by the same operation; and (3) the fabrication of steel by the fusion of cemented iron sponge

produced by the reduction of ores, forge scoriæ, etc., by means of gas derived from peat or hydrogenous matters.

Newton, 1848, Marcy, 1849, directed a stream of air, or of air mingled with carbonic oxide, upon the surface of the molten metal in a reverberatory furnace. This failed for lack of penetration.

Nasmyth employed blowing-tubes to inject steam below the surface of the metal, to agitate the iron mechanically, and by the decomposition of the steam furnish oxygen for the removal of the carbon, and hydrogen for separating the sulphur and phosphorus. The process failed by too great a reduction of temperature.

Martien added air to the steam.

Bessemer used air alone, introduced through tubes.

Berard added hydrogen gas, generated in a separate vessel, to the air of Bessemer, the intention being, as with Nasmyth, to remove the sulphur, phosphorus, and arsenic.

Krupp's steel is prepared from the spiegel ore of Siegen by puddling and then melting in crucibles. The success of the process is due to the quality of the ore, and the remarkable size of the blocks resulting is due to the skill of the workmen, the extent of the furnace, and the power and manageability of the machinery.

The establishment of F. Krupp, at Essen, Prussia, manufactured, in 1873, 150,000,000 lbs. of cast-steel, against 130,000,000 in 1870; 8,810 workmen, and engines amounting to 9,595 horse-power, are employed. 528 furnaces for smelting, heating, and converting; 169 forges, 260 welding and puddling furnaces, 245 coke-furnaces, 130 various other furnaces, 342 turning-lathes, 130 planing-machines, 73 cutting-machines, 172 boring-machines, 94 grinding-benches, 209 various other machines, 174 steam-boilers, 265 steam-engines (from 1,000 horse-power downward), and 58 steam-hammers (from 30 tons downward), were in use. The various articles manufactured consist of axles, wheels, tires for railways, rails, springs for railway and tramway cars for mines, axles for steam-ships, boiler-plates, rollers, tool-steel, cannon, gun-carriages, etc.

By Knowles's method a retort is used instead of a crucible, and the crude iron is mixed with hot gases rich in carbon.

Bessemer's process was introduced to the notice of the British Association at Cheltenham in 1856. It consists in converting pig-iron into malleable by driving air through the molten metal to burn out the impurities, and then converting it into steel by the addition of the requisite ingredient. The effect of the blast is to burn out the silicon, carbon, sulphur, and phosphorus. See BESSEMER-PROCESS; CONVERTOR; PLANT.

Mr. A. L. Holley's improved Bessemer apparatus is designed to enable a greater number of charges to be converted into steel in a given time.

For this purpose the convertors have each two or more movable bottoms, which are run to or from the body of the convertor on cars, and raised and lowered by a hydraulic lift. The tuyeres are packed with dry material, so that no time is lost in waiting for it to set. The two convertors are both placed on the same side of the ingot-pit, and the chimneys are in the walls of the building, so as not to interfere with the cranes.

In Atwood's process, iodide of potassium is used to take up the phosphorus existing in the iron.

While the usual English method of making steel has been by the *cementation* process, *raising* the amount of carbon in *bar*-iron, on the Continent of Europe the *raw* method has been a favorite, pig-iron being *puddled* in a charcoal furnace, *lowering* the amount of carbon in the *cast*-iron.

Riepe's process, used by the Lowmoor Iron Company, consists in adding to the pig-iron in a puddling-furnace a little iron-slag, salt, clay, and oxide of manganese. The molten metal is worked beneath the scum and rolled into balls.

Captain Uchatius, of the Imperial Arsenal, Vienna, granulates cast-iron by running it from the furnace into agitated cold water. The grains are put into a crucible with an oxygen-yielding material such as spathose iron ore, and the pig-iron gives up some of its impurities to the oxygen.

Chenot's method is to incorporate with a peculiar iron carbonaceous matters, such as fat, resins, tar, etc.

Mushet fuses malleable iron with carbonaceous matters in crucibles.

Vickers combines iron scrap, ground charcoal, and black oxide of manganese.

Heaton's process consists in the use of nitrate of soda, producing what he terms crude steel, which may be afterward converted into pure iron or steel. He uses a cylindrical convertor, in the bottom of which is placed a charge of Chili saltpeter (an impure nitrate of soda), mixed with quartz sand, and often with lime, binoxide of manganese, fluor spar, or other material, covered with a perforated iron plate, for the purpose of dividing the generated gas into a number of small streams and preventing its too rapid formation at the beginning of the process. The molten iron is run into the convertor from the blast furnace or a cupola, and the operation commences, slowly at first, but afterward, owing, as is supposed, to the breaking up of the iron plate, very energetically, and is generally completed in from 2½ to 5 minutes. The metal is allowed to cool in the convertor, and when still red-hot is broken up, preparatory to being made into steel, either in the reverberatory furnace or in crucibles.

In Ellerhausen's process, iron ore, generally the magnetic oxide, is mixed with melted pig-iron, in order to take up the carbon, so as to reduce the metal to steel or wrought-iron, as may be desired.

g. Siemens-Martin steel is obtained by melting a certain quantity of cast-iron in a Siemens furnace and adding wrought-iron until the bath attains the desired degree of carbonization. Ferro-manganese is then added to remove the oxides and free oxygen, and the bath is run into ingot-molds.

"In the Martin-Siemens reverberatory furnace the decarbonization of the pig-iron is effected by the reactions, upon the molten bath, of wrought-iron or ore and of the furnace-flame. The operation is slower and more completely under control than that of the Bessemer method; and the ease and regularity with which any desired grade of steel can be produced has led to the employment of this method for some purposes to which the Bessemer is less adapted, — for instance, the manufacture of boiler-plates, machine and tool steel, etc. But the gradual perfection of the arrangements and manipulations of the Martin system, in such works as those of Siemens in Great Britain, Martin in France, and also the establishment at Terre Noire in the South of France, has brought about a competition between Bessemer and Martin steel on the chosen ground of the former, namely, the manufacture of rails.

"One of the advantages of the Martin process in this competition seems to be its capacity of employing old iron rails (usually containing phosphorus) in making new steel rails. It does not appear that the treatment eliminates the phosphorus, but, on the contrary, that a steel is produced containing more phosphorus than was hitherto supposed consistent with tenacity. The secret is asserted to lie in the reduction of the quantity of carbon in proportion as that of phosphorus is increased, or, as it has been expressed, in the substitution of phosphorus for carbon as a 'steelifying agent.' Phosphorus has been universally regarded as the great foe of the steel manufacturer; and if by this means it can be utilized as an ally, a very large amount of material will be rendered available for making steel, and the transformation of thousands of miles of iron tracks on the railroads of the world into tracks of steel will be greatly facilitated. It must be added that engineers and metallurgists are still doubtful about 'phosphorus-steel rails,' though the reports concerning their use in France for a year or two past have been generally favorable.

"The decisive effect produced by minute proportions of a substance like phosphorus in combination with iron may be seen in the fact that one tenth of one per cent of it is considered all that ordinary 'carbon-steels' will bear, while even the 'phosphorus-steel,' of which so much is said, never contains so much as half of one per cent; and usually, we are informed, the proportion of phosphorus in it is about 0.35 per cent, — that of carbon being perhaps 0.12 per cent." — RAYMOND.

Siemens's apparatus for producing steel or iron direct from the ore consists of a set of four regenerators with reversing-valves and gas-producers; the converting chamber is of iron, rests upon anti-friction rollers, and is rotated by gearing. Bauxite, a mineral containing a large proportion of alumina and peroxide of iron, is mixed with small proportions of clay and graphite to form the lining.

The ore is broken into fragments not larger than peas, and, mixed with lime or other *flux*, is charged into the chamber, which is slowly rotated until the mass becomes red-hot; about 25 or 30 per cent of small coal of uniform size is added, and the velocity of rotation increased. A rapid reaction ensues; the peroxide of iron, being reduced to magnetic oxide, commences to fuse, metallic iron is precipitated by the carbon, while the fluxing materials form a slag with the silicious portion of the ore. The rotative velocity is now reduced, the mass as it turns over continually presenting a fresh surface to the heated lining of the chamber and to the flame; carbonic-oxide gas is evolved from the mixture of ore and carbon, and heated air only is introduced from the regenerator to effect its combustion within the chamber, the gas from the producers being nearly or entirely shut off. When the reduction is nearly complete the rotation is stopped, the fluid slag drawn off; the chamber is again set in motion to form the iron into balls, which are shingled in the usual way.

The process may be so conducted as to produce a steel which is afterward transformed into cast-steel by transferring the balls while hot directly to the steel-melting furnace, without being hammered or shingled. This method is preferred, but the metal may be thus converted entirely within the rotating chamber. In this case the amount of carbonaceous matter is somewhat increased; and after the cinder is tapped off, from 10 to 15 per cent of ferro-manganese or spiegeleisen is thrown in, and the heat rapidly increased by urging the influx of heated air and gas from the regenerator. This reduces the metal to a fluid state, when it may be drawn off into molds and afterward hammered or rolled into bars.

h. Granulated steel is made by running melted pig-iron into a cistern of water over a wheel. The fragments are exposed to heat, imbedded in powdered hematite or sparry iron ore. These extract the car-

bon from the surface of the fragments, which are then remelted to form steel.

i. Chromium steel, — a steel containing chromium. It is made in crucibles by adding to the charge either ferro-chromium (an alloy of iron and chromium) or chromic iron ore with charcoal dust. The chromium is reduced by the charcoal and alloys with the steel, giving it great tenacity and hardness, without destroying its malleability or its tempering property.

It is described and claimed in the patent of Baur, No. 49,495, August 22, 1865. See also his subsequent patents, No. 99,624 of 1870, No. 123,445 of 1872.

The chrome is mined near Baltimore, contains 60 per cent oxide of chromium, also protoxide of iron, magnesia, and alumina, but no silica.

On account of its tensile strength it was adopted for the spans of the Mississippi Bridge at St. Louis. Dynamic tests were made in London, also at the West Point Foundry, the average strength of 12 specimens at the latter place being 179,980 lbs. to the square inch, the lowest 163,760 lbs., and the highest 198,910 lbs. The highest strength of steel given in Percy's "Metallurgy of Iron and Steel" is 132,909 lbs. per square inch. The following occurs in the report of Captain J. B. Eads, the engineer of the bridge: —

"Chromium unites with iron and forms an alloy similar in its properties to steel. Chromium is quite different from carbon in some important particulars. It is a metal, while carbon is not. It has little or no affinity for oxygen, and is not affected by excessive heating, while carbon has a great affinity for it, and by the application of heat it is liable to be burnt out of the steel. . . . This steel comes from the rolls much more smoothly than carbon steel, and works quite as easily; being capable of sustaining a greater degree of heat than the carbon steel, it takes the form of the rolls more readily. The tests made of its ultimate tensile strength are considerably in excess of the specifications. In compression almost any degree of resistance can be obtained by the addition of chrome."

It has also been used with great success in planer-saw teeth, stave-machines, rock-drills, machine-tools, etc.

j. Phosphorus steel is the invention of M. Tessie du Motay.

"He," as Holley says, "did not stumble upon a good steel, high in phosphorus, and then avoid mixtures which would give high phosphorus, but set out to make steel containing (for rail grade) .12 carbon, .25 phosphorus, and .75 manganese, as a new article of manufacture, and using cheaper materials."

In the Du Motay process, manganese plays an important part, it acting as an antidote to the large amount of phosphorus, and also in structural steels, toughening, then increasing their soundness, and, of course, as it neutralizes phosphorus, preventing red-shortness.

k. Tungsten steel, a steel containing tungsten. Its production is similar to that of chromium steel, tungsten or Wolframite being substituted for the chromium compounds. Its properties are also similar, and it is an excellent tool-steel, though great difficulty is experienced in obtaining uniformity in the product. It is also remarkable for its great magnetic capacity.

In Barron's process, tools, such as axes, hatchets, and hoes, are cast from pig-iron. They are then placed in rotating drums to remove the roughness, and afterward heated in iron boxes, with oxide of iron and other materials to remove the carbon. They are next placed in a large retort, and subjected to the action of gasoline, and also of charcoal gas, generated in two retorts, by the action of which they are in a few minutes converted into steel, and are afterward ground, polished, and tempered.

Mr. J. L. Davies, of Swansea, Wales, states that resin oil intimately mixed with about one fourth its weight of the residue of paraffine stills will restore steel which has been injured by burning.

Levallois, of Paris, has patented in France three alloys which are very hard, and are made by fusing soft iron, tungsten, and nickel, in a crucible with suitable flux.

The first quality contains 93 parts soft iron, 6½ parts tungsten, and ½ part nickel.

The second is composed of 95 parts soft iron, 4½ tungsten, and ½ part nickel.

In the third, there are 97 parts soft iron, 2½ tungsten, and ½ nickel.

The flux consists of 36 parts boracic acid, 32 parts calcined quartz, and 32 parts of washed carbonate of lime.

l. The *Damascus steel* is made from the ore by the same process which produces the *wootz*.

This is smelted from a magnetic oxide, yielding, by the crude process employed, only about 15 per cent. The ore is placed in a clay crucible with bits of dry wood, covered by green leaves of particular plants. The crucibles are luted with clay and submitted to a blast charcoal furnace. The fire is kept at the highest possible temperature for nearly three hours, and on removing from the fire and cooling, the crucibles are broken, and the steel found as a lump at the bottom. Selections from these lumps are exposed again to a red heat for several hours, and then drawn out under the hammer.

It has been long supposed that fagoting short bars, remelting, and working them over and over, was the true secret of the superiority of the Damascus blades. General Anossoff, a Russian, made many experiments with great minuteness of detail at Zlatoosk in the Ural, where were mines yielding ore. His most successful process was melting the ore with graphite in crucibles in the proportion of eleven pounds of ore with five of graphite, and $^1/_{32}$ part of iron scales with $^1/_{24}$ of dolomite as a flux. The crucible is placed in a blast furnace and kept from four to six hours.

The following are General Anossoff's requisites for the best steel: Charcoal of the clearest sort, as that from pine; a furnace of the most refractory materials; the best quality of crucibles; iron very malleable and ductile; pure native graphite, or that obtained by pulverizing the best crucibles; flux of dolomite or calcined quartz; a high temperature, and fusion continued as long as possible. The working after the crucible is cold is simply repeated heatings and forgings. The sword-blades are tempered in hot oil. The razors made from this steel are of very superior quality, but the cost is excessive; the steel being valued at $1.10 per pound. The blades produced by General Anossoff seem to be of equal value with the original Damascus blades, one of them cutting through a gauze handkerchief floating in the air, cleaving bones and even nails without injury to the edge. General Anossoff died in 1851, and it is said the cutlery made at his establishment is not of so good a quality as when he personally superintended its manufacture.

See also TEMPERING; ANNEALING.

Antoine Galy-Cayalat's process for casting steel under pressure to avoid the formation of air-bubbles, consists in providing the head of the flask with a metallic cap, which is fitted and secured so as to be perfectly tight, and, when the pouring is completed, introducing through a pipe provided with a stop-cock a small charge of an explosive compound composed of niter 80, charcoal 20; this ignites on coming in contact with the fused metal in the flask, causing a pressure equivalent to that of a high head of metal; compressing the fluid metal in the mold and expelling the bubbles of gas therefrom. See STEEL-CASTING; STEEL-PRESS.

2. A round rod of steel, having longitudinal striations, used for sharpening knives.

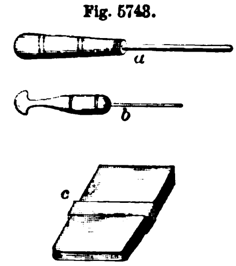
Fig. 5742.

Sharpening the Butcher-Knife (from Thebes).

In the sculptures at Thebes, butchers are represented sharpening their knives on a round bar of metal which is suspended from their girdles or from the hem of the apron, as shown in the figure. This was evidently a steel. It was for a long time supposed that steel or iron was unknown to the Egyptians, but this is disproved by the paintings and by later discoveries. Some of the sickles are represented blue and others red, indicating *steel* and *bronze*.

3. A steel is used by curriers in giving the fine, recurved edge to the knife wherewith to shave the flesh side of the hide upon the beam. The edge is brought up by the whetstone and *turning-steel*, and afterward preserved by the *finger-steel*, which the beam-man holds between his fingers while using the knife.

Fig. 5743.



Currier's Steels.

4. An angular piece of steel, which is struck with a flint to produce sparks in order to ignite tinder.

The striking of fire by flint and steel is mentioned by Virgil and Pliny. The Anglo-Saxon *fyr-stan*.

Steel-bronze. The name given to a very hard and tenacious alloy used as a substitute for steel. Its composition varies but little from that of the usual gun-metal, — 90 copper, 10 tin, — which, in making a gun, is cast upon a copper core of less diameter than the bore. The piece is then reamed out until it is ¼ inch less

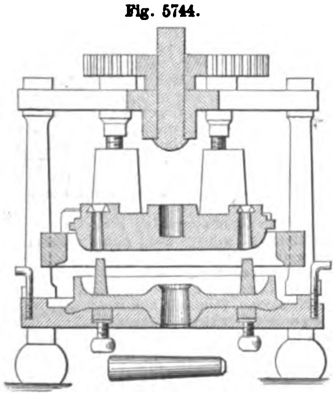
than the bore intended. Conical plugs of hard steel are then driven through it by hydraulic pressure, which confers upon the metal the peculiar qualities.

It was patented by S. B. Dean, Boston, Mass., May 18, 1869, and an order was given in 1870 by the U. S. Ordnance Office for some guns made by his process. His claim reads: "As a new manufacture, a bronze gun, in which the metal immediately surrounding the bore is put in the condition that is produced by the process of condensation set forth."

Colonel Uchatius, director of the Arsenal at Vienna, uses an alloy of 90 to 92 per cent of copper and 10 to 8 per cent of tin, and casts under a pressure of 80 tons, producing a very hard, tenacious metal, but one with little more elasticity than ordinary bronze. On cold-rolling this bronze, cast under pressure, into an ingot, its power of resistance, its elasticity, and its hardness were increased. In casting guns, a double mold with a solid forged copper core 0.05 metre in diameter was used. The cylinders obtained were 0.62 metre in diameter and 0.30 metre long; they were turned down to 0 18 metre outside, and the interior bored out to 0.08 metre. The cylinder was then opened out by means of conical steel drifts and an hydraulic press, so that it was enlarged 2 per cent. The bronze produced in this manner is declared to have all the hardness, homogeneousness, and power of resistance of steel tubes. Its wearing qualities are as great, and the cost of bronze guns made in this way is much less than steel, if the value of the old bronze be taken into account.

The plan has been adopted for the Austrian ordnance. The first cost of the steel-bronze cannon is placed at less than half that of a Krupp steel piece, and very much below that of a Whitworth compressed-steel gun, which, at a rough estimate, is about 20 per cent more expensive than Krupp's.

Fig. 5744.



Apparatus for making Cast-Steel Castings.

Steel-cast'ing. Fig. 5744 is an apparatus for making compressed cast-steel castings. The metallic molds are so arranged that the top part serves as the follower of a press, and is operated upon by screws. The top fits closely into the matrix, and is provided with ingates for the metal, which are closed by slides when the mold is full. The pressure is applied to the metal while in a melted state, by means of the screws, with sufficient force to expel the air and gas from and solidify the metal. See also STEEL-PRESS.

Steel'er. (*Shipwrighting.*) The foremost or aftermost plank in a strake, which is dropped short of the stern or stern-post of a vessel.

Steel-fur'nace. A metallurgic furnace in which ore or iron is treated for the production or refining of steel.

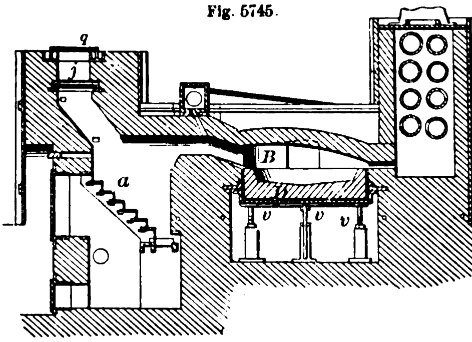
Steel is produced from bar-iron in furnaces in which the bars are built up with charcoal and heated. See CEMENTATION-FURNACE.

Other furnaces operate upon ore of certain kinds to produce steel directly.

Again, other furnaces operate upon steel of a certain quality which is broken up and heated in crucibles. See CAST-STEEL.

Fig. 5745 is a furnace for melting and refining steel. An open hearth *D* of refractory material is inclosed in a metallic pan, which is supported and made adjustable vertically by means of

Fig. 5745.

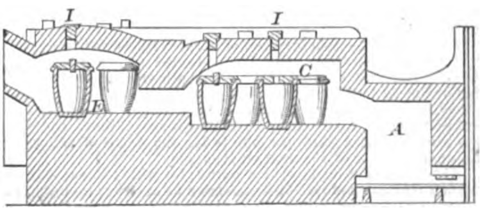


Steel-Refining Furnace.

screws *v v*. The upper part of the fuel-chamber *j* is provided with a slide, on which the fuel is deposited, and has a cover *q*, made gas-tight by an annular space containing water or sand. *a* is the fire-grate The furnace *B* is reverberatory.

In Fig 5746, *A* is the fire-chamber; *C* a crucible-chamber, from which the products of combustion pass to a second crucible-chamber *E*. Each chamber is provided with apertures at top, closed by plugs *I I*. The crucible-covers are also provided with plugs, the construction being such that the metal can be

Fig. 5746.



Steel-Furnace.

readily inspected during the process, and the crucibles removed from or placed in the furnace at any stage of the process without interrupting the operation.

Steel-head'ed Rail. A railway-rail having an upper surface or tread of *steel* welded on to a body of iron. The steel is usually so disposed in the fagot as to form the head when the rail is rolled. See RAIL.

Steel-mill. 1. A mill with metallic grinding-surfaces, usually of steel, but sometimes of cast-iron, as being cheaper and sufficient for the purpose.

Coffee and spice mills are instances.

2. (*Mining.*) A steel wheel revolving in contact with a flint, to make a light in a mine. A device used before the invention of the *safety-lamp*. See Fig. 2952, page 1314.

Steel-pen. Metallic pens, or at least graving instruments, would appear to be coëval with the introduction of metal. The first implement of the pen kind was probably a sort of flint stylus, with which the primitive race whose remains are found in the bone caverns of France traced the rude outlines of the mammoth and the reindeer upon the bones of animals. Metallic pens or gravers appear very early in history, those of iron being referred to by Job and by Jeremiah. These may have been either gravers or chisels. See PEN.

The ordinary pen of the Egyptians and of the ancients in general was a reed, cut and split as in the modern practice. This is still employed among the Orientals. See PEN.

The quill-pen was first introduced in the sixth century A. D., but did not entirely supplant the reed until long afterward.

Job refers to three modes of writing: —

Printed (traced) *in a book.* Probably on a sheet of linen, bark, or a palm-leaf; for this was before the invention of parchment by Eumenes II. of Pergamos (197 B. C.). The use of the *papyrus* was local, though very ancient, and Pliny ("History

of Nature," Lib. XIII. ch. 11) was much mistaken in stating that it was not used before the conquest of Egypt by Alexander the Great, 332 B. C. Rolls of papyrus inscribed by a reed pen and a pigment are found in the mummy envelopes, and were common in ancient times. Bark is referred to by Pliny as common. Palm-leaves are yet used in Southern Asia for this purpose, the writing being done with an *iron pen* or pointed instrument, which etches through one of the layers of cellular matter on the leaf; coloring matter is then rubbed into the channels made by the stylus.

Graven with an iron pen and lead. If this be the correct mode of analyzing the sentence, it refers to the mode of writing by a pointed instrument on a leaden tablet. Pausanius (Lib. XII. ch. 31), giving an account of the Bœotians, who lived near fount Helicon, states that "they showed me a leaden table near to the fountain, on which Hesiod's works were written; but a great part had perished by the injuries of time."

In the rock forever. Chiseled or engraved inscriptions on tablets of stone or on the vertical faces of rocks and cliffs. It seems hardly necessary to multiply instances of the carving of inscriptions on rocks. The Egyptian hieroglyphics are as old as Osymandyas (2100 B. C.). The sarcophagi of Egypt and Phœnicia are elaborately carved with inscriptions in their respective characters.

Thompson ("The Land and the Book"), in speaking of the Pass of Dog River, says: —

"In this grand, wild gorge is an assemblage of ancient mementos to be found nowhere else in a single group, so far as I know.

"That old road, climbing the rocky pass, along which the Phœnician, Egyptian, Assyrian, Persian, Greek, Roman, Arab, Frank, and Turk have marched their countless hosts for 4,000 years, has much to tell the student of man's past history, could we but break the seal and read the long roll of revelations. Those faintly cut emblems of Sesostris; those stern, cold soldiers of Chaldea; those inscriptions in Persian, Greek, Latin, and Arabic, — embody a chain of history which we long to solve." See PEN.

The original flexible iron-pen of modern times was an experimental affair probably, and is mentioned by Chamberlaque, 1685. The first steel-pen in regular use was made by Wise, in London, in 1803, and for several years thereafter. Under great discouragement he persistently carried round his wares, and gradually broke the ground for the Hawkinses, Gillotts, and Perrys who succeeded him. To him is due the credit of being the original inventor of the modern steel-pen.

Wise's pen was made with a barrel, by which it was slipped upon a straight handle. In its portable form it was mounted in a bone case for the pocket.

Perry's first pens were of steel, rolled from wire, the material costing 7 shillings a pound. 5 shillings each was paid the workman for making them; this was afterward reduced to 36 shillings per gross, which price was continued for several years.

Joseph Gillott, originally a Sheffield cutler, and afterward a workman in light steel articles, as buckles, chains, and other articles of that class, gave a great impulse to the steel-pen manufacture, 1822. Previous to his entering the business the pens were cut out with shears and finished with the file. Gillott adapted the stamping-press to the requirements of the manufacture, as cutting out the blanks, forming the slits, bending the metal, and impressing the makers' name on the pens. He also devised improved modes of preparing the metal for the action of the press, tempering, cleansing, and polishing, and, in short, many little details of manufacture necessary to give them the required flexibility to enable them to compete with the quill-pen. One great difficulty to be overcome was their extreme hardness and stiffness; this was effected by making slits at the side in addition to the central one, which had previously been solely used. A farther improvement, that of cross-grinding the points, was subsequently adopted. The first gross of pens with three slits was sold for £7. In 1830 the price was $ 2.00; in 1832, $ 1.50; in 1861, 12 cents, and a common variety for 4 cents, a gross. About 1,300 tons of steel are annually consumed, the number of pens produced in England alone being about 1,000,000,000.

The steel used is a very fine quality of spring-steel, supplied to the pen-makers in sheets 5 feet long by 18 inches wide. These are cut into strips of certain widths according to the size of pen required, packed in cast iron air-tight boxes placed in a furnace and kept at a red heat for about 12 hours; they are then removed to a cooling muffle, and very gradually cooled. The strips are then pickled to remove the scale, and afterward cleansed by rolling in revolving tubs with emery. They are next passed through a series of rolls to reduce them to the proper thickness, which varies greatly in different styles of pen. After rolling, each strip, for first-class work, is gaged with a gage which indicates differences so small as the 1,000th of an inch, and those varying from the true thickness are thrown out. The strips are fed by hand to presses having dies, which cut out the blanks. Another operator takes the flat blanks and feeds them to a fly-press, which cuts the perforation or perforations and the side slits. After piercing they are placed in sealed iron boxes, heated and annealed for 18 hours. Each blank is then stamped in another pass with the maker's name and the device, if any. The metal, now very soft, is shaped to the proper curve by means of fly-presses of heavier construction; barrel-pens are passed through two presses successively. They are then hardened. For this purpose they are placed in small iron pans and heated to a regulated degree of heat; this operation is conducted with great nicety. When the exact heat has been attained, the pans are taken out of the furnace and emptied into a tank containing oil; by this means they are suddenly cooled and rendered extremely brittle. Having been cleansed they are next put in a revolving iron barrel and heated over a fire, letting down the temper and rendering them elastic. In order to whiten them, if this is desired, they are placed in revolving barrels with emery, otherwise they remain of a brown or blue color.

To this succeeds grinding, which is effected by passing the pen lightly backward and forward several times over a small revolving emery-wheel, an operation requiring great delicacy of manipulation.

The central slit is then made by a fly-press, provided with nicely adjusted gages for holding the pen, and two cutters with sharp, smooth, strong edges, one of which cuts into the nib on each side. The points in the better class of pens are now rounded, and the pens polished. They are next colored by heating, as in tempering, and then lacquered or varnished. Some are coated with copper, aluminium, silver, or gold. Finally, in some establishments, each pen is examined with a magnifier to find out defects which may have previously escaped observation. The defective ones are thrown out, and the remainder are then ready for being placed on cards or boxed.

Steel-plate En-grav'ing. This art does not necessarily differ essentially from copperplate engraving; the change, however, in the material operated upon has led to various modifications in the process which could not have occurred with copper; to wit, the inherent capacity of the metal for hardening and softening.

Like copperplate, steel may be engraved by various modes, in *line*, *stipple*, *mezzotint*, *aquatint*. (See ENGRAVING, page 804, where a list occurs of the various modes, each described in its alphabetical place.) The prime art of engraving, and the one to which artists refer when speaking of engraving as an art, is known technically as *line-engraving*, in which the work consists of lines of various forms, the characters of skin, hair, fabric, wood, metal, ground, foliage, water in motion or calm, cloud, or sky, are given by various kinds of lines; the force and prominence being due to the depth, width, and nearness of the lines, enabling them to hold a greater body of ink in the places where depth of color is required, according to the effects required in the picture.

The origin of the art of engraving is very ancient, and is referred to in ENGRAVING, page 804; and COPPERPLATE ENGRAVING, page 618; that of *steel*-plate engraving can hardly be said to have existed previous to Jacob Perkins, of Massachusetts, the inventor of the *transfer-process*. This is described under BANK-NOTE ENGRAVING, page 228, and the *transfer-press* is shown and described under that caption. (See also TRANSFER-PRESS.) It was invented by Perkins, and brought into operation by him in England about 1837, the firm name of "Perkins, Fairbairn, and Heath" soon becoming famous in this branch of the art. The system, however, has never flourished to any notable extent in England, the Bank of England authorities, it was thought, taking a dislike to it as a foreign innovation, and preferring a system which does not produce artistic results, but those of a certain clear and clean precision and unvarying character. They have also, as mentioned in page 229, adopted *surface-printing*, as distinguished from the ordinary copperplate printing (see pages 618, 619). The Bank of Ireland adopted the Perkins method.

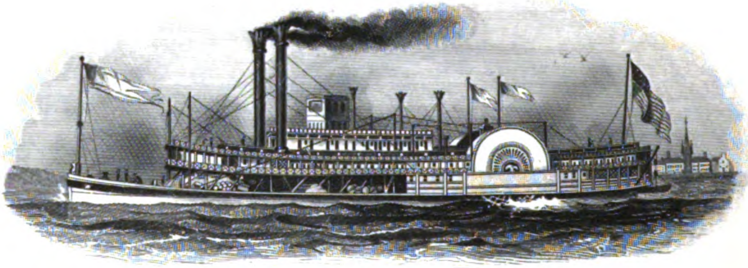
Nowhere has the transfer system been carried to so great an extent or perfection as in the United States, and especially in the Bureau of Engraving and Printing, United States Treasury Department. This bureau was organized by S. M. Clark, under the act of June 11, 1862, and has been in charge of G. B. McCartee since August, 1868. The engraving division is superintended by G. W. Casilear.

To these officers the writer is indebted for much of the folowing information, and for specimen of work on Plate LXIV. to illustrate the subject.

The process in the U. S. Treasury is as follows: —

A piece of decarbonized steel, one eighth of an inch in thickness, and somewhat larger than a bank-note, is softened by artificial means, to make it ready for the engraver, who is necessarily an artist of great skill and experience. The engraving of a single die often occupies many months, but, of course, this is a variable element, depending upon the difficulty and size of the work. The principal engraved work of the bureau consists of vignette portraits and the ornamental work upon bank-notes, with which all are familiar. The *denomination counters*, consisting of a variety of oval and circular forms interlacing each other in a series of lines and elongated dots, thus forming curious and complex figures, are executed by a geometrical lathe, a complicated and ingenious mechanism having almost kaleidoscopic powers in the production of geometric figures and designs. This is described under ROSE-ENGINE, pages 1983, 1984. See also GEOMETRIC LATHE, page 963.) When the engraver's work is completed, being in *intaglio*, the steel block, now called

STEEL PLATE ENGRAVING



WILSON SEWING MACHINE C° MANUFACTORY.
Grand Crossing, Chicago, Ill. U.S.

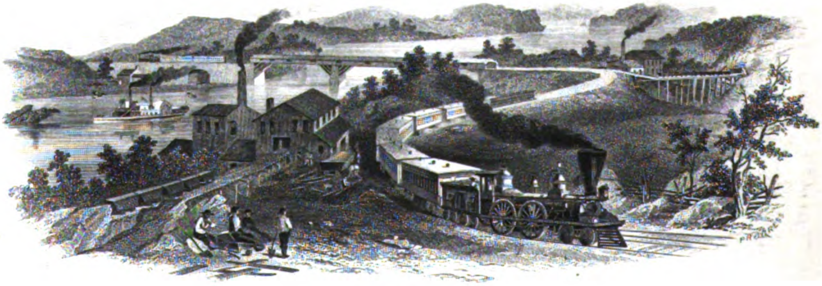
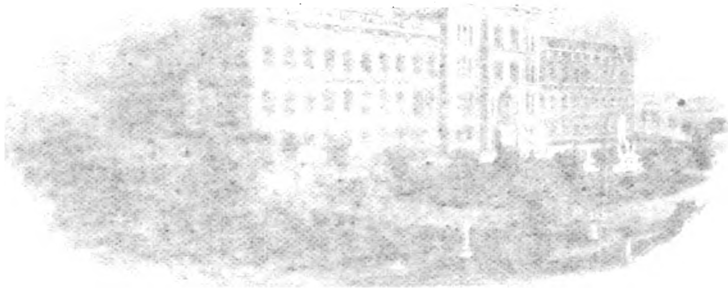


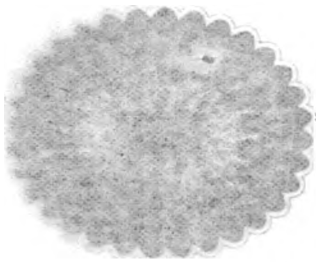
Plate LXIV

See Page 2368.

WASHINGTON



MANUFACTORY



a *bed-piece* or *die*, is subjected to the hardening process. It is inclosed in an iron box filled with charcoal of bone or ivory, and heated to a white heat, after which it is withdrawn and plunged into a bath of oil, a process familiar in the arts. Having thus been hardened, it is placed upon the bed of a TRANSFER-PRESS (which see), a decarbonized cylinder roll adjusted over it, and then submitted to pressure, the roll being moved backward and forward until it has received an impression of the original plate in *relievo*. (See ROLLER-DIE, Fig. 4403.) The roll itself is then hardened, and is capable, by means of the transfer-press, of repeating the original engraving upon the softened steel-plate from which the notes are to be eventually printed.

As the different portions of a note are upon separate rollers, great care is required in assembling the various impressions, each being in turn adjusted above the portion of the plate where its design is to occur. This is originally a matter of extreme delicacy, requiring taste and care of no ordinary degree, but as necessity occurs for making other exact copies of the same engraving, a register is kept of the exact position of the roller relatively to the surface of the plate for subsequent guidance. The notes are printed in sheets of four, so that the necessity for this accuracy occurs even in the first plate, as it afterward recurs in the preparation of succeeding plates of the same denomination.

Plate LXIV. illustrates several features in bank-note engraving: the vignettes executed in line-work by etching, graver, and ruling-machine originally, although the plate from which the impression is taken is the result of the transfer process described. At the bottom is a specimen of the work of the *rose-engine*, and is known technically as a *counter*, forming a shield, label, or escutcheon, according to shape, on which a number, as "500" or "1,000," is worked, as familiar, especially in smaller denominations, to all of us.

The securities of the government are printed on *distinctive* paper, made by J. M. Wilcox, of Glen Mills, Delaware County, Pennsylvania. The essential feature of this paper is a localized fiber imbedded in the body of the paper at the time of its manufacture on the Fourdrinier machine (1, Plate XXXVII.). By the localization of different fibers upon particular sections of the printed notes of various denominations, the raising of notes to a higher denomination is prevented. This mode of making paper belongs exclusively to the government, and as it necessitates large and expensive machinery, it furnishes an additional safeguard.

The mode of trimming and separating the currency is the invention of Mr. Larmon, the engineer of the bureau.

The most important feature introduced into steel-plate engraving since the invention of the transfer-process by Perkins is an adaptation of the process by G. W. Casilear, the superintendent of engraving, to the reproduction of engraved letters and script by rolling in the separate letters of a word from a roller-die which has all the letters of the alphabet on its periphery. It was formerly the practice to engrave each line of lettering, which was then taken up on a roller and transferred to the plate, as described with artistic designs; but, by Mr. Casilear's method, a complete alphabet of any required style, plain, ornamental, or script, is engraved on a plate and taken up on a roller, which is then used, one letter at a time, to produce any word or line required upon the plate which is to furnish the impressions. A force of two men is now sufficient to do the work formerly done by twelve, and in a more accurately uniform manner.

Other improvements have originated in the bureau, among which may be cited devices to prevent the alteration of numbers; an automatic register adjusted to every press and to the paper machinery, to keep an accurate account of every sheet worked; a process for water-proofing notes and fractional currency; the adaptation of power to the numbering-machine; an improved medallion-machine which rules with greater precision and celerity than by previous methods; a peculiar process by which the seal is attached by SURFACE-PRINTING (which see).

It may be added that the note itself is the joint product of peculiar paper and of impressed designs of the ordinary plate-printing process and of the surface process; the rose-engine work is capable of being worked either way; and by an adaptation of Mr. Casilear the medallion work can be made of a compound series of crossing lines, giving a network appearance and a texture which produces very happy effects. See SURFACE-PRINTING.

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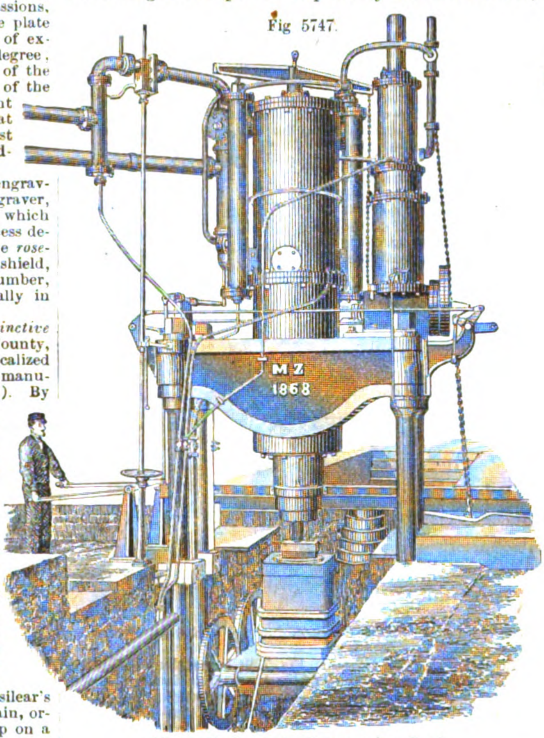
Fig. 5747.



Hydraulic Press for Compressing Steel.

the metal was run from the furnace into a ladle, which, by means of a turn-table crane, was conveyed to the ingot-molds, and the metal turned into the latter. The molds were placed on an ingot-carriage, and after filling they were run under an hydraulic press. See also STEEL-CASTING.

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Steel-topped Rail. A railway-rail whose *tread* or upper surface is of steel welded on to an iron body. See RAIL.

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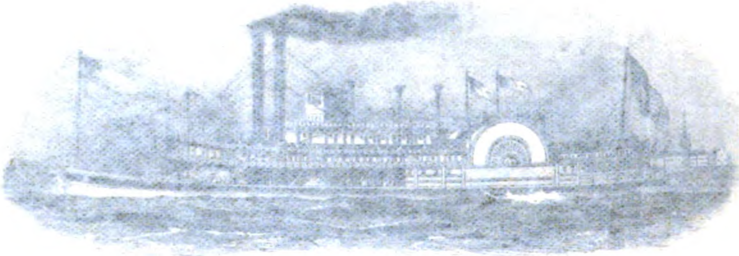

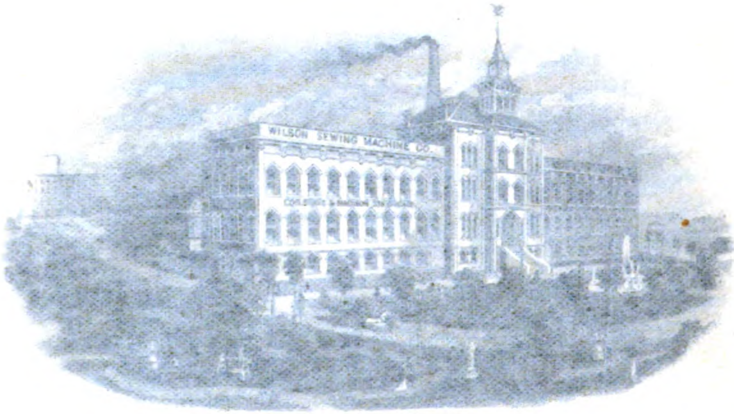

WILSON SEWING MACHINE Co. MANUFACTORY
Grand Crossing, Chicago, Ill. U.S.

See Page 1568.

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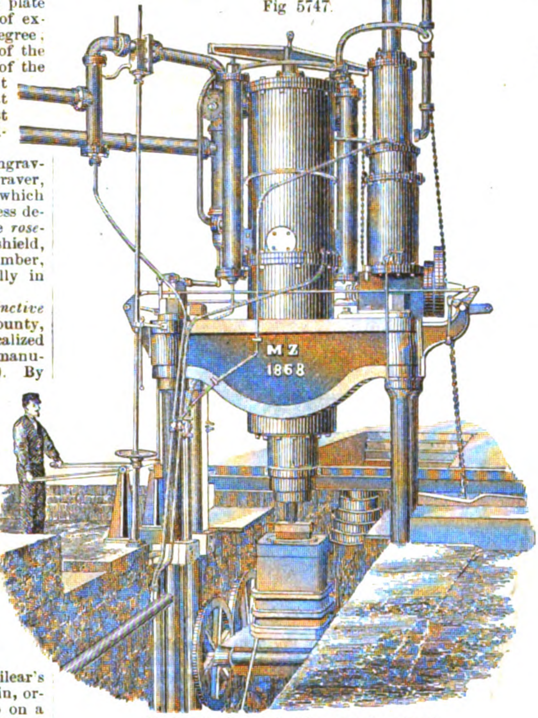

Hydraulic Press for Compressing Steel.

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Steel′yard. A weigh-beam having arms of unequal length. In the usual form (*A*, Fig. 5748), the scale is suspended from the shorter arm, and the weight is adjustable upon the longer arm, which is graduated.

A single weight is thus made available for weighing objects having different gravity.

The *balance* with equal arms (*libra*) is more ancient than the steelyard (*statera*). The latter is said to have been invented in Campania, a Greek colony. The balance-beam is the feature of the Egyptian instrument. See BALANCE.

The fundamental principle of the steelyard is given by Archimedes in his book "De Equiponderantibus." He there demonstrates that a balance with unequal arms will be in equilibrio if the two weights in the opposite scales are reciprocally proportional to the arms of the balance.

The *Chinese balance* is a tapering rod of square section, and is suspended by a silk cord. The object depends from the shorter arm, and the *standard* weight is adjustable on the larger graduated arm. Four points of suspension are provided, at different relative distances from the ends, so as to increase the range of the instrument. A corresponding set of graduations is marked on each of the four sides.

The *Danish balance* (*B*) is the inverse of the Chinese or Roman balance. The weight being attached to one end, and the object being suspended from the other, a loop forms the means of suspension of the beam, and is passed backward and forward until the equilibrium is obtained. The weight of the goods is then to the weight of the lead reciprocally as their respective distances from the loop.

Fig. 5748.

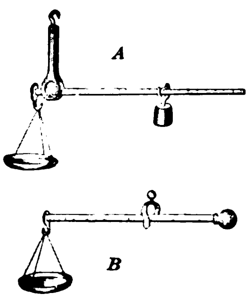
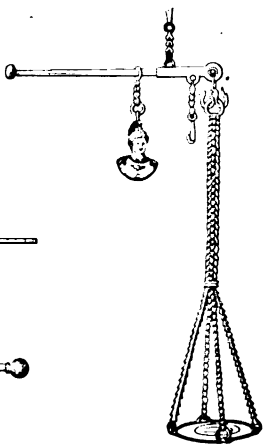


Fig. 5749.



Steelyard and Danish Balance. *Roman Statera.*

The *Roman balance* (*statera*), Fig. 5749, is mentioned 315 B. C., and had the center of gravity of the lever immediately over the point of support, so that the beam was equally balanced on its axis, the effect of the weight of the longer arm of the lever being neutralized by the addition of metal to the shorter arm. The longer arm was then divided into parts, each equal to the length of the shorter arm, and these portions were again subdivided.

A Roman balance found at Pompeii shows that they also had two centers of suspension for varying grades of weights.

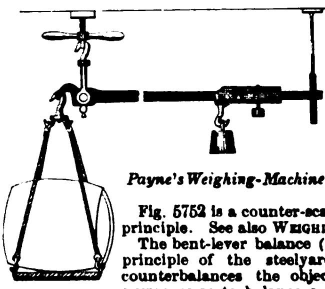
The modern *steelyard* is substantially similar to the Roman balance, but it is not regarded as essential that the unweighted beam should balance at its fulcrum. The commencement of the divisions begins at that point where, the weight being placed, equilibrium is established. To increase the range of the steelyard, the Chinese plan has been adopted of increasing the number of points of suspension. The upper and lower sides of the longer arm are graduated in accordance with the proportions which exist between the points of suspension of the beam and the load. The beam is suspended by one or the other of the hooks; the end hook swings over, so as to be in place for weighing in either case.

Beranger (France) makes a steelyard in which the weight traverses along a screw the length of the graduated arm, and parallel to it. The head of the screw is 4 inches in diameter, and divided into 100 parts, which permits the weight to be adjusted to a distance equal to $\frac{1}{100}$ part of the pitch of the screw.

Dearborn's steelyard (Massachusetts, 1800) has the center of motion, center of gravity, and point of suspension adjustable, so that it vibrates like a scale-beam when unloaded and when loaded in equilibrium.

Fig. 5750 is Payne's weighing-machine. The weights are attached to a graduated box, which slides with some friction on the beam. The larger weight is used for the hundred weights and quarters, which are indicated by the graduations on the beam. The smaller weight is employed for determining the pounds and ounces, which are shown by the graduations on the upper part of the sliding-box.

Fig. 5750.



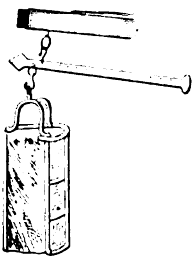
Payne's Weighing-Machine.

Fig. 5751 shows a convenient application of the steelyard to weighing bags of grain, and to articles contained in a pan.

Fig. 5752 is a counter-scale, on the steelyard principle. See also WEIGHING-MACHINE.

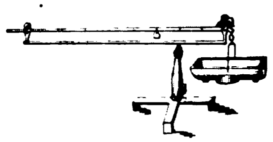
The bent-lever balance (Fig. 5753) is on the principle of the steelyard; the arm which counterbalances the object exerts a greater power, so as to balance a greater weight as it approaches a horizontal position. It is a combination of the bent-lever balance and steelyard. The cast-iron frame *a b c* is heavier toward *a*, and is pivoted at *f*; *e h* is a movable suspender, which may be applied at either of the three points *e k g*. The instrument has three scales, *l m n*; the first indicates to single ounces the weight of a body not exceeding 2 pounds when the suspender is placed at *g*; when the suspender is at *k*, any quantity between 2 and 11 pounds may be weighed on the scale *m*, which is divided into parts showing 2 ounces. The third scale *n*, with the suspender at *e*, is employed for bodies weighing from 11 to 30 pounds; it is divided to quarter-pounds. The principle may, of course, be applied to balances of greater capacity.

Fig. 5751.



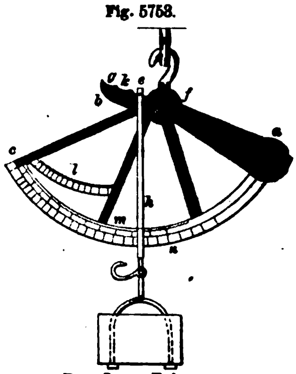
Bag-Weigher.

Fig. 5752.



Counter-Scales.

Fig. 5753.

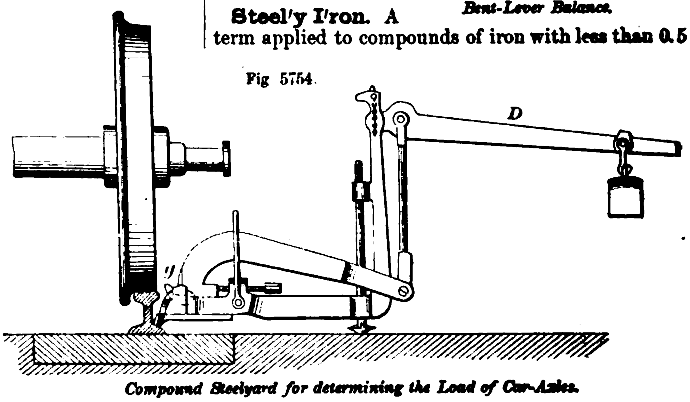


Bent-Lever Balance.

Fig 5754 is an apparatus for determining the load of car-axles. The prong *g* is introduced beneath the tread of the wheel, and the weight transferred through the compound system of levers to the graduated bar *D*.

Steel'y I'ron. A term applied to compounds of iron with less than 0.5

Fig 5754.



Compound Steelyard for determining the Load of Car-Axles.

per cent of carbon. The quality is intermediate between steel and iron. *Semi-steel.*

Steen'ing. (*Masonry.*) A well-wall, half a brick thick. *Steining.*

Steep'er. A vat in which the indigo-plant is soaked for maceration, previous to soaking in the beating-vat.

Steep'ing. The watering or wetting of flax haulm, to facilitate the separation of the woody matter (*shives*) from the fiber (*hare*).

Also to soften and remove the mucilage.

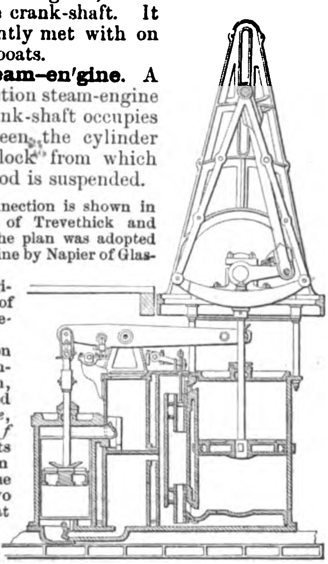
The flax-straw is tied in bundles and placed in ponds or rivers from 8 to 12 days, when it is taken out and spread on the grass. *Grassing.* See FLAX.

Stee'ple. (*Architecture.*) A spire or lantern. The superstructure above the tower of a church. See TOWER.

Stee'ple-en'gine. (*Steam-engineering.*) A form of marine engine, deriving its name from the high erection on deck required for the guides to the connecting-rod, which works above the crank-shaft. It is not unfrequently met with on American river-boats.

Stee'ple Steam-en'gine. A form of direct-action steam-engine in which the crank-shaft occupies a position between the cylinder and the slide-block from which the connecting-rod is suspended.

Fig. 5755.



Steeple-Engine.

The mode of connection is shown in the steam-carriage of Trevethick and Vivian, 1802, but the plan was adopted into the marine engine by Napier of Glasgow (Fig. 5755).

Fig. 5756 is a longitudinal section of Maudslay's steeple-engine.

a is the cast-iron frame; *b*, the cylinder; *c*, the piston, connected by the rod *d* to the cross-head *e*, guided by the wheel *f* between the uprights *g g*; rods *h*, one on each side, connect the cross-head *e* with two cranks, one shown at *i*, to which the fly-wheel shaft is connected. Two eccentric wheels *n* on the fly-wheel shaft give motion to the levers *v t* by means of connecting-rods *p*. The lever *o*, turning on the bearing *q*, works the cold-water pump *s* by the rod *r*; the lever *t*, supported on the center *v*, works the air-pump *j* and the hot-water pump; the condenser *j'* surrounds the air-pump, and is itself surrounded by one of the cold-water cisterns *k k*, which are connected by the pipe *k'*. The steam-passages are opened and closed by an eccentric *u* on the crank-shaft, through the medium of the rod *u'*, bent lever *w*, and connecting-rod *x* and lever *x'*, operating the steam-cock *y*. The valve *z* in the steam-pipe is opened or closed for a longer or shorter time, depending on the velocity of the engine, by a cam-piece on the governor spindle, operating through connecting levers. *w'* is a lever for working the engine by hand.

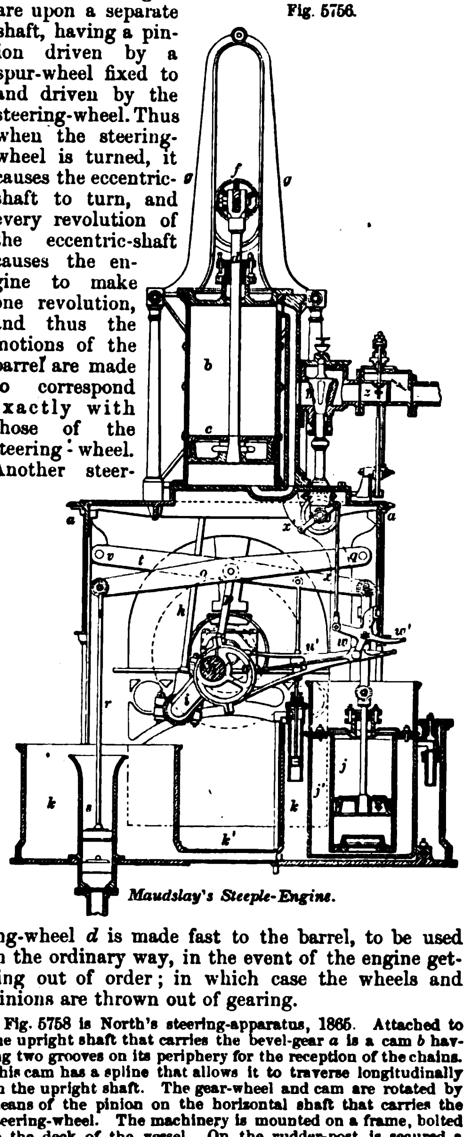
Steer'age. (*Nautical.*) The part of a 'tween-decks just forward of the cabin.

Steer'age-way. (*Nautical.*) Motion of a vessel sufficient to enable her to feel the effect of the rudder.

Steer'ing-ap'pa-ra'tus. A device in aid of the steersman, being interposed between the tiller or tiller-wheel and the rudder-head. See also STEERING-WHEEL.

In Sickel's steam-steering apparatus (Fig. 5757), in use since 1860, the steering-wheel *a* and the barrel *c* for the steering-chains are upon separate shafts, in a line with each other. On the shaft *b* of the steering-barrel is a toothed wheel, gearing with a pinion upon a crank-shaft, which is driven by a small steam-engine having two cylinders working at a right angle to each other. The eccentrics which work the slide-valves of that engine are upon a separate shaft, having a pinion driven by a spur-wheel fixed to and driven by the steering-wheel. Thus when the steering-wheel is turned, it causes the eccentric-shaft to turn, and every revolution of the eccentric-shaft causes the engine to make one revolution, and thus the motions of the barrel are made to correspond exactly with those of the steering-wheel. Another steering-wheel *d* is made fast to the barrel, to be used in the ordinary way, in the event of the engine getting out of order; in which case the wheels and pinions are thrown out of gearing.

Fig. 5756.



Maudslay's Steeple-Engine.

Fig. 5758 is North's steering-apparatus, 1865. Attached to the upright shaft that carries the bevel-gear *a* is a cam *b* having two grooves on its periphery for the reception of the chains. This cam has a spline that allows it to traverse longitudinally on the upright shaft. The gear-wheel and cam are rotated by means of the pinion on the horizontal shaft that carries the steering-wheel. The machinery is mounted on a frame, bolted to the deck of the vessel. On the rudder-post is secured a quadrant *d*, so depressed in its periphery to correspond with the eccentric action of the cam *c* in its rotation as always to present the same face to its action. The periphery of the segment has two grooves for the reception of the chain. When the rudder is "hard up" the quadrant presents its longest radius to the shortest radius of the cam, thereby increasing the power upon the rudder at the time when it is most required.

In Fig. 5759, the tiller-wheel shaft has a right and left handed screw which passes through nuts which are connected by arms to the gudgeons of the rudder-head. The rotation of the shaft draws the nuts simultaneously toward or from the rudder, and rotates the latter on its axis.

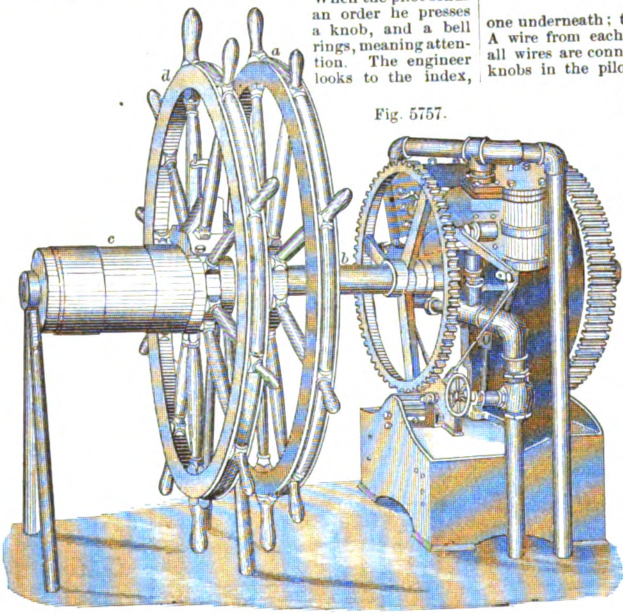
Hunt's steering and propelling apparatus (English patent) combines the two operations in one, the axis of the screw being made to oscillate in a horizontal plane by means of the tiller, while the rotation of the axis by the engine is not affected. *a* is a driving-shaft rotated by the steam-engine; *b*. a bearer; *c e d m n*, the gearing and shafting connecting the shaft *a* with the short shaft *i* of the propeller. The shaft *d* is carried down to the step *z* projecting from the stern-post, and is inclosed by a case *f* which has independent motions thereon by means of

the tiller w. The trunk g is formed by an enlargement of the case f, and incloses the lower pair of bevel-gears m and n, and the short shaft i, to whose end the propeller p p' is attached by a coupling o. This arrangement is used in the propulsion.

The steering part of the apparatus consists of a tiller-wheel w, shaft q, bearing r, and bevel-wheel t gearing into a similar bevel-wheel (see the other figure) on the end of a short screw-shaft v which takes into a quadrant x attached to the top of the case f above the plate on which the vertical plate q is stepped. When the steersman turns the wheel w, motion is communicated to the quadrant x and the case f, thereby rotating the propeller-shaft i o in a horizontal plane, and thereby varying the angle of presentation of the axis of the propeller to port or starboard, as the case may be, giving a positive lateral propulsion to the stern of the vessel.

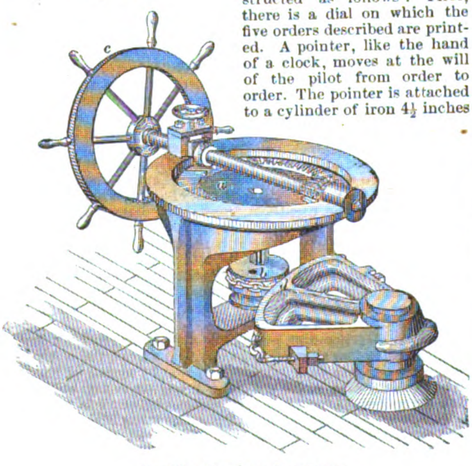
Blackie's electric signal for steering-apparatus is to enable the pilot of a vessel to communicate with the engineer or helmsman. When the pilot sends an order he presses a knob, and a bell rings, meaning attention. The engineer looks to the index, which resembles a clock face, on which are printed the 5 general orders used, namely, *stop; ahead easy; ahead full speed; back easy; back full speed*. The pointer indicates the order, and always remains at the last, and is locked. The device by which the pilot transmits his orders to the engineer is constructed as follows: First, there is a dial on which the five orders described are printed. A pointer, like the hand of a clock, moves at the will of the pilot from order to order. The pointer is attached to a cylinder of iron 4½ inches long, ½ inch diameter, which leads from the center of the dial backward at right angles, and is supported at each end eccentrically. On each side are two electro-magnets and one underneath; there being one magnet for each order. A wire from each magnet leads to the pilot-house, and all wires are connected with a battery. By means of five knobs in the pilot-house the connections are made; one on each wire. The iron cylinder, or keeper, moves from side to side, or downward, according to the attraction of the magnet; and as the pointer is attached to the keeper or cylinder, the movements on the dial will correspond with movements of the keeper, by reason of its eccentric motions. By a double arrangement of wires in connection with a galvanometer, the rudder is made to indicate its position on a dial for the observation of the captain and pilot.

Fig. 5757.



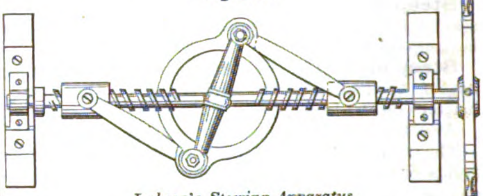
Sickel's Steam-Steering Gear.

Fig. 5758.



North's Steering-Apparatus.

Fig. 5759.



Jackson's Steering-Apparatus.

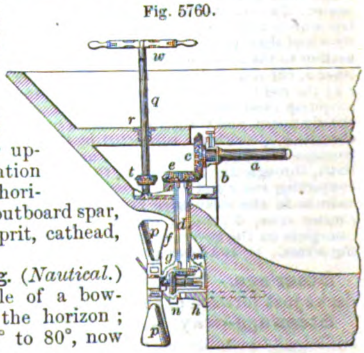
Steer'ing-wheel. (*Shipbuilding.*) A wheel by which a rudder is turned through the medium of a tiller-rope winding on the axis of the wheel.

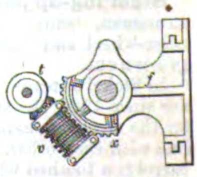
In the cut, Fig. 5761, — x is the *rudder-head*; x t the *tiller*, having a pair of blocks fixed to its forward end t. e e are a pair of eye-bolts in the deck, to which are made fast the ends or standing parts of the steering-chains or wheel-ropes. The chains are led through the blocks of the tiller, then through a pair of fixed blocks b b attached to the deck, and then through a pair of fixed blocks beneath the barrel of the steering-wheel w, and hidden by the latter in the figure. The chains then pass through holes or tubes in the deck or decks that lie between the tiller and the wheel, and then pass round the barrel, to which they are fastened at the middle of its upper side.

The steering-wheels are from 3 to 6 feet in diameter, and one may be placed at each end of the barrel.

The lower rim of the wheel must move in an opposite direction to the rudder, that is, in the same direction as a *tiller* pointing forward.

Fig. 5760.





Hunt's Propeller and Steerer.

Steeve. (*Nautical.*) The slope or upward deviation from the horizontal of an outboard spar, as the bowsprit, cathead, etc.

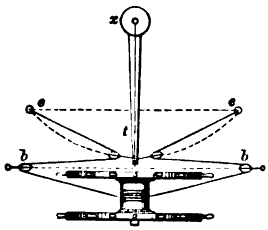
Steev'ing. (*Nautical.*) *a.* The angle of a bowsprit with the horizon; formerly 70° to 80°, now much less.

b. Stowing bales in a hold by means of a jack-screw.

Steg'a-nog'ra-phy. The art of writing in cipher.

Stein'ing. (*Masonry.*) Lining a well with bricks. The wall may be carried up on a curb which is lowered by under cutting, the wall re-

Fig. 5761.



Steering-Wheel.

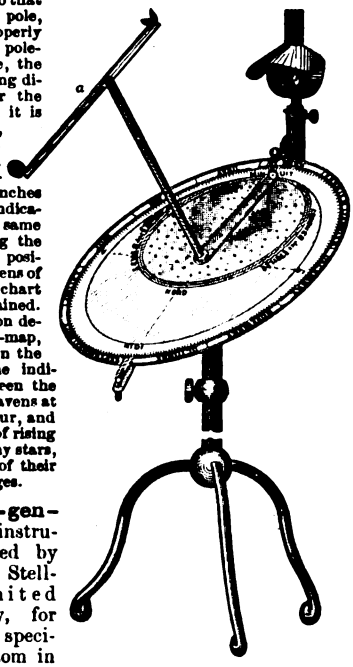
ceiving additions at top as it sinks. See CURB.

Stel'la. (*Surgical.*) A star-shaped bandage crossed like the letter X, applied to the shoulder in cases of fracture of the clavicle or scapula, or dislocation of the humerus.

Stel'lar In'di-ca'-tor. An instrument for enabling an observer to recognize the different stars and point out their positions in the heavens.

It consists of a stand carrying a table, on which is a celestial chart, and having its circumference graduated to show the days and months. The table is inclined at an angle equal to that of the elevated pole, and being properly set, using the pole-star as a guide, the sight-bar *a* being directed to a star the name of which it is desired to know, the star and its name are found on the chart between the branches of the alidade indicator *b*. In the same way, by setting the indicator, the position in the heavens of any star on the chart may be ascertained. From the portion devoted to the star-map, included between the branches of the indicator, may be seen the aspect of the heavens at any day and hour, and also the hours of rising and setting of any stars, and the times of their meridian passages.

Fig. 5762.



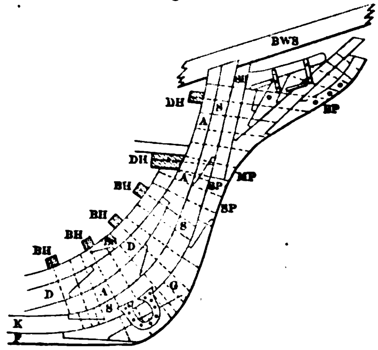
Stellar Indicator.

Stell'wa-gen-cup. An instrument invented by Lieutenant Stellwagen, United States Navy, for bringing up specimens of bottom in sounding. It consists of a hollow cone attached to the bottom of the sounding-lead, and having a flexible cap over which may be an inflexible disk, rising and allowing the mud, sand, etc., to enter the cup when the lead strikes the bottom, but falling and preventing it from being washed out when drawn up.

Stem. 1. (*Shipbuilding.*) The upright piece of timber or bar of iron at the fore end of a vessel, to which the forward ends of the stakes are united. With wooden stems, the lower end is scarfed into the keel. The upper end supports the bowsprit, and in the obtuse angle is the *figure-head*. The advanced edge of the *stem* is the *cut-water*.

S, stem.
K, keel.
A, apron.
D, deadwood.
SS, stemson.
DH, deck-hooks.
BH, breast-hooks.
SP, stem-piece, or independent piece.
MP, main or lace piece.
BP, bobstay-piece.
BWS, bowsprit.
G, gripe.
F, false keel.

Fig. 5763.



Stem and Allied Parts.

2. (*Vehicle.*) The bar to which the bow of a falling hood is hinged.

3. (*Mining.*) A day's work.

4. (*Valve.*) The projecting-rod which guides a valve in its reciprocations.

5. Of a thermometer, hydrometer, etc. The narrowed part, usually graduated or having a graduated scale beside it.

Stem-knee. (*Shipbuilding.*) One uniting the stem with the keel.

Stem'mer. (*Mining.*) A piece of iron with which clay is rammed into the blasting-holes to make them water-tight.

Stem'ming. (*Mining.*) The stuff beaten down upon a charge of powder.

Stem-piece. (*Shipbuilding.*) A piece in front of the stem, into which the main piece of the head is stepped. See STEM.

The stem-piece is sometimes called the *independent piece* (SP in Fig. 5763).

Stem'ple. (*Mining.*) One of the cross-bars of wood placed in the shaft of a mine and serving the purpose of steps.

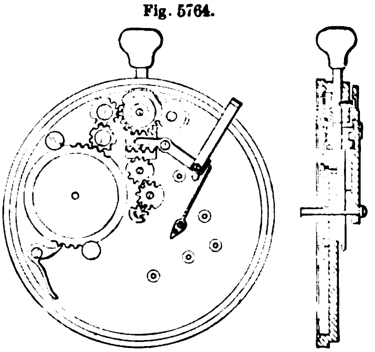
Stem-post. (*Shipbuilding.*) The vertical timber forming the prow of a vessel. The *stem*.

Stem'son. (*Shipbuilding.*) A knee-piece whose horizontal arm is scarfed to the keelson and vertical arm fayed into the throats of the transoms.

Stem-wind'ing Watch. A watch having a stem or pendant which may be thrown into engagement with a winding wheel so as to wind up the spring without the intervention of a key.

Its use is to avoid the trouble of carrying a watch-key, and to prevent the access of dust to the works. Some act by merely pushing the pendant in, and some by turning it round. Some of the *stem-winders* are so constructed that by pushing in the

Fig. 5764.



Howard's Stem-Winding Watch.

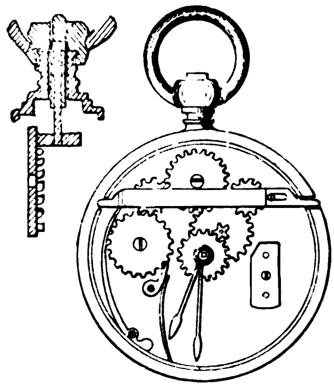
pendant it is brought into relation with the hand-setting mechanism, and by pushing it to another certain distance, it is brought into connection with the winding portion.

In other devices the winding is accomplished by means of a fluted knob at the end of the pendant. The arbor of the winder has a ratchet and click, so that it cannot be turned in the wrong direction. Like a *Breguet key* in this respect.

Berollas's stem-winding watch (English) has a chain which makes one turn around the pulley of the going-barrel and terminates in a button at the end of the pendant, so that it may be grasped by the finger and thumb. To wind the watch, the button and chain are drawn out, giving the barrel-pulley one rotation; a recoil-spring draws in the chain, allowing a second pull to the winding work. This is repeated till the watch is fully wound.

Howard's stem-winding watch has a double-contrate wheel which is splined upon the stem, and is engaged with a train of gears to either wind the watch or set the hands. The barrel is fitted into an opening in the dial-plate, and is supported therein by a toothed flange resting on and attached to the dial-plate, so as to allow the winding of the barrel. A spring pawl prevents the barrel from turning in a contrary direction when the watch is running down.

Fig. 5765.

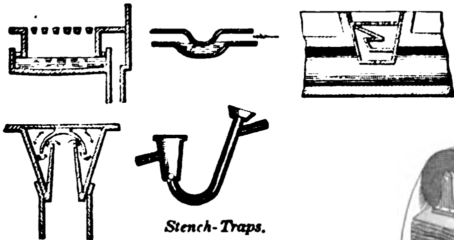


Wadsworth's Stem-Winding Watch.

In Wadsworth's stem-winding watch, by the arrangement of the bar carrying the gears, the main-spring can be wound by turning the pendant, whether the case is open or closed. To set the hands, the bar is first pressed inward to establish the necessary connection between them and the pendant, and disconnect the pendant and main-spring, and then, by turning, regulate the hands.

See also patents to Smith and Folsom, 1873; Rice and Gerry, 1868; Jacob, 1869; Himmer, 1869.

Fig. 5766.



Stench-Traps.

Stench-trap. A depression in a drain in which water collects, to prevent the reflex passage of air. The figure shows various forms for sinks and pipes. See also WATER-CLOSET.

Sten'cil. A thin plate out of which patterns or letters have been cut. The plate being laid on the object, the pattern is made thereon by brushing on the color.

In early times playing-cards were thus made. Chatto, in his "History of Playing-Cards," London, 1848, states that the earliest cards he has noticed are of the year 1440, and were made by stencils. Cards was an Oriental game, and was introduced into Europe about 1360–1390. Covellusso states that three packs of cards were made for Charles VI. of France in 1393. Laws in relation to their manufacture and use were passed in Italy, France, Germany, and England, from the fourteenth to the sixteenth centuries.

Theodoric, king of the Ostrogoths (Eastern Goths), who founded a kingdom in Italy A. D. 493, was so illiterate that he could not write four letters at the foot of his edicts, but had them cut out of a plate of gold, and traced out the letters with a *quill*. It is inferred by some that he used the quill as a pen, which would be the first recorded use of it as a writing instrument; but it is most likely that he used the feather as a brush and the plate as a stencil-plate.

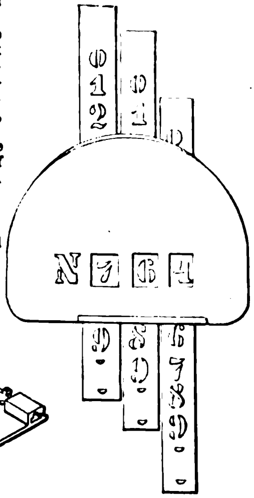
The Emperor Justin, about the same time, used a wooden stamp.

Stencil-plates are now made of thin sheets of brass; they were formerly made of pasteboard, tin, or sheet-iron. The ink used is known as *stencil-paste*, and is essentially a water-color, as ordinary paint or printer's ink does not dry fast enough. It is put up in boxes, like blacking. The indelible ink used for clothes-marking stencil-plates is of a different character, and comes in bottles, at the rate of 25 cents an ounce, or $ 20 per thousand vials.

For many purposes it is more convenient to have a set of letters which can be arranged to form a name or direction. Fig. 5767 shows one form, a *combination stencil*, in which the letter-plates are latched together.

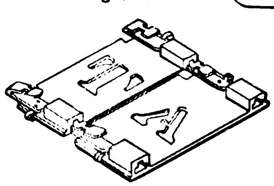
In Fig. 5768, the frame has a series of apertures, and the numbers on the slides are brought into consecution thereat as required.

Fig. 5768.



Stencil-Numbering Plate.

Fig. 5767.



Stencil-Plate.

Sten'cil-cut'ter. (*Metal-working.*) A tool or instrument for cutting letters out of stencil-plates. The tools used in cutting stencil-plates are dies, chisels, compasses, and lignum-vitæ blocks.

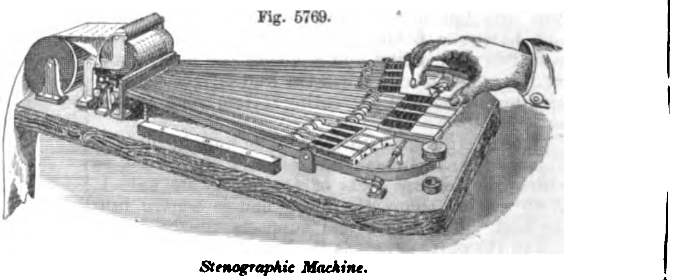
Sten'cil-plate. A thin plate of brass in which letters are cut, used in marking boxes and merchandise. See STENCIL.

Sten'o-graph'ic Ma-chine'. A mechanical writer.

A French form of the instrument is shown in Fig. 5769. It consists of a keyboard operated as shown by the hand of the reporter, and composed of twelve black and an equal number of white keys. On each side of the instrument is a large key moved by a pressure of the wrist, and serving to give supplementary signs which simplify the reading of the characters printed.

All the keys, when operated, produce indications in ink on a roll of paper, which is taken from a reel in manner similar to

Fig. 5769.



Stenographic Machine.

that on the Morse telegraphic apparatus. The black keys, however, give long marks, while the white ones cause simple dots to be transcribed. At each pressure of the fingers on the keyboard, the paper is automatically unrolled for about .02 of an inch, so that on each line any combination of twelve double signs may be imprinted, and these signs are arranged in three groups of four each, and read from left to right in the ordinary manner.

The number of characters which may be made on each division of four is more than sufficient to require a single movement to form a single letter. In other words, with practice, three letters or less can be written at once. If the useless letters be suppressed, such as double letters, e mute, etc., frequently a single movement will produce an entire word. In case, however, the word is to be continued to the next line, a movement of one of the wrist keys makes a character indicating the fact.

The manipulation of the keyboard requires great skill. Learning to read the characters is very easy, but at least six months' practice is necessary for one to become an expert operator capable of following every word as it is uttered in a large assembly.

The paper roll is of no great length. About sixty or seventy feet, four inches in width, is required for an hour's continuous writing. See also TYPE-WRITER.

Stent'er. A *tenter;* the term may be deemed a corruption from *tenter.* It is common in Scotland and in the North of England. Various inflections are found: *stent, stenter, stenter-hook, stenting-machine.* See TENTER.

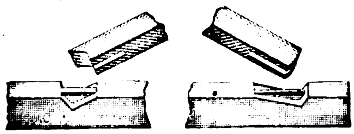
Stent'ing. (*Mining.*) An opening in a wall in a coal-mine.

Sten'ton. (*Mining.*) A passage between two winning headways.

Sten'ton Wall. (*Mining.*) The pillar of coal between two winning headways.

Step. 1. (*Carpentry.*) *a.* The foot-piece of a

Fig. 5770.



Rafter Stepped into a Beam.

timber, as in the example, in which the foot of a principal rafter is stepped into a tie-beam.

b. The *tread* of a stair.

c. A *round* or *rung* of a ladder.

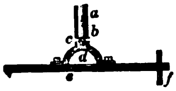
2. (*Vehicle.*) A foot-piece for ascending a carriage.

3. (*Shipwrighting.*) The block in which the foot of a mast is placed.

4. (*Machinery.*) *a.* The lower brass of a journal-box or pillow-block.

b. The socket for the lower pivot of a spindle or vertical shaft. An *ink.* Sometimes called a *breast.*

Fig. 5771.



Adjustable Step for Millstone-Spindle.

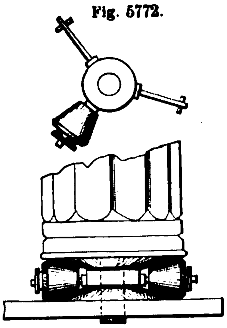
a, foot-stalk.
b, toe.
c, step.
d, foot-bridge.
e, bridge-tree.
f, lighter-screw.

A device similar in principle is used for a step-bearing. The rollers in this case are necessarily conical, as the portion of each more distant from the center of revolution traverses a greater space than that nearer to the axis of the vertical shaft. The three rollers are frustums of cones, and are axled upon radial arms, which keep them in their relative position. The pivot of the vertical shaft passes through the annular piece from which the radial axles diverge. Each roller rotates on its own axle, and the system revolves around the pivot of the shaft. Conical bearings on the end of the shaft and on the bed-plate have a conformity of outline with the rollers.

Gardner's step for vertical shafts (Fig. 5773) may have balls in a cylindrical recess, upon which a conical shoulder near the foot of the shaft rests (*A*); or the recess may be of conical form, and the friction-rollers conical frustums (*B*).

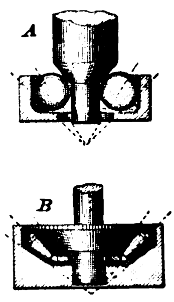
Fig. 5774 is a self-oiling step for vertical spindles. The step *b* rests in a counter-box in the chamber *a*. The end of the spindle is somewhat tapering, and, as it rotates, creates a centrifugal action in the oil, which flows over the edge at *c* into the chamber *d*, and rises through the hole *e* beneath the step to renew the lubrication of the spindle.

Fig. 5772.



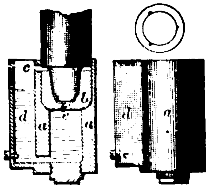
Step-Bearing.

Fig. 5773.



Gardner's Shaft-Step.

Fig. 5774.



Self-Oiling Step for Vertical Spindles.

Step-bit. (*Locksmithing.*) A notched key-bit.

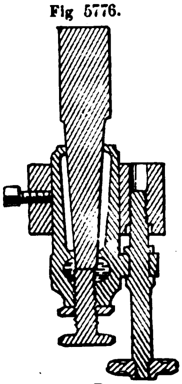
Step-box. (*Machinery.*) A case for a bearing surface at the lower end of a vertical spindle or shaft.

Fig. 5775.

Step-Bit.

In the example, the adjusting-screw may be made to adjust the spindle, together with the socket-sleeve, to different hights, and by the same adjusting-screw — the step-screw being backed out and the spindle fixed — the spindle can be tightened in its socket.

Fig. 5776.



Step-Box.

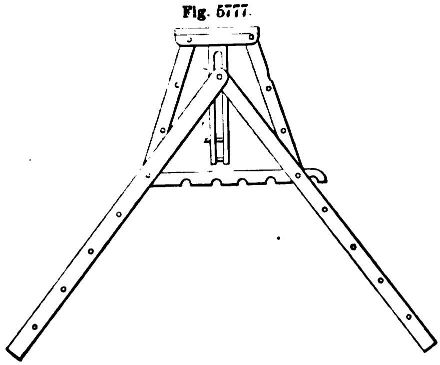
Step-cov'er. (*Vehicle.*) A lid to cover a carriage-step when the door is closed, to prevent the accumulation of mud thereon. When the door is opened it is retracted, and sometimes acts as a protector, to keep the dress from contact with the wheel.

Step-grate. A furnace-grate in several successive hights, like a stairs. See *e, f,* Fig. 2304, page 1012.

Step-lad'der. A portable ladder usually having flat steps, and its own means of support by struts or posts.

In Fig. 5777, the ladder is stayed at the required extension by a notched brace, which catches upon a round; the feet of the upper platform rest upon the rounds of the ladder.

Fig. 5777.



Orchard-Ladder.

In Fig. 5778, the brace and stay-rods slide on the staples, so as to allow of folding together or spreading apart of the sides and legs in position for use.

Fig. 5778.

Step-Ladder.

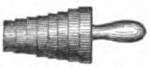
In Fig. 5779, the notched pivoted side pieces are braced together, inclosing the hinged supporting legs and folding together for removal.

Fig. 5779.

Library-Ladder.

Stepped Gage. One having a series of notches which may fit varying sizes of holes.

Fig. 5780.

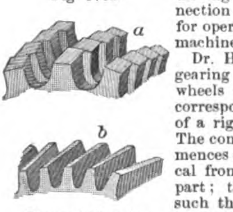


Stepped Gage.

Stepped Gear'ing. (*Machinery.*) An invention of Dr. Hooke for obtaining a continuous bearing between the meshing surfaces of gear-wheels.

Each wheel is composed of two, three, or more separate sets of teeth, which, instead of being in line, are arranged in steps (*a*, Fig 5781). It is sometimes used for driving screw-propellers, and in connection with a rack of similar character for operating the beds of large planing-machines.

Fig 5781.



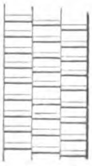
Stepped Gearing.

Dr. Hooke also invented the screw-gearing *b*. This consists of a pair of wheels whose teeth are of helical form, corresponding respectively to the threads of a right-hand and a left-hand screw. The contact of each pair of teeth commences at the foremost end of the helical front, and terminates at the back part; the pitch of the helices being such that the contact of one pair of teeth does not terminate until that of the next pair has commenced, thus causing great uniformity and smoothness of motion.

Stepped Key. The stepped key was shown in Rountree's lock, English patent, 1790. See BIT-KEY.

Fig. 5782. Fig. 5783.

Stepped Key.



Stepped Rack.

Stepped Rack. A rack having teeth arranged in several rows, which alternate with each other so as to produce the uniformity of motion due to smaller teeth, without sacrifice of strength. The teeth of the pinion with which it gears are, of course, correspondingly arranged.

Step'ping-line. (*Ship-building.*) The bearding line or trace of the inner surface of the ship's skin, at the points where it rises toward each end of the vessel.

Steps. A ladder for in-door use, such as for a library or for house-cleaning purposes. See STEP-LADDER.

Ste're-o-bate. A base; the lower part or basement of a building or column. A *stylobate.*

Ste're-och'ro-my. The name is derived from words signifying solid color, the binding material being soluble glass. This silicious material protects the colors against atmospheric influences.

From Ott we learn that Echter and Kaulbach, the artists of Munich, proceed as follows: —

The wall to be painted is first coated with a layer of ordinary lime mortar, to equalize the surface, which must be exposed to the air for several days, so as to become entirely dry and carbonated, as the soluble glass afterward employed would be immediately decomposed by caustic lime. Professor Fuchs, the inventor of stereochromy, recommends moistening the wall with a solution of carbonate of ammonia, so as to accelerate the saturation of the lime. When dry, it is washed several times with a moderately diluted solution of double water-glass, allowing it to dry each time. See SOLUBLE GLASS.

The ground being thus prepared, the upper layer may be added soon after. This also consists of lime cement one tenth of an inch thick. The sand employed must be of a grain not exceeding a certain size, and fine powder must be rejected. A rough grain is rather advantageous, and, as Kaulbach says, it ought to feel like a rasp. For a picture to be viewed at a long distance a less fine grain is required than for a picture to be viewed at a short distance.

This coat being dry, it is moistened with a solution of one part of phosphoric acid in six parts of water, the object being to remove the thin layer formed of carbonate of lime, which would prevent the absorption of the soluble glass subsequently spread over it. The soluble glass here referred to must be the double water-glass, clarified with *liquor silicum.* It is diluted with an equal bulk of water, and the operation has to be repeated twice. Too much water-glass prevents the ground from taking the colors. Rain-water is used exclusively throughout the operation.

The ground being thus completed, the painting may be proceeded with, although some delay increases the capacity of absorption. The colors to be used are ground in pure water, and the wall has to be frequently but carefully sprinkled with water, in order to displace the air from the pores, and insure the adhesion of the colors.

The colors are fixed with a solution of soluble glass. They do not admit of being wet with a brush, and the solution is therefore sprinkled upon the painting in a fine shower or mist by a syringe. The operation of alternate sprinkling and drying is continued till the colors adhere so firmly that by rubbing them with the finger they are not disturbed.

Ste're-o-graph. The representation of a solid on a plane.

Ste're-om'e-ter. 1. An instrument for measuring the solid or liquid contents or the capacity of a vessel.

2. An instrument invented by M. Say, a French officer of engineers, for determining the specific gravity of porous bodies, powders, etc.

It consists of a long glass tube, whose upper and lower portions are separated by a partition, but communicate through an aperture so small as to prevent the passage of fine solid particles, and provided with an air-tight cover. The substance to be examined is placed in the upper part and the lower end of the tube plunged into mercury, until this fluid rises to a certain mark on the tube; the air-tight cover is then placed on, and the tube raised until the contained air is expanded to twice its original bulk. The porous substance is then removed, and the operation repeated. This gives the bulk which it would occupy in a solid state, and from its weight compared with that of an equal volume of water its specific gravity is deduced.

Owing to the variations in bulk of the included air under different conditions of atmospheric pressure and temperature, the instrument requires too much care to be taken in order to produce accurate results to render it practically useful.

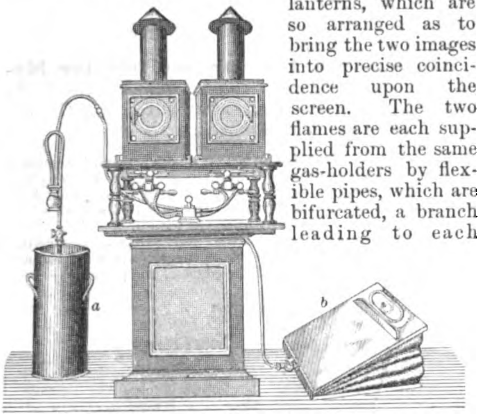
An instrument afterward constructed on the same principle by Sir John Leslie was by him termed a *coniometer.*

Ste're-o-mon'o-scope. A contrivance of M. Claudet, by which a stereoscopic effect is produced by receiving the image of an object on a plate of unpolished glass. The glass is set in a black screen, and the image is projected through a lens, and may be viewed, thus magnified, with the naked eye or with lenses. — COSMOS, Vol. XII. p. 493.

Ste're-op'ti-con. An instrument for exhibiting photographic pictures greatly magnified upon a screen or wall with stereoscopic effect. The oxy-

calcium or oxy-hydrogen lights are preferably employed for illuminating the two magic-lanterns, which are so arranged as to bring the two images into precise coincidence upon the screen. The two flames are each supplied from the same gas-holders by flexible pipes, which are bifurcated, a branch leading to each

Fig. 5784.



Stereopticon.

flame. *a* is the hydrogen and *b* the oxygen gas-holder.

Ste'reo-scope. An instrument employed to represent solid figures, by combining in one image two representations of the object as seen by each eye separately. Two pictures of an object or scene taken from different points of view are seen in a single picture of that object, having the actual appearance of relief or solidity.

"The stereoscope consists of two mirrors placed each at an angle of 45°, or of two semi-lenses turned with their curved sides toward each other. To view its phenomena, two pictures are obtained by the camera on photographic paper, of any object, in two positions, corresponding with the condition of viewing it with two eyes. By the mirrors or the lenses these dissimilar pictures are combined within the eye, and the vision of an actually solid object is produced from the pictures represented on a plane surface." — HUNT.

Euclid, 300 B. C.; Galen, A. D. 131; Leonardo da Vinci, died A. D. 1519; and Baptista Porta, A. D. 1600, each noticed the fact that in viewing an object the eyes received dissimilar impressions, owing to the difference in position of the eyes relatively to the object.

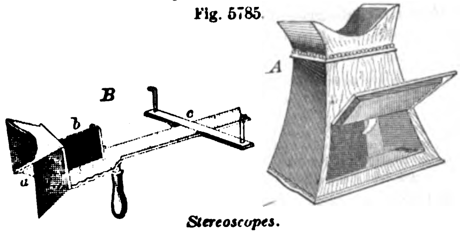
As the vision of an object is compounded of two dissimilar images, an instrument is required to take two pictures, and another instrument is required to optically combine them. One instrument is the binocular photographic camera, and the other instrument is the stereoscope.

The following story is told of the first introduction of the stereoscope to the *savants* of France. "The Abbé Moigno took the instrument to Arago, and tried to interest him in it; but Arago unluckily had a defect of vision which made him see double, so that on looking into the stereoscope he saw only a medley of four pictures. The Abbé then went to Savart, but he was quite incapable of appreciating the thing, for he had but one eye. Becquerel was next visited, but he was nearly blind, and consequently cared little for the new optical toy. The Abbé, not discouraged, called next upon Puillet, of the Conservatoire des Arts et Métiers. He was a good deal interested in the description of the apparatus, but unfortunately he squinted, and therefore could see nothing in it but a blurred mixture of images. Lastly, Biot was tried, but Biot was an earnest advocate of the corpuscular theory of light, and until he could be assured that the new contrivance did not contradict that theory, he *would* not see anything in it. Under the circumstances, the wonder is that the stereoscope ever got fairly into France." — *American "Journal of Chemistry."*

The reflecting form was contrived by Wheatstone in 1838; the lenticular was subsequently devised by Brewster, and is that now in general use.

Brewster's lenticular stereotype consists of a pyramidal box, blackened on the inside, and having a lid for the admission of light, when the pictures are opaque. The box is open below, in order to let the light pass through the pictures when they are transparent. The top of the box consists of two portions, in one of which is the right-eye tube, containing a semi-lens or quarter-lens, and in the other portion is the left-eye tube, similarly furnished with a semi or a quarter lens. The two dissimilar pictures (or slide) are placed in a groove in the bottom of the box (*A*, Fig. 5785), when, on looking through the eye-tubes, the pictures are seen united into one single picture, the objects standing out with an almost magical appearance of relief and solidity. By means of the semi-lenses the two dissimilar stereographs are transferred to a middle point, where they are united to produce the stereoscopic effect.

Fig. 5785.



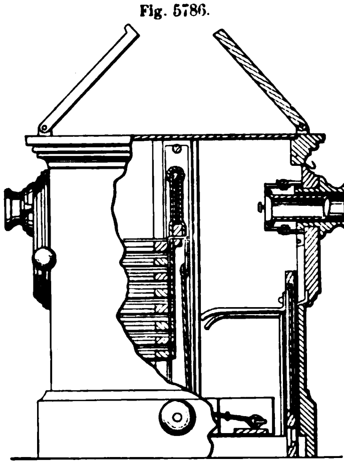
Stereoscopes.

Fig. 5785, *B*, also represents a common form. The box *a* through which the pictures are viewed contains the two semi-lenses, one on each side of the plate *b*, which is designed to prevent each eye from seeing the picture intended for the other. The card on which the pictures are mounted is held by the slide *c*, which may be adjusted to suit the proper visual distance for each individual.

Numerous minor improvements have since been made on the original instrument of Brewster.

Stereoscopes are also made on a larger scale, to hold from 48 to 600 pictures, which are arranged on a chain so as to be revolved and brought consecutively into view. These stereoscopes are adapted to stand on the floor or table, according to size and capacity for pictures.

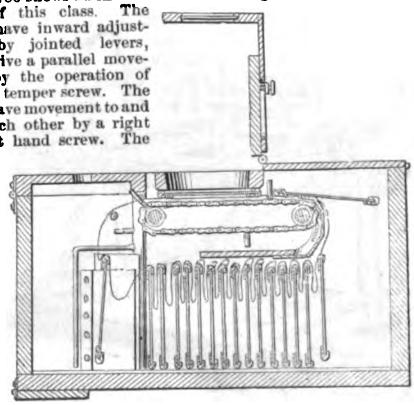
Fig. 5786.



Stereoscope.

Fig. 5786 shows an instrument of this class. The lenses have inward adjustment by jointed levers, which give a parallel movement by the operation of a single temper screw. The tubes have movement to and from each other by a right and left hand screw. The

Fig. 5787.



Stereoscope.

pictures are held by spring clamps which are strung upon cords and brought up to view by turning a shaft in the usual manner.

In Fig. 5787, the pictures are attached to endless ribbons, and by the revolution of a shaft are fed consecutively into position to be viewed. Retiring from this position they are arranged in a rank, ready for the next presentation.

Ste're-o-scop'ic Lens. A combination of two semi-lenses used in the lenticular stereoscope of Sir David Brewster.

The two are placed at such a distance apart that each eye views the object through that one of the semi-lenses which is opposite to it, the visual lines from the object to each eye passing through points equidistant from the margin of each semi-lens, and at a distance apart equal to that between the two eyes, usually about $2\frac{1}{2}$ inches. The two images are thus visually combined and magnified at the same time.

Ste're-o-stat'ic Arch. A linear arch sustaining the pressure of a material in which at any given point there are a pair of conjugate pressures, one vertical and the other in a fixed direction horizontal or inclined. The conditions involve the symmetrical distribution of the vertical load on either side of a vertical axis traversing the crown of the arch.

Ste're-o-type-block. (*Printing.*) A block on which a stereotype is mounted to make it type-high.

Important works are generally stereotyped, and the plates stored; to meet this use blocks are made

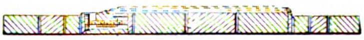
Fig. 5788.

Stereotype-Block.

with clasps, and are adapted to hold plates within a given range of sizes.

In Fig. 5788, the stereotype plate is mounted upon quadrats set up in a chase; the clamps which hold the edges of the plate are inserted among the quadrats.

Fig. 5789.



Stereotype-Plate Holder.

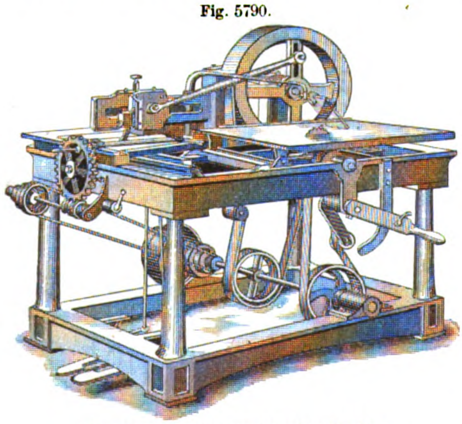
In Fig. 5789, the frame is formed of separate pieces clamped in the chase, and has catch-plates and screw-adjusted catches to clamp the plate.

See also American patents: —

35,986, of 1862.	128,826, of 1872.	145,179, of 1873.
96,534, of 1869.	127,512, of 1872.	138,290, of 1873.
102,013, of 1870.	136,769, of 1872.	146,163, of 1874.
118,439, of 1871.	136,244, of 1873	146,454, of 1874.
118,425, of 1871.	139,393, of 1873.	

Ste're-o-type Ma'trix-ma-chine'. See TYPOGRAPHIC MACHINE.

Fig. 5790.



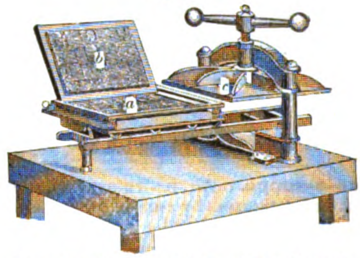
Stereotype Planing and Sawing Machine.

Ste're-o-type-met'al. The alloy for stereotype-plates is composed of the same materials as ordinary type-metal. An alloy composed of 500 lead, 300 tin, and 225 cadmium, has, on account of its hardness, been proposed for stereotype-plates and backing for electrotypes.

Ste're-o-type Plan'ing and Saw'ing Machine'. A machine for roughly planing the backs of stereotype-plates previous to submitting them to the action of the shaving-machine.

The plate is laid face downward on a table, which is advanced by a worm and worm-wheel, and, as it passes beneath two rollers which hold it firmly down, the back is traversed by a tool similar to the ordinary lathe-cutter, fixed in a head which is reciprocated by pitman connection with a fly-wheel. The tool cuts only in one direction; the carriage has a quick return motion. A circular saw and table at the other end of the machine are used for dressing off the edges of the plates.

Fig. 5791.

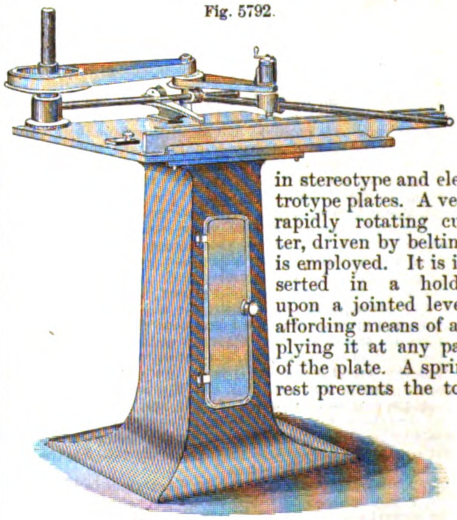


Press for Stereotype-Molding (Clay Process).

Ste're-o-type-press. A small press for use in the clay process. (See STEREOTYPING.) *a* is the bed; *b* is the tympan, which may be large enough to cover the form, or consist only of hinges and clamps for holding a metallic plate; *c* is the platen.

Ste're-o-type Rout'ing-ma-chine'. (*Printing.*) A machine for deepening the blank spaces

Fig. 5792.

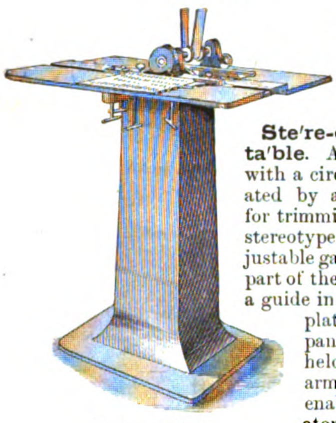


Stereotype Routing-Machine.

in stereotype and electrotype plates. A very rapidly rotating cutter, driven by belting, is employed. It is inserted in a holder upon a jointed lever, affording means of applying it at any part of the plate. A spring rest prevents the tool from touching the plate until pressed down by the operator.

Ste're-o-type-saw. A circular saw used for trimming the edges of stereotype plates. It is mounted on a stand having a table, on which the plate is laid and advanced by hand to the Hoe saw,

Fig. 5793.



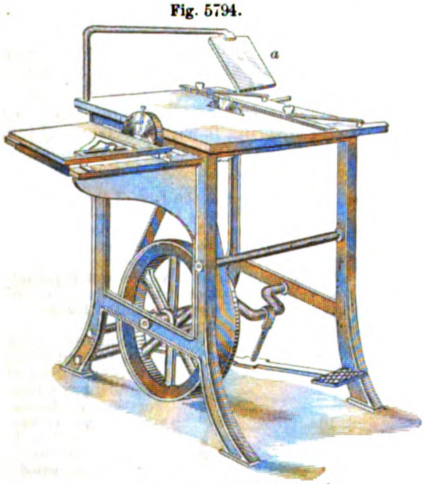
Stereotype-Saw.

which is driven by belt and pulley connection with the other machinery, or with a treadle.

Ste′re-o-type Saw-ta′ble. A table provided with a circular saw operated by a treadle, used for trimming the edges of stereotype-plates. An adjustable gage on the upper part of the table serves as a guide in presenting the plate to the saw. A pane *a* of glass, held by a crooked arm over the table, enables the operator to view the work without being struck by the flying particles of metal. At one end of the saw-mandrel is a cutter-head, with a sliding table for squaring up metallic blocks, etc.

Ste′re-o-type Shav′ing-ma-chine′. A machine for planing the backs of stereotype-plates. The plate is laid face downward on a traveling-bed, and is held by a ledge while it is drawn forward under a stationary knife, which takes off a shaving of the requisite thickness. Motion is imparted to the bed

Fig. 5794.



Stereotype Saw-Table.

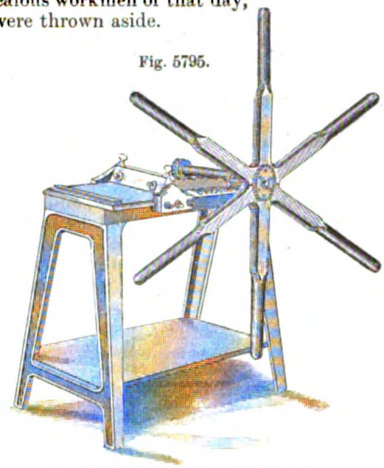
by turning the spoke-levers, which turn a pinion gearing with a rack.

Ste′re-o-type Shoot′ing-board. The shooting-board used in stereotyping is a cast-iron plate *d* with a planed upper surface, having ledges for holding a stereotype-plate firm while its edges are dressed off with a side-plane *c*. The lower figures *a a* show the positions of the stereotype-plates when *squaring* or *beveling* the edges.

Ste′re-o-typ′ing. The art of making solid plates forming an exact fac-simile of the page of type as set up by the compositor, and from which impressions are taken in the usual manner.

The *plaster process* was invented by William Ged, a goldsmith of Edinburgh, who was employed by the University of Oxford in 1731 to manufacture plates for Bibles and prayer-books. These were injured by the jealous workmen of that day, and were thrown aside.

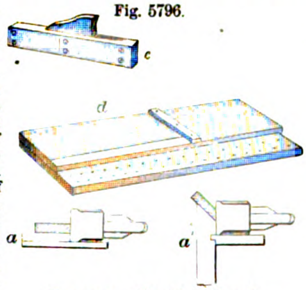
Fig. 5795.



Stereotype Shaving-Machine.

In 1698, J. Van der Mey, in Holland, had printed a quarto Bible and some other books from pages of type soldered together at the back, but this was not true stereotyping.

Fig. 5796.



Stereotype Shooting-Board.

About 1779, Van der Mey's process was revived by Dr. Alex Tilloch of Glasgow, but it still does not seem to have come into general use, as we hear little of it until it was taken up by the French printers.

Carey's method of stereotyping, France, 1793, was as follows: The form was attached to a block suspended face downward from a beam, and was suddenly allowed to fall upon a surface of hot lead, just in the act of solidifying. The matrix thus obtained was used in a similar manner to obtain a relief cast or *cameo* impression, by dropping upon another surface of hot lead.

Didot (France) modified the plan by casting his types with a harder alloy, consisting of lead 30, antimony 30, tin 30, copper 10, and a form of such type was pressed by a fly-press into a surface of pure lead.

The matrix thus obtained was attached to the hammer of a stamping-press, on the bed of which was a paper-frame inclosing type-metal in a state of fusion. When on the point of setting, the metal was rolled up into a mass, and the matrix of the page brought down upon it, flattening it out and giving a stereotype-plate suitable for printing. This plan was adopted in Didot's edition of 200 vols

Herhan's plan (French) was to set up the form in copper matrixes, intaglio, and take a casting in type-metal therefrom, procuring a cameo impression at one operation.

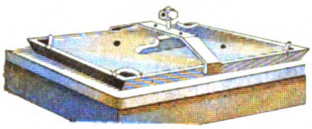
"The invention of solid types by the Parisian printers, Didot and Herhan, is thought a great improvement. These types, instead of being detached characters, like the common, form a solid mass for each page, which, being incapable of derangement, fixes forever the purity of the text. A great saving of paper results, as it is not necessary to take off a greater number of impressions than are wanted at one time." — *Monthly Magazine*, January, 1799.

Ged's process was substantially the "plaster" process as used at the present day.

In this the type is set up in the usual way, except that shoulder-high *spaces* and *quadrats* are employed. The face of the form is thinly and evenly oiled with a brush, and it is surrounded by a rectangular frame termed a *flask*. Plaster of Paris mixed with water is then poured upon it, forming a mold corresponding to the face of the form. When this has sufficiently hardened, it is withdrawn by turning screws at the four corners of the flask, and it is afterward

dried in an oven until all the moisture is driven off. The mold is then placed face downward upon a cast-iron plate, termed a *floating-plate*, and this is placed within a cast-iron tray, termed a *dipping-pan*, having a lid

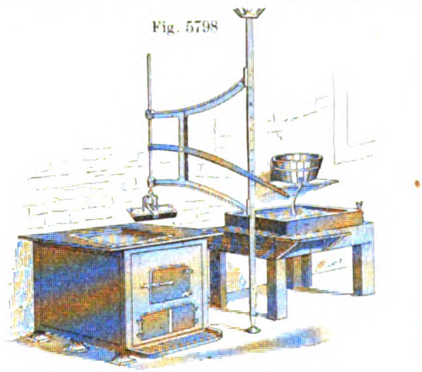
Fig. 5797.



Dipping-Pan.

which is secured by means of a screw, and the whole is heated to about 400° Fahr., lifted by means of a crane suspended over a pot of molten metal, and gently lowered into the bath, where it is immersed to near the bottom, the metal flowing in and filling

Fig. 5798.



Stereotyping Apparatus.

up all the cavities in the face of the mold, though forming but a thin film on the back. After remaining 8 or 10 minutes in the metal, the arrangement is lifted therefrom by the crane, swung over the cooling-trough, and lowered upon a stone, so that the bottom part just comes in contact with the water; the face part is first cooled, and as shrinkage takes place it is filled up from behind. The pan is then opened, the mold separated from the cast by beating with a mallet, and the face examined, to see if there are any irremediable defects; if not, the plate is planed on the back and dressed on the sides, to adapt it to fit the *block* on which it is placed for printing. (See STEREOTYPE PLANING-MACHINE; STEREOTYPE SHAVING-MACHINE.) The planing is effected by a peculiar machine, worked in a manner analogous to the engravers' plate printing-press, and the sides are squared by a saw (see STEREOTYPE-SAW; STEREOTYPE SAW-TABLE), and beveled by a plane while held on the shooting-board (see STEREOTYPE SHOOTING-BOARD). Any flat shallow places into which the paper might be pressed and gather ink are worked deeper by the STEREOTYPE ROUTING-MACHINE (which see).

Stereotyping was introduced into the United States by David Bruce, of New York, in 1813; the first work cast in America was the New Testament, in bourgeois, in 1814.

The curving of stereotype-plates to adapt them to a cylinder printing-press was patented in England by Cowper in 1815; but was not practiced with any great success until of late years, when it was introduced upon daily newspapers in connection with the revolving type-cylinder of Hoe.

Clay, or Clay-and-Plaster Process.

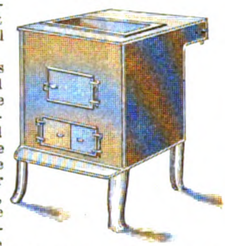
The form is locked up with *high furniture* and *slugs*, and placed on the bed *a* of the press shown in Fig. 5791 (STEREOTYPE-PRESS). The face of the type is brushed over with benzine or naphtha, and covered with a cloth or paper.

A detachable plate is hinged like a tympan to the press-bed. On the face of this plate a mixture of equal parts ground potter's clay and gypsum, moistened to the consistency of mortar, is spread with a trowel to the depth of about ¼ of an inch.

The tympan is now turned down on the form, the bed runs under the platen, and a partial impression is taken, sufficient to give the general outline of the *form* to the clay coating. The press is then opened, the cloth removed, and also any surplus material which has been thrown up by the first pressure, and would be likely to bind. The press is again closed, and a complete impression taken, imbedding the type in the plastic material to the desired extent.

The metallic plate carrying this mold is then removed from the press, and hardened by drying. When dry, it is set afloat face upward in a vat of melted type-metal, as the most convenient means of bringing mold and metal to a uniform temperature.

Fig. 5799.



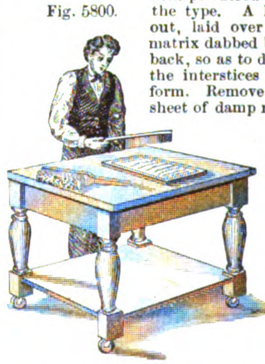
Stereotyping-Furnace and Metal-Pot.

A wire bent like a horseshoe is then put on the plate, around three sides of the mold. The wire is somewhat thicker than a completed stereotype-plate. A second sheet of metal is clamped over the wire, as in a molder's flask. The plate is then put in a rack or trough with its open edge upward, and the metal poured in. The cooling may be hastened by turning water on the outside of the flask. When the casting is removed the clay adheres to the face of the plate, and is removed by washing. The plate is then planed, trimmed, and dressed up for use. Curved plates for cylinders are made from a flat form by using a sheet of spring steel of the desired curvature, for a base plate, which is spread flat on the tympan and the plastic material is applied to what is to be the concave side. After the impression is taken the sheet is released, and resumes its normal curvature, bending the plastic mold with it. The face of the plate is of course somewhat distorted, the stereotype appearing as if taken from type a little more condensed one way than that actually employed in the form.

The *papier-maché* process was invented by Wilson, in Scotland, in 1823. It is a very expeditious process, and is generally used on the daily papers of large circulation. A paper matrix is formed by spreading paste over a sheet of moderately thick unsized paper and covering it with successive sheets of tissue-paper, each carefully patted down smooth, and the pack then saturated.

The face of the type is oiled, the face of the paper treated with powdered French chalk and laid upon the type. A linen rag is wetted, wrung out, laid over the paper, and then the matrix dabbed by a beating-brush from the back, so as to drive the soft paper into all the interstices between the letters of the form. Remove the cloth, lay a reinforce sheet of damp matrix paper upon the back of the matrix, and beat it again without the cloth, to perfect the impression and establish a junction. For large establishments a matrix-rolling machine is used. Put a double thickness of blanket upon the matrix, place form and matrix in a press, and screw down tight. The lighted gas heats the press and the form, and dries the paper matrix. The press is unscrewed, the matrix removed, its edges pared, and it warmed on the molding-press. The matrix is then placed in the previously heated iron casting-mold; a casting-gage to determine the thickness of the stereotype is placed round three sides of the matrix, the other side being left open for a gate, at which the molten metal is poured in. The cover is screwed tight, the mold tipped to bring the mouth up, and the metal poured in. When the metal is *set*, the mold is opened and the matrix removed. The plate is then trimmed and otherwise prepared in the usual manner.

Fig. 5800.



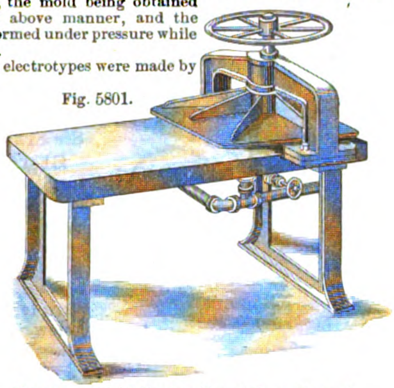
Beating-Table (Papier-Maché Process).

Mr. Muir, of Glasgow, employed gutta-percha slabs for forming stereotype-molds; the process consisted simply in applying the slab while hot to the form of type, and subjecting it for some 15 minutes to the action of a screw-press. The face of the mold being afterward black-leaded, an electrotype cast was

taken. He also made stereotype-plates from the same substance, the mold being obtained in the above manner, and the plate formed under pressure while heated.

Iron electrotypes were made by

Fig. 5801.



Stereotype-Mold Drying-Press (Paper Process).

Klein, a Russian, and the process patented in the United States, September 29, 1868. See also "Scientific American," November 18 and November 27, 1868.

In Joyce's process for obtaining plates in relief from intaglio molds, patented July 14, 1874, a smooth plate of iron, such as is used in the clay process of stereotyping, is covered with a thin layer of suitable composition, ordinary thin clay and pulverized plaster. When dry, the design or writing is cut into the composition by means of pointed or sharp-edged graving-tools, so as to expose the face of the plate at those parts which are to show black in the print. The nature of the material enables a skilled draftsman to cut his design in the matrix without the necessity of previously making a drawing on the surface, or of transferring from a drawing on paper. In case a design is to be copied, the paper is laid directly on the face of the mold, and the lines traced through with a blunt-pointed instrument, the composition being sufficiently yielding to receive and retain the impression; its texture also admits of erasures and corrections being made. When the design is finished, the plate and matrix are heated, and a cast is made with stereotype-metal in the manner usual in the clay process, a somewhat higher temperature, however, being required to ensure the perfection of the face which is formed by the mold-plate. The stereotype-plate thus formed is trimmed, planed, and finished in the usual way, the depressions being deepened by routing, if necessary.

This process enables cuts, maps, autographic or fac-simile writings, etc., to be produced in a form suitable for working on an ordinary letter-press in a very simple and expeditious manner.

ELECTROTYPING.

Electrotyping is an application of the art of electro-plating which originated with Volta, Cruickshank, and Wollaston, about 1800-1801. In 1838, Spencer, of London, made casts of coins and cast in intaglio from the matrixes thus formed; in the same year Jacobi, of Dorpat, in Russia, made casts by electro deposit, which caused him to be put in charge of the work of gilding the dome of St. Isaac, at St. Petersburg.

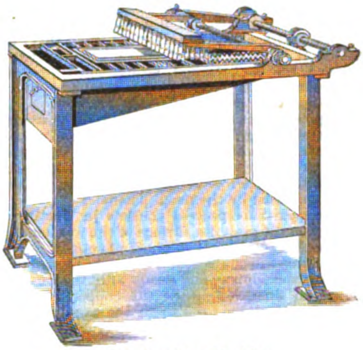
Electrotyping originated with Mr. Joseph A. Adams, a wood-engraver, of New York, who made casts (1839-41) from wood-cuts, some engravings being printed from electrotype-plates in the latter year. Many improvements in detail have been added since in the processes as well as the appliances. Robert Murray introduced graphite as a coating for the forms and molds. He first communicated his discovery to the Royal Industrial Institution of London, and afterward received a silver medal from the Society of Arts.

The process of electrotyping is as follows: The form is locked up very tightly, and is then coated with a surface of graphite, commonly known as *black-lead*, but it is a misnomer. This is put on with a brush, and may be done very evenly and speedily by a machine in which the brush is reciprocated over the type by hand-wheel, crank, and pitman. A soft brush and very finely powdered graphite are used; the superfluous powder being removed and the face of the type cleaned by the palm of the hand.

A shallow pan, known as a molding-pan, is then filled with melted yellow wax, making a smooth, even surface, which is black-leaded. The pan is then secured to the head of the press, and the form placed on the bed, which is then raised, delivering an impression of the type upon the wax.

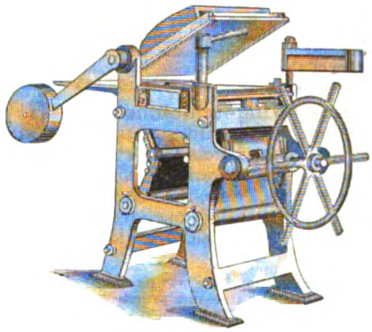
The pan is removed from the head of press, placed on a table, and then *built-up*, as it is termed. This consists in running wax upon the portions where large spaces occur between type, in order that corresponding portions in the electrotype may not be touched by the inking-roller, or touched by the sagging down of the paper in printing.

Fig. 5802.



Black-Leading Machine.

Fig. 5803.

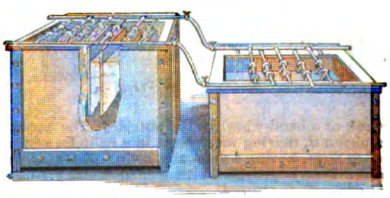


Electrotype-Press.

The wax mold being *built* is ready for black-leading, to give it a conducting surface upon which the metal may be deposited in the bath, superfluous black-lead being removed with a bellows. Black-lead, being nearly pure carbon, is a poor conductor, and a part of the metal of the pan is scraped clean, to form a place for the commencement of the deposit. The back of the molding pan is waxed, to prevent deposit of copper thereon, and the face of the matrix is wetted, to drive away all films or bubbles of air which may otherwise be attached to the black-leaded surface of the type.

In the much-improved wet process of *black-leading*, invented by Silas P. Knight, of Harper Brothers' establishment in New York, the wax mold is laid face upward on the floor of an inclosed box, and a torrent of finely pulverized graphite suspended in water is poured upon it by means of a rotary pump, a hose, and a distributing-nozzle, which dashes the liquid equally over the whole surface of the mold. Superfluous graphite is then removed by copious washing, an extremely fine film of graphite adhering to the wax. This answers a triple purpose; it coats the mold with graphite, wets it ready for the bath, and expels air-bubbles from the letters. This process prevents entirely the circulation of black-lead in the air, which has heretofore been so objectionable in the process of electrotyping.

Fig. 5804.



Electrotyping Bath and Battery.

The mold is then placed in the bath, containing a solution of sulphate of copper, and is made a part of an electric circuit, in which is also included the zinc element in the sulphuric-acid solution in the other bath. A film of copper is deposited on the black-lead surface of the mold; and when this *shell* is sufficiently thick it is taken from the bath, the wax removed, the shell trimmed, the back tinned, straightened, backed with an alloy of type-metal, then shaved to a thickness, and mounted on a block to make it *type-high*.

Adams's process consists in adding finely pulverized tin to the graphite for facing the wax mold: the effect in the sulphate-of-copper bath is to cause a rapid deposition of copper by the substitution of copper for the tin, the latter being seized by the oxygen while the copper is deposited upon the graphite. The film is after increased by the usual means.

Knight's expeditious process consists in dusting fine iron filings upon the wet graphite surface of the wax mold, and then pouring upon it a solution of sulphate of copper. Stirring with a brush expedites the contact, and a decomposition takes place; the acid leaves the copper, and forms with the iron a sulphate solution, which floats off, while the copper is freed and deposited in a pure metallic form upon the graphite. The black surface takes on a ruddy tinge with marvelous rapidity.

The electric-connection gripper is designed to hold and sustain the molding-pan and make an electric connection with the prepared conducting-pan of the mold only, while the metallic pan itself is out of the current of electricity and receives no deposit.

The galvanoplastic process of M. Coblence for obtaining electrotypes of wood-engravings is as follows: A frame is laid upon a marble block, and then covered with a solution of wax, colophane, and turpentine. This mixture on the frame, after cooling, becomes hard, and presents a smooth, even surface. An engraved wooden block is then placed upon the surface of the frame and subjected to a strong pressure. The imprint, or matrix in cameo, having been coated with graphite, is then placed vertically in a galvanoplastic bath, and a cast, an exact reproduction of the wood-engraving, is obtained. The shell is then backed with type-metal and finished in the usual way.

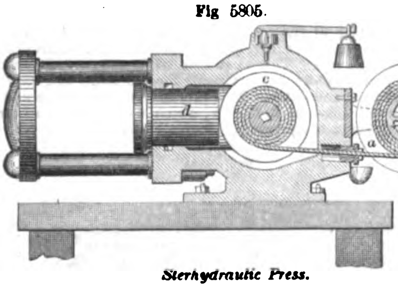
Ste're-o-typ'ing-ma-chine'. One in which type are brought forward seriatim to impress the material for a matrix from which a stereotype-plate is to be cast. The operation is similar to that of a type-composing machine, the letters, spaces, punctuation-marks, etc., being operated by keys, on a manual like a piano-forte. See also TYPOGRAPHIC MACHINE.

Nelson's stereotype-machine was exhibited in New York in 1867. An apparatus on the same principle was also exhibited at the Paris Exposition in 1867. In this but one type of each sort was used, which was arranged at the end of a key-lever, and imprinted itself in the proper place on a bed of clay moving automatically. This, when completed, was served as the ordinary plaster casts for stereotyping, the liquid metal being poured in, and in a few moments producing complete stereotype-plates.

Ster-hy-drau'lic Press. A press in which a powerful hydrostatic pressure is obtained by introducing into the cylinder of a hydraulic press already filled with liquid, not an additional amount of liquid by successive impulses, as in the case of the hydraulic press, but a solid substance, usually a solid cord, by a steady, uninterrupted movement.

The cord *a* is wound from an exterior pulley *b* on to a pulley *c*, which is inclosed within the apparatus, while it is operated

Fig 5805.



Sterhydraulic Press.

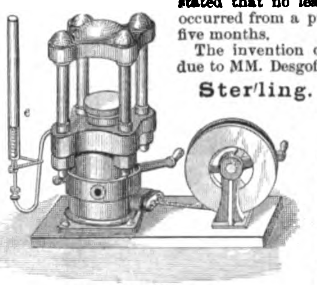
by a crank or a band-wheel on the outside. The pressure acts upon a piston *d*, moving water-tight in a cylinder as usual.

Another form, having a vertically acting piston, is shown in Fig. 5806. This is provided with a manometer *e*, to show the amount of pressure exerted.

The liquid employed for filling the chamber is oil; the rope, about 4/10 inch in diameter, is of catgut; the packing, combed hemp; this in time becomes compacted to a horny consistency, and it is stated that no leakage whatever has occurred from a press in daily use for five months.

The invention of this apparatus is due to MM. Desgoffe and Ollivier.

Fig. 5806.



Sterhydraulic Press.

Ster'ling. (*Engineering.*) See STARLING.

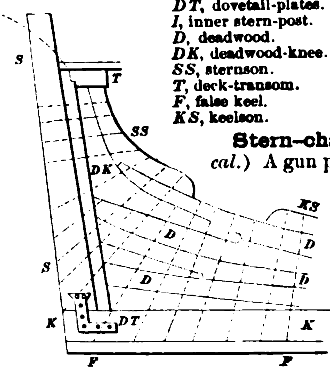
Stern. (*Shipwrighting.*) The *after part* of a vessel. The rail around the upper edge is the *taffrail*. The *stern* terminates below at the junction of the *stern-post* with the keel. Sterns are *round* or *square*.

A ship is said to be *down by the stern* when drawing more water aft than forward.

Of the parts in a vessel's stern, —

Fig. 5807.

S is the stern-post.
K, keel.
DT, dovetail-plates.
I, inner stern-post.
D, deadwood.
DK, deadwood-knee.
SS, sternson.
T, deck-transom.
F, false keel.
KS, keelson.



Parts in a Vessel's Stern.

Stern-chas'er. (*Nautical.*) A gun pointing through a stern-port.

Stern-fast. (*Nautical.*) A warp mooring the after part of a vessel to a wharf or quay.

Stern-frame. (*Shipbuilding.*) That composed of the *stern-post*, *transom*, and *fashion-pieces*.

Stern-knee. One uniting the stern-post and keel.

Stern-port. (*Nautical.*) An opening in the stern of a ship. A *cargo*, *light*, *air*, or *gun* port, as the case may be.

Stern-post. (*Shipbuilding.*) A slightly raking straight piece, rising from the after end of the keel, to which it is secured by tenons and dovetail-plates. See STERN.

Stern-sheets. (*Nautical.*) That part of a boat which is included between the stern and the aftermost thwart.

It is the place of honor in the boats of a government or other vessel, and for passengers in ferry-boats and wherries.

Stern'son. (*Shipbuilding.*) A binding-piece above the deadwood in the stern, and practically forming an extension of the keelson, on which the stern-post is stepped.

Ster'ro-met'al. An alloy invented by Baron Rosthorn of the Imperial Arsenal, Vienna, and used as a gun-metal.

It has, —

Copper	55.04	or	57.63
Tin	0.83		0.15
Zinc	42.36		40.22
Iron	1.77		1.86

It differs from *Keir's metal*, English patent, December 10, 1779, mainly in having a small quantity of tin.

Keir's metal is, —

Copper	100
Zinc	75
Iron	10

See ALLOY.

Stet. (*Printing.*) *Let it stand.* A marginal mark directing attention to a portion of the matter, and countermanding an order to expunge it.

A series of dots made below the matter has the same effect.

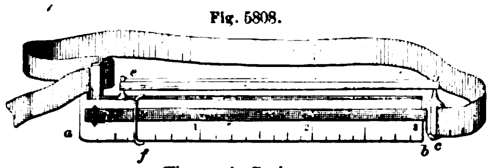
Ste-thom'e-ter. (*Surgical.*) An instrument for measuring the external movement in the walls of the chest during respiration, as a means of diagnosis in thoracic disease.

In one form a cord is extended round the chest, and its extension, as the thorax is expanded, works an index-finger on a dial-plate. It thus becomes a measure of the expansive power and capacity of the lungs.

The *spirometer* measures the quantity of air inhaled, but is the measure of the *thoracic* and the *diaphragmatic* breathing; the latter is that of tranquil respiration, known as *tidal* breathing; the former comes in as auxiliary, is the result of volition, or results from the impeding of abdominal expansion, and is known as *complementary* breathing. The stethometer measures the costal expansion.

Tiemann's stèthometer consists of an outer case marked with a scale of three inches *a b*, within which moves a slide *c d* bear-

Fig. 5808.



Tiemann's Stethometer.

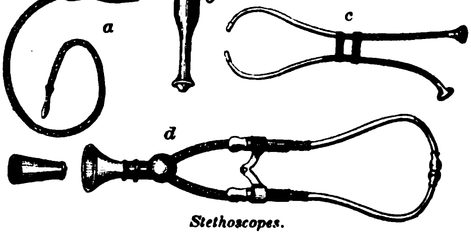
ing an indicator *d*. To the end of this slide is attached an ordinary measuring-tape, the first three inches being cut off, so as to render the scale continuous; this is passed around the chest and drawn through the catch at the opposite end of the instrument. As the lungs are inflated the slide is drawn out, and the indicator shows the exact amount of expansion. A hard rubber ring *f*, sliding easily over the scale, may be used to render the stethometer self-registering; *e e* is an elastic band to draw the two portions of the instrument together.

Dr. J. C. Draper states that in ordinary respiration, on making sixteen respirations in the minute, and continuing the experiment for twenty minutes, the average of five different series of experiments gives 622 cubic inches of air expired each minute (38 7/8 at each expiration).

Steth'o-scope. (*Surgical.*) An auscultation-instrument, invented by Laënnec for exploring the chest. It is a hollow cylinder of wood with a funnel-shaped end, which is placed upon the chest, while the operator listens at the other end to the audible murmurs of the thoracic viscera.

It is variously constructed of cedar or metal, with horn, hard rubber, or ivory mountings. Flexible instruments of rubber

Fig. 5809.



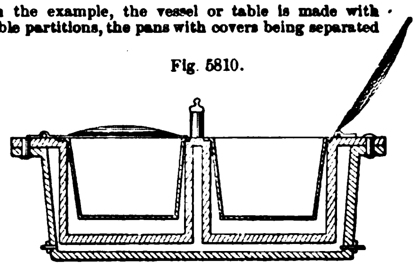
Stethoscopes.

are also used, and are provided with one or two ear-tubes. In the latter case, the pulsation or murmur being appreciable by both ears, a more definite impression is attained. When the bi-tubular stethoscope has distinct mouths and ear-pieces it is termed *differential*, as the comparative conditions of the respective sides of the chest may be examined thereby. *a b c* (Fig. 5809) are various forms. *d* is Camma's double-tube stethoscope.

Stew-pan. A cooking-utensil for exposing meats to a prolonged gentle heat; usually in well-appointed kitchens a charcoal-furnace or steam-bath.

In the example, the vessel or table is made with double partitions, the pans with covers being separated

Fig. 5810.



Stew-Kettle.

by a double jacket, leaving a space for steam to enter and pass around a pipe in each end at the bottom.

Stib'i-um. A name for antimony ore. Its abbreviation *Sb* is used in chemistry as the symbol for metallic antimony.

Stic-ca'to. (*Music.*) An Italian instrument having bars of wood of gradual size and depth of tone, suspended in a box and played by percussion. Resembles a dulcimer. The *lapideon* or *wood-harmonicon.* See also XYLOPHONE.

Stick. 1. (*Wood-working.*) To plane the moldings on sash-bars and rails. See SASH-STICKING MACHINE.

2. A rammer used in filling cartridges.

3. (*Pyrotechnics.*) The slat which trails behind a rocket and directs its flight.

4. (*Printing.*) *a.* A compositor's hand-tray for holding type. (See COMPOSING-STICK.) A *stick-ful* is as much as the *stick* will hold, and the *matter* is then lifted and placed in the *galley.*

b. Furniture for locking up a form in a chase or galley. Known according to position as *head*-stick, *foot*-stick, *side*-stick, or *gutter*-stick, the latter being between the pages. *Quoins* driven around the *sticks lock* the *matter* in the *chase.*

5. A walking-cane. (See CANE, page 443.) For the ethics and romance of the subject, see "The Story of the Stick in all Ages and Lands." Translated and adapted from the French of Antony Real (Fernand Michel). New York: J. W. Bouton.

Stick-chim'ney. One made with sticks laid crosswise and plastered with clay inside and out. Common in the West with log-cabins.

Stick'er. (*Music.*) A rod connecting the far end of the key of an organ-manual with the lever by which the valve is opened, to allow the wind to pass from the chest to the appropriate reed or pipe of the organ.

Stick'ing. 1. (*Mining.*) A narrow vein of ore.

2. (*Carpentry.*) *Running* or *striking* a molding with a molding-plane.

Stick'ing-plas'ter. Two solutions are first made: one, an ounce of isinglass in eight ounces of hot water; and the other, of two drachms of gum benzoin in two ounces of rectified spirits. These solutions are to be strained and mixed. Several coats of this mixture kept fluid by a gentle heat are then to be applied with a camel's-hair brush to a piece of silk stretched on a frame, each coat being allowed to dry before the next is applied. A layer of a solution composed of one ounce of Chian turpentine in two ounces of tincture of benzoin is then to be applied to the other side of the silk and allowed to dry.

Stiff-bit. (*Harness.*) A bit without a joint, like a snaffle; or branches, like a curb-bit.

It is a stiff bar with rings at the end as cheek-bars

to keep the rings out of the horse's mouth. It is usually of round iron.

Hale's *driving-bit*, September 10, 1867, is of round iron, and is covered with a rubber tube.

Dawson's *bit*, September 24, 1867, has a bar of twisted wire with a soft rubber covering.

Arnold's *stiff-bit*, August 7, 1866, is tubular. Metallic straps are passed around the bridle-rings and are screwed into the ends of the bit.

Stiff'en-ing-gird'er. A truss girder which distributes the weight of the platform and load upon the suspension-chain and prevents undulations.

Sti'fler. (*Military Engineering.*) A small mine made for the purpose of interrupting the operations of the enemy's miners. A *camouflet*.

Sti'fle-shoe. (*Farriery.*) A horseshoe which has a curved bar beneath it, exposing a rounded surface to the ground, so as to give it an insecure foundation. It is placed on the foot of the sound leg, in order to induce the animal to throw the weight of the hind-quarters upon the foot of that leg which is *stifled*, that is, has a luxated or weak *stifle-joint*.

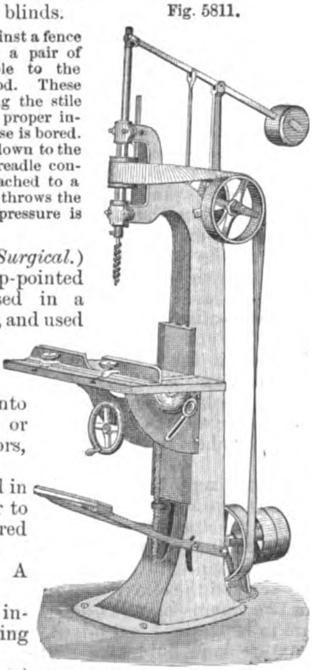
Stile. 1. One of the vertical bars in a wooden frame, as of a door or sash. In the former they receive the *rails* and *panels;* in the latter, the *rails* and *bars*. See DOOR; SASH.

2. A frame of bars and steps, which may be climbed by a pedestrian, but opposes the passage of horses and cattle.

3. The gnomon of a sun-dial.

Stile-bor'ing Ma-chine'. (*Wood-working.*) A machine for boring the circular mortises to receive the tenons on the end of slats for Venetian blinds.

Fig. 5811.



Stile-Boring Machine.

The stile is held against a fence on the feed-table by a pair of gage-wheels adjustable to the thickness of the wood. These turn freely, permitting the stile to be fed forward the proper interval after each mortise is bored. The auger is brought down to the work by pressing a treadle connected with a rod attached to a weighted lever, which throws the auger up when the pressure is withdrawn.

Sti-lette'. 1. (*Surgical.*) *a.* A small, sharp-pointed instrument inclosed in a cannula, or sheath, and used for making openings for the introduction of the said cannula into dropsical tissues or cavities, into tumors, etc.

b. A wire placed in a flexible catheter to give it the required form and rigidity.

2. (*Weapon.*) A dagger. *Stiletto.*

3. A pointed instrument for making eyelet-holes.

Still. In its most general sense, an apparatus by which the volatile matters which enter into the composition of certain substances are eliminated by means of heat, being usually recondensed in their own proper form. This includes apparatus for extracting tar, etc., from wood.

In a more restricted sense, it is applied to apparatus for extracting and condensing the more volatile parts of liquids, as alcohol from saccharine solutions which have undergone the vinous fermentation.

The volatilization and recondensation unchanged of such substances as mercury, sulphur, or zinc, is, properly speaking, *sublimation*.

Though the decomposition of sulphuret of mercury by distillation, or rather sublimation, is mentioned by Dioscorides, yet the first distillation of a fluid, that of fresh water from sea-water, is to be found in the commentary of Alexander of Aphrodisias in Caria, to Aristotle de Meteorol. Alexander lived under the reigns of Septimius Severus and Caracalla.

"Zosimus the Panopolitan" (about A. D. 400) "had described in former times the operation of distillation by which water may be purified; the Arabs called the apparatus for effecting it an *alembic*." In his treatise, the process is concealed in mythical language.

Djafar (Gebir), who lived toward the end of the eighth century, was the first to describe nitric acid and aqua regia. The former he obtained by distilling in a retort Cyprus vitriol, alum, and saltpeter. The latter made gold potable, and no doubt induced the worthy Arabian to think that he was on the eve of the discovery of the transmutation of metals.

To Rhazes, born A. D. 860, physician-in-chief to the great hospital at Bagdad, is due the credit of the discovery of *absolute* alcohol, which he obtained by distilling spirit of wine from quicklime. He also prepared sulphuric acid.

Achild Bechil obtained phosphorus by the distillation together of urine, clay, lime, and powdered charcoal.

"The preparation of nitric acid and aqua regia by Djafar (whose proper name was Abu-Mussah-Dschafar, and also known as Gebir) is more than 500 years anterior to Albertus Magnus and Raymond Lully, and almost 700 years anterior to the Erfurt monk, Basilius Valentinus. Nevertheless, the discovery of these dissolving acids, which constitutes an epoch in chemical knowledge, was long ascribed to the three last-named Europeans. Respecting the rules given by Rhazes, see Hofer, Hist. de la Chimie, I. 325. Although Alexander of Aphrodisias, properly speaking, only describes circumstantially distillation from sea-water, yet he also indicates that wine may also be distilled. This is the more remarkable, because Aristotle had put forward the erroneous opinion that in natural evaporation fresh water only rose from wine, as from the salt water of the seas.

"The Arabians are to be regarded as the proper founders of the *physical sciences*, in the sense which we are now accustomed to attach to the term." — HUMBOLDT.

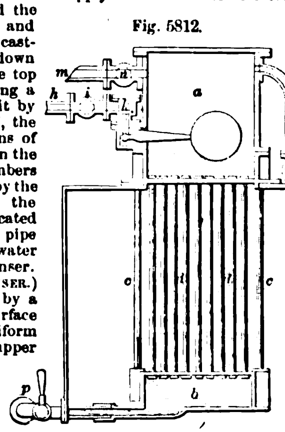
Europe unquestionably owes its knowledge of the art of distillation to the Arabs. Arnold di Villa Nova, 1318, practiced distilling spirits of wine. The use of wines and spirits being prohibited to the Mohammedans, alcoholic spirit was never common among them, and we find that long after its introduction into Europe it was regarded rather as a sovereign remedy, as its Latin name *aqua vitæ*, perpetuated in the French *eau de vie*, implies. It was originally derived from wine or the marc of grapes; the distillation from grain was of later origin.

Quiros distilled fresh from salt water on his ship on a considerable scale, and this has been frequently done since.

Perhaps the simplest apparatus for this purpose is that employed in the Polar expedition of Captain Phipps, in 1773, otherwise principally noted from the fact that Nelson, then a boy, served on one of the vessels. It consisted simply of a caldron having a spout, at the end of which a large swab or bunch of rope-yarns was suspended; this condensed the vapor free from salt, the water dripping into a vessel beneath. It is said, to have furnished a sufficient supply for the ship's company.

Hall's *sea-water still* for the supply of fresh water to steam-boilers, to make good the loss by the safety-valve and leakage, consists of a cast-iron vessel *a* bolted down over an aperture in the top of a boiler, and having a vessel *b* connected to it by rods *c c* and tubes *d d*, the latter forming a means of communication between the upper and lower chambers *a b*. Sea-water enters by the pipe *h* and stands in the still to the hight indicated in the illustration; the pipe proceeds from the cold-water chamber of the condenser. (See SURFACE-CONDENSER.) *k* is a valve governed by a float by which the surface of water is kept at a uniform level. From the upper part of the chamber *a*, a pipe *m* proceeds to the upper chamber of the SURFACE-CONDENSER (which see), and a stop-cock *n* gov-

Fig. 5812.



Sea-Water Still.

erns the passage. *p* is the blow-off cock by which the water is expelled when it has attained a given degree of saturation.

When the water in the boiler has sunk below the desired level, the engineer opens the cock *n* leading to the refrigerator of the condenser, and the steam in the chamber *a* rushes through the pipe *m* and reaches the condenser, where it is condensed and passed to the boiler along with the water resulting from the condensation of the steam from the cylinder. The partial vacuum in chamber *a* causes the water to boil rapidly, and the evolution of steam followed by its condensation and subsequent propulsion to the boiler by the action of the air-pump, restores the proper water-level in the boiler, which is observed by the engineer, and the cock *n* closed.

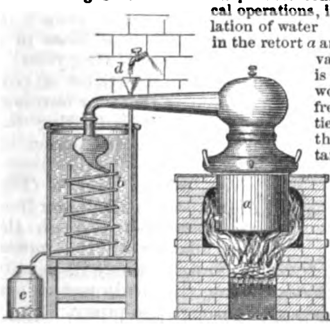
i is the stop-cock in the water-supply pipe.

When the salt water reaches the point of saturation, the cocks *n i* are shut, and the cock *p* opened; the latter connects with a discharge-pipe passing through the side of the vessel, and the water and sediment are driven out.

By means of this still, fresh water evaporated from sea-water is obtained to compensate for losses by leakage and escape. This still was employed upon the "Sirius," 320 horse-power, which crossed the Atlantic in 1838. The "Great Western" and "Sirius" were 19 years behind the steamer "Savannah," which crossed eastward in 1819. See STEAMBOAT.

The common still consists of a retort, or still proper, in which the substance is heated, and a condenser, called a worm, on account of its usually having a spiral shape. The retort is generally made in two parts; the *pan* or *copper*, to which heat is applied, and the *head*, which is removable. (See ALEMBIC.) It is made in some cases of earthenware, but more generally of copper, plain or electro-plated with silver; for some special purposes of platinum, and for others it may be of iron or glass.

Fig. 5813.



Fresh-Water Still.

Fig. 5813 is a simple form of still, adapted for common pharmaceutical operations, including the distillation of water. This being placed in the retort *a* and heat applied, the vapor passes over and is condensed in the worm *b*, the water freed from its impurities being received in the vessel *c*. The tank surrounding the worm is constantly supplied with cool water, which enters by the pipe *d*, having its outlet near the bottom, and is discharged near the top.

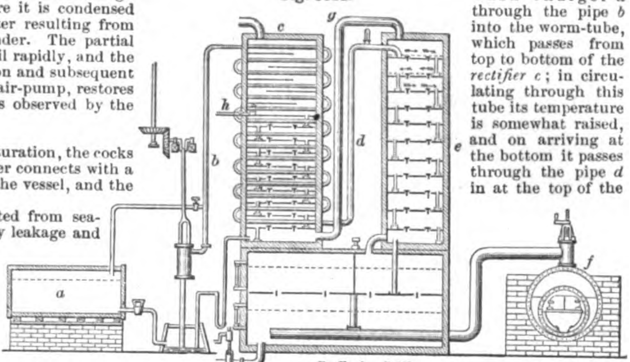
The mode of obtaining the attar of roses at Ghazepore on the Ganges is thus described by Hooker, the naturalist: —

"The rose-gardens surround the town: they are fields, with low bushes of the plant, grown in rows, red with blossoms in the morning, all of which are, however, plucked long before midday. The petals are put into clay stills, with twice their weight of water, and the produce, distilled over, exposed to the fresh air, for a night, in open vessels. The attar is skimmed from the exposed pans, and sells at £10 ($50) the rupee weight (silver coin worth nearly 50 cents). To make this weight twenty thousand flowers are required. The attar is frequently adulterated with sandalwood oil."

Continuous distillation was first carried out by Baglioli, and afterward much improved by Blumenthal and Derosne. See Muspratt, page 75, *et sequitur*. The process is now very generally adopted for distillates which are to be produced in large quantities, high and low wines, and the various grades of petroleum oils being procured from the mash or wine and from crude petroleum respectively at one operation. The forms of apparatus employed are very numerous, many being specially adapted for petroleum. See PETROLEUM-STILL.

In the manufacture of ardent spirits, the alcoholic liquor is obtained from the fermentation of a saccharine solution, derived generally from grain, potatoes, grapes, or sugar. The alcohol, being more volatile than water, passes over first, but with it a large proportion of water is always condensed. To separate this water and obtain spirit of the required strength, it is necessary to redistill the product or return it to the still, and proceed with the operation until the required strength is attained. Dorn's still, yet employed in Germany, was one of the earliest invented for this purpose. Of the improvements on this, Derosne's is generally used in France, while Coffey's (Fig 5814) is preferred in England. In this the saccharine solution, or *wash*, is pumped from the wash-charger *a* through the pipe *b* into the worm-tube, which passes from top to bottom of the *rectifier c*; in circulating through this tube its temperature is somewhat raised, and on arriving at the bottom it passes through the pipe *d* in at the top of the *analyzer e*. Here it falls successively from one to another of a series of shelves, perforated, and having valves for the entry of steam from the boiler *f*, by which they are heated. As the wash gradually descends in the analyzer, it becomes rapidly weaker, partly from condensation of the steam which passes into it, and partly from the loss of alcohol either evaporated or expelled by the steam, till when it arrives at the bottom it has parted with all its spirit. At the same time, the vapor as it rises through each shelf of the analyzer becomes richer in alcohol. On arriving at the top it passes through the pipe *g* in at the bottom of the rectifier; here it ascends in a similar way through the descending wash until it arrives at *h*, above which it merely circulates around the upper convolutions of the wash-pipe, the low temperature of which condenses the spirit, which, collecting on a shelf, flows off by a tube into the finished-spirit condenser, and is finally conveyed to the receiver.

Fig. 5814.



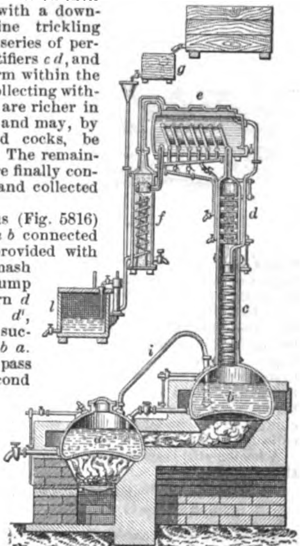
Coffey's Still.

In order to economize heat, the water-supply pipe of the boiler is of spiral form, and is immersed in a trough which receives the boiling-hot spent wash.

Cellier Blumenthal's apparatus, improved by Derosne (Fig. 5815), consists of two stills *a b*, a first rectifier *c*, a second rectifier *d*, a warmer and dephlegmator *e*, a condenser *f*, a regulator *g*, and a contrivance for regulating the flow of wine from the cistern above.

The stills *a b* are filled with wine, the first acting as a boiler; the low-wine vapors pass through the pipe *i* to the bottom of the still *b*, and the vapors from this on their upward course meet with a downward current of wine trickling through and among a series of perforated disks in the rectifiers *c d*, and are condensed in a worm within the fore-warmer *e*; those collecting within the first of the coils are richer in alcohol than the rest, and may, by appropriate pipes and cocks, be drawn off separately. The remaining alcoholic vapors are finally condensed in the worm *f* and collected in the cistern *l*.

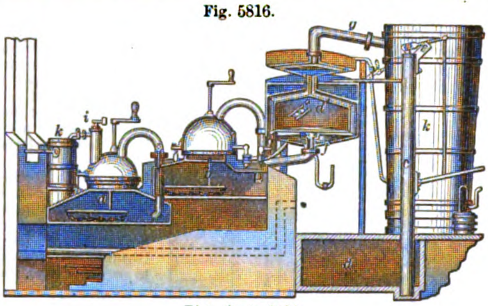
Fig. 5815.



Cellier Blumenthal's Still.

Pistorius's apparatus (Fig. 5816) consists of two stills *a b* connected by pipes, and each provided with mash-stirrers. The mash is transferred by the pump *c* from the mash-cistern *d* to the fore-warmer *d'*, whence it is conveyed successively to the stills *b a*. The alcoholic vapors pass from the first to the second still, and sometimes to a third, then entering the rectifier *e* above the mash fore-warmer, and in part being condensed in the low-wine cistern *f* beneath, finally pass by the pipe *g* into the condenser *h*. The pipe *i* is provided with an inwardly opening safety-valve, and connects with a small cistern *k*, from which samples, showing the progress of the operation, may be taken.

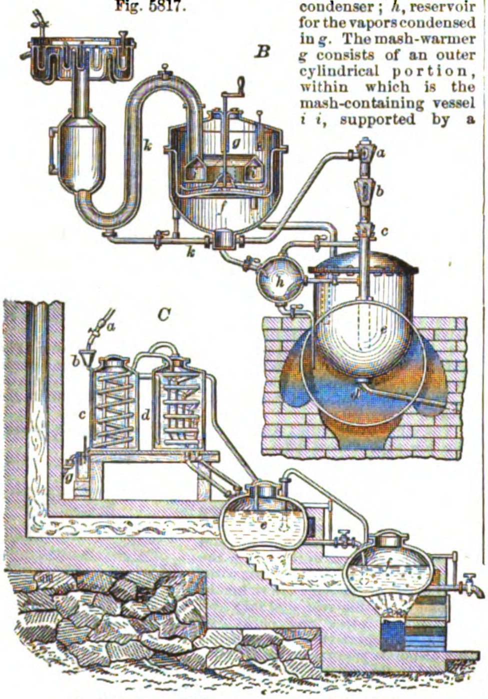
Fig. 5816.



Pistorius's Still.

Siemens's apparatus (*B*, Fig. 5817) comprises two mash-stills set in a boiler and capable of being alternately used by means of the three cocks *a b c*. *d* is the boiler; *e*, one of the mash-retorts; *f*, low-wine receiver; *g*, fore-warmer; *h*, reservoir in which the condensed water for boiler-feed is collected; *g*, dephlegmator, or water-condenser; *h*, reservoir for the vapors condensed in *g*. The mash-warmer *g* consists of an outer cylindrical portion, within which is the mash-containing vessel *i i*, supported by a flange and provided with a rotary stirrer: it is heated by vapors entering through the pipe *k*, which afterward pass into the lower cylinder of the dephlegmator.

Fig. 5817.



B, *Siemens's Still.* *C*, *Langier's Still.*

In Langier's apparatus *C*, the fluid to be distilled flows from the tube *a* into the funnel *b*, and thence into the vessel *c*, entering its lower part and serving to condense the alcoholic vapor. From thence it passes through another tube to the lower part of the vessel *d*, whence it is successively conducted to the upper and lower stills *e f*; the vaporized portions return through the stills and condensers in a reverse direction, undergoing a final condensation in the worm *c*, and the alcohol is collected in the receiver *g*.

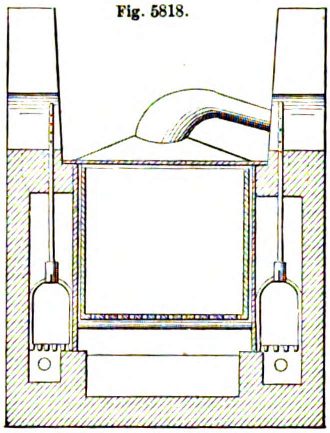
A leaden still is used for obtaining fluoric acid, from the distillation of

Fluoride of calcium	1 part.
Sulphuric acid	2 parts.

The result of the process is a vapor of hydrofluoric acid which is condensed in the worm, sulphate of lime remaining in the still.

The still or retort for distillation of sulphuric acid is made either of platinum or glass, according to the manner in which the process is conducted. See SULPHURIC-ACID APPARATUS.

Fig. 5818.



Still for distilling Pine Wood.

Fig. 5818 is a still for distilling tar from pine wood. The billets of wood are packed vertically in a box, which is then placed in the retort; the grate is vertically adjustable, to act first upon the wood and afterward upon the tar.

Still'age. A low stool to keep cloths off the floor of a bleachery.

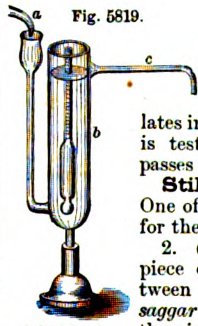
Still'ing. A stand for casks. A *stillion.*

Stil'lion. A stand for casks. The *rounds* or *cleansing vats* of a brewery stand on *stillions* in a trough which conveys away the overflowing yeast.

Stillions are also used to support articles of pottery in the drying kiln to prepare them for burning.

Still-watch'er. A device for indicating the progress of a distillation by the density of the liquid given over. Mohr's (Fig. 5819) receives the liquor from the condenser through the bent adapter *a*. It accumulates in the vessel *b*, where its density is tested by the hydrometer, and passes off through the pipe *c*.

Fig. 5819.



Still-Watcher.

Stilt. 1. (*Hydraulic Engineering.*) One of a set of piles forming the back for the sheet-piling of a *starling.*

2. (*Pottery.*) A little, pointed piece of pottery, used to place between pieces of biscuit ware in the *saggar* to prevent the adherence of the pieces.

3. (*Husbandry.*) A term sometimes applied to the handles of a plow; the word "handles" being confined to the upper end of the stilts, where they are grasped by the hands. The term "stilts," in this sense, is regarded by Webster as an English provincialism. They are usually termed handles in this country.

4. A stave with a foot support; a pair of them being used to raise a person above the ground in walking. In England and the United States stilts are but a sport or exercise, but in the Landes, a flat pasture-country of Southwestern France, the shepherds use them habitually.

Stink-ball. A nasty pyrotechnic, which makes a suffocating smoke and odor, to be thrown among working parties, or on an enemy's deck at close quarters. It is composed of pitch, rosin, niter, gunpowder, colophony, assafœtida, sulphur, etc. Used by the Chinese and Malay pirates.

Stink-pot. A vessel used by the Chinese and Malay pirates to throw on board a vessel to suffocate the crew.

Stink-trap. A device for preventing the passage of mephitic air and gases from the receiving openings of drains. See AIR-TRAP; STENCH-TRAP.

Stint. (*Mining.*) A given quantity of work to be performed.

Stip'ple. Another name for *chalk* engraving; so called because it consists of dots, and resembles chalk-drawings made upon rough paper.

Dots are made instead of lines, and these are closer, deeper, and larger, in accordance with the depth of color desired.

The chalk-drawings of Sir Thomas Lawrence were much admired, and the style became fashionable. This mode of engraving originated with Jacob Bylaert, of London, in 1769, and was practiced in France during the early part of last century, but did not arrive at the greatest excellence until early in the present century. It does not fall within the scope of this work to enumerate the masters in this style of the art of engraving, but the softness and beauty of its finish in representing flesh and statuary are very admirable. Bartolozzi is said to have brought it to perfection; more brilliancy and vigor have been attained by later engravers, but not more grace and softness. It is usual to form the basis by etching in the dots, but the beauty of finish, rotundity, and delicacy are the work of the graver.

They are made through a *ground* on the plate, and then *bit-in* by acid. Afterward they are modified, deepened, and enlarged by the action of a graver, whose *belly* is concave, so as to present the point more vertically to the face of the plate than usual in *line* engraving, where the belly is slightly convex.

The *ground* is a resinous mixture, which is spread smoothly upon the heated plate, and then allowed to cool. When this is removed by the etching-needle, the subsequent action of the acid makes little pits in the plate, which hold the ink when printing. See GROUND; ENGRAVING.

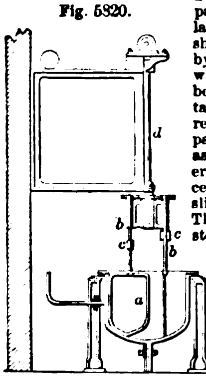
Stip'pling-ma-chine'. (*Metal-working.*) A machine or tool for giving a roughened or, as it is termed, *matted* surface to metal in order that the *dead* portions may form a foil to the more lustrous ones.

See patents 111,086, January 17, 1871; 126,408, May 7, 1872; 128,290, June 25, 1872.

Stir'rer. A mechanical device to keep a solution from settling.

The mechanical stirrer for color-pans in a calico-printing works consists of a brass rod bent into the form shown at *a*. Two of these are suspended in each pan by hooks from the shafts *b b*, collars *c c* slipping over the joints. The shafts *b b* have independent rotation by the spur-wheels meshing with a wheel on the shaft *d*, from which they both depend, and which is itself rotated by bevel gears above. The stirrers are thus revolved around the pan, and rotate around each other, so as to be brought in contact with every part of the color. When the process is finished, the collars *c c* may be slid up and the stirrers unhooked. The pans are supplied by pipes with steam and cold water.

Fig. 5820.



Stirrer.

Stir'ring-bud'dle. (*Mining.*) See BUDDLE.

Stir'rup. 1. (*Manege.*) A loop or ring suspended from the saddle for the foot of the rider.

Fig. 5821 shows several kinds of stirrups.

a is formed of a block of wood, through which the stirrup-leather is rove. *a'* is the block detached.

b has a pair of branches, which, if a rider be thrown and the foot catch in the stirrup, pull apart and release the foot *b'* is a spring which holds the parts in normal position, except when the strain occurs in case of accident.

c is also a safety-stirrup, having a pivoted foot-rest which throws the foot of a dismounted rider out of the stirrup.

d has a roller at the top and joints at the sides, to release the foot.

e has a guard to keep the foot from penetrating so far that it would be jammed in case of accident.

f is the Engle stirrup. It has a bent wooden frame, with arms united at top by a ferrule and stirrup-strap.

g shows the frame detached. *h* is the hood

The ancients mounted their horses in various ways: —

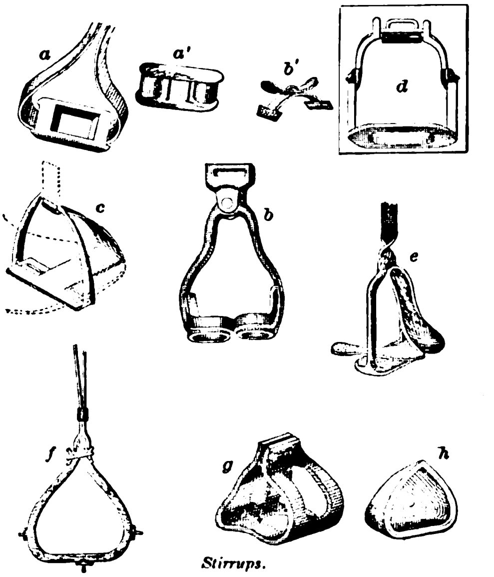
By vaulting.

By short ladders.

By teaching their horses to kneel.

By horse-blocks.

Fig. 5821.



Stirrups.

By grooms, who lifted them on.

By the hands or knees of their servants.

By a step or projecting-bar on their spears.

No traces of the stirrup are found in the old Greek and Latin writings, coins, or statues. The celebrated equestrian statues of Trajan and Antoninus are destitute of stirrups, the legs of the riders hanging down without any support whatever. Xenophon does not mention them in his work on horsemanship and the art of riding. See SADDLE.

Hippocrates and Galen speak of a disease among the Scythians occasioned by long and frequent riding, because the legs hang down without any support. There is no word in Greek or Latin, down to the sixth century, which signifies the stirrup or its use.

The first mention of the stirrup is in the work ascribed to the Emperor Mauritius, in the sixth century. He says, "The horseman must have at his side two iron *scalæ*." Leo VI., in his work on tactics, ninth century, uses the same word and describes the function of the stirrup. In the twelfth century they were common.

The Greek and Roman soldiers were trained to vault on to horseback, but in some cases mounted by a step on the spear which rested against the horse.

Stirrups were introduced into England by the Saxons. Stirrups and spurs appear on seals of the eleventh century.

The Japanese stirrups are of iron or *sappan* wood, very thick and heavy, not unlike the sole of a boot, and open on one side, so that the foot may be easily introduced or withdrawn. The stirrup-leathers are short, the rider's knees being much bent.

2. (*Machinery.*) A band or strap which is bent around one object and is secured to another by its tangs or branches.

Fig. 5822.

Stirrup.

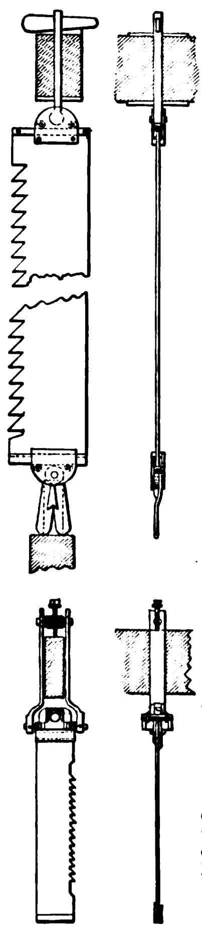
3. The iron loop or clevis by which the mill-saw is suspended from the *muley-head*, or in the sash. A *saw-buckle*. The example (Fig. 5823) shows two forms. The saw-blade may be held by a cotter or key which passes through a hole in the saw and above the bar from which it is suspended; or it may have cheek-pieces riveted to it, which afford hold for clamping devices.

4. (*Carpentry.*) *a.* A device for holding a rafter-post or strut to a tie. In wooden construction it consists of a wrought-iron loop secured by a through bolt to one piece and embracing the foot of the other. Fig. 5824 shows that employed for connecting a principal rafter and tie-beam. In iron framing the stirrup is usually wrought on the tie.

b. An iron strap to support a beam.

5. (*Nautical.*) A rope with an eye at the end for

Fig. 5823.

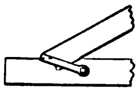


Stirrups for Mill-Saws.

supporting a foot-rope below its yard.

6. (*Shipbuilding.*) A plate which laps on each side of a vessel's dead-wood at the stem or stern, and bolts through all.

Fig. 5824.



Rafter-Stirrup.

Stir'rup-bar. (*Saddlery.*) The part of a saddle to which the stirrup-strap is attached. Some of the patented styles are called spring-bars.

Stir'rup-ir'on. (*Saddlery.*) The ring suspended from a saddle and in which a foot is placed.

Stir'rup-leath'er. (*Saddlery.*) The strap by which the stirrup is attached to the saddle.

Stir'rup-strap. A band by which a stirrup is suspended.

Stitch. A pass of a needle in sewing. The mode of making the stitch and the kind of stitch characterize the various kinds of sewing-machines. See SEWING-MACHINES, pages 2123, 2124, and Plate LVII.

The amount of thread taken by the different kinds of stitch is about as follows: —

Lock-stitch being	=	1
Chain-stitch is	=	1.8
Double-thread chain	=	2.5

Thread to the yard of average goods, depending on thickness of fabric: —

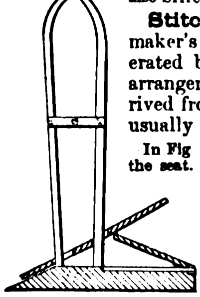
Lock-stitch........ 2.5 to 3 yards.
Chain-stitch....... 4.5 to 5.4 yards.
Double chain-stitch 6.25.

Stitch'ing. (*Bookbinding.*) Fastening the sheets of a pamphlet or book together by threads passed through holes simply *stabbed* through the pile. A cheap substitute for *sewing*.

Stitch'ing-clamp. A work-holder much used by saddlers and harness-makers, and by others stitching stiff material.

In Fig. 5825, the pivoted jaw is opened or closed by pressure on the respective ends of the toggle-treadle, which is pivoted to one leg, and hinged to a plate connecting it with the base-piece. See also STITCHING-HORSE.

Fig. 5825.



Stitching-Clamp.

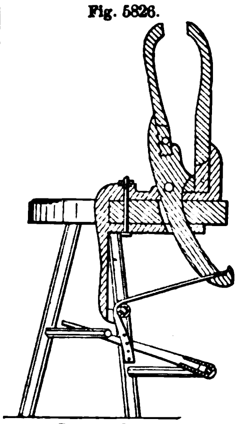
Stitch'ing-horse. A harness-maker's work-holder, having jaws operated by treadle and cord, or similar arrangement. The term *horse* is derived from the fact that the workman usually sits astride of the seat.

In Fig. 5826, the clamp-frame is bolted on the seat. The moving jaw runs beneath the seat, and is actuated by a strap passing over a sheave to a treadle.

In Fig. 5827, instead of securing the clamp rigidly to the frame, it is made vertically adjustable, to suit the varying stature of persons using it. The pin secures it at the required hight to plates depending from the seat.

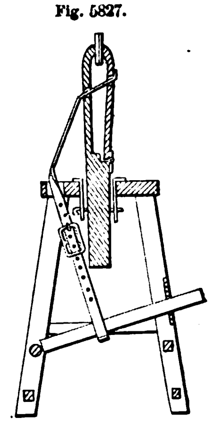
In Depp's stitching-horse, October 27, 1868, the weight of the workman closes the jaws, the seat being connected thereto by lever and cord.

Fig. 5826.



Sewing-Clamp.

Fig. 5827.

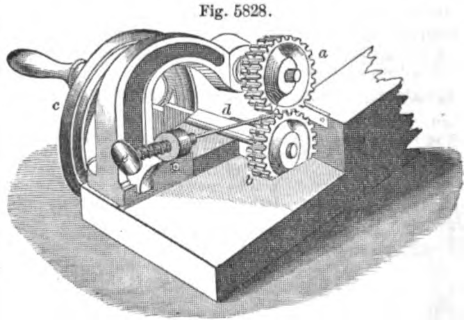


Stitching-Horse.

Stitch'ing-ma-chine'. The stitching-machine used for sewing together the ends of pieces of cotton cloth, for bleaching, washing, singeing, printing, dyeing, etc., was invented by Charles Morey, in England, in 1849.

It has two toothed wheels *a b*, gearing with each other and rotated by a handle on the fly-wheel *c*, the teeth of the wheels are cut away at the center, so as to form a continuous groove,

Fig. 5828.

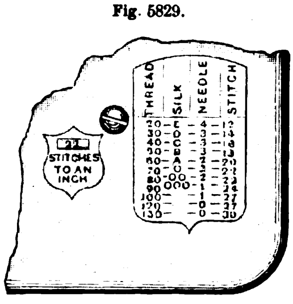


Stitching-Machine.

to which the point of the needle *d* is presented; this has an eye near its point, and is kept to its work by a spring. The cloth is crimped by passing through the rollers, and pushed forward against the needle, which carries the thread through the folds. When the ends of the two pieces have been joined in this way, the crimps are straightened out by pulling upon the edges. When a fresh thread is to be inserted, the needle is drawn back by the button *e* on the end of the holder. See SEWING-MACHINE, Figs. 4852, 4853.

Stitch-reg'u-la'tor. (*Sewing-machine.*) A device to determine the length of stitch according to the quality or thickness of goods, or for other cause. Some devices for this purpose are shown under SEWING-MACHINE. See Fig. 4867.

Fig. 5829.



Stitch-Regulator.

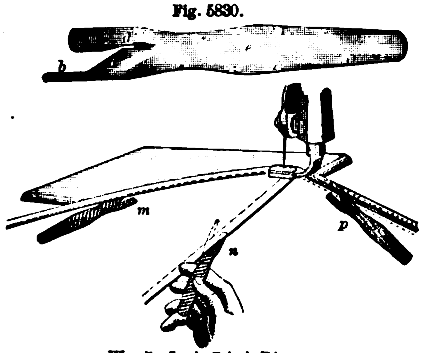
The Willcox and Gibbs machine has a table on its cloth-plate, showing the proper relation of size of thread or silk, size of needle, and length of stitch. The oscillating lever has a segment of a cylinder, attached on the periphery of which are the

various numbers from 12 to 30, representing those numbers of stitches to an inch. As the lever is adjusted, each of these numbers is exposed at an opening in the cloth-plate seen within the shield. The proper thread and appropriate needle being determined, the suitable stitch is indicated and the lever moved until the determined number is exposed at the opening in the plate.

Stitch-rip'per. An instrument for opening a seam by cutting the stitches.

That shown is Wood's stitch-ripper, which is a flat tool with a guide *b*, guard *e*, blade *a*, and eye *d*. The figure shows it in three positions *m n p*, and above is one of the instruments on a larger scale. The guide enters between the folds, so as to bring the blade across the line of stitching.

Fig. 5830.

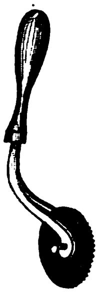


Wood's Lock-Stitch Ripper.

Stitch-wheel. (*Saddlery.*) A pricking-tool for marking out the site for a row of stitches, so as to render them uniform. The wheels are made with 8, 10, 12, or 14 points to the inch, and each fits in the same holder.

Called also *pricking-wheel*, the handle or carrier being called a *pricking-carriage*.

Fig. 5831.



Stitch-Wheel.

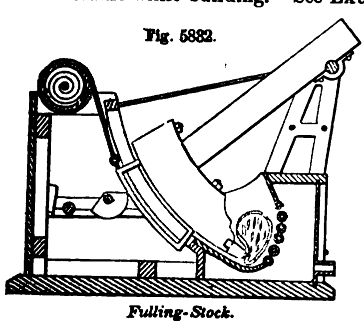
Stock. The term is applied to the principal piece, main frame, or handle of an implement or arm. That to which others are attached, or in which they are inserted, as, —

The barrel and lock to the *stock* of a fire-arm.
The trail to the *stock* of a gun-carriage.
The bit in the *stock* of a brace or a plane.
The shank in the *stock* of an anchor.
The anvil to its *stock* or pillar.
The screw-cutting die in its *stock*, or holder.
The irons to the *stock* of a plow.
The *beater* in a fulling-mill.
The wooden frame which supports the wheel and post of a spinning-wheel.
The *post* of an anchor.

1. (*Nautical.*) The cross-bar at the upper end of the shank of an anchor, which cants the anchor and turns a fluke down.

2. (*Shipbuilding.*) The frame which supports a vessel and its cradle while building. See LAUNCH.

Fig. 5832.



Fulling-Stock.

3. (*Building.*) Red and gray bricks used in party-colored brickwork.

4. (*Fulling.*) The beater of a fulling-mill.

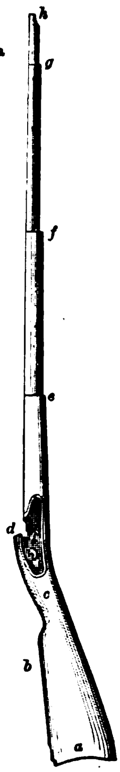
5. (*Husbandry.*) The part of a plow or other implement to which the *irons*, draft, and handles are attached.

6. That part of a fire-arm to which the barrel and lock are attached.

The stock of the United States service musket is made of well-seasoned black-walnut. The different parts are shown by their respective letters in the cut.

a, *butt*; the enlarged rear portion having a *cheek-piece* and *heel-plate*.
b, *comb*.
c, *handle*, *hand*, or *small*; its length and *bend* or *crook* determine the *fall* or *drop*.
d, head, having a *brass* side and *lock* side.
e, shoulder for lower band. At this point is the *thimble* for the ramrod.
f, shoulder for middle band.
g, shoulder for upper band.
h, shoulder and tenon for tip.
i, bed for lock.

Fig. 5833.



Gun-Stock.

7. (*Joinery.*) *a.* That arm of a bevel which is applied to the base or molding side; the *tongue* being applied to ascertain the angle of the meeting surface, or adjustable to test whether the proper bevel has been attained.

The *stock* forms a case for the *tongue*.

b. The *brace* which holds a bit for boring.

c. The block which holds the plane-bit.

8. (*Machinery.*) The handle which contains the screw-cutting die. See *f*, Fig. 4739.

9. Rags and material for making paper. Said also of other material used in business.

10. Lumber of regular market size, as distinguished from *dimension lumber*, which is sawn to specific sizes, to order; and may be beams, scantling, boards, etc. See STOCK-GANG.

The stock-saws of lumber regions are *gang-saws*, a number of saw-blades being arranged parallel in a gate and ripping the log into boards of the usual sizes. See SLABBING-GANG; STOCK-GANG.

11. Formerly, that part of the tally which the creditor took away as the evidence of the king's debt. (See ABACUS; TALLY.) The part retained in the Exchequer was called the *counter-foil*, or *counter-stock*.

Stock'ade. 1. (*Fortification.*) Stout timbers planted in the ground so as to touch each other, and loopholed for musketry.

In its most effective form it is 8 or 9 feet high, has a *ditch* in front, and a *banquette* in the rear.

2. (*Civil Engineering.*) A row of piles, or a series of rows with brushwood in the intervals, driven into a sea or river shore, to prevent the erosion of the banks. See GROIN; SEA-WALL; DIKE; RIVER-WALL; EMBANKMENT.

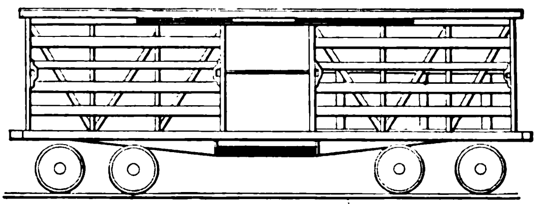
Stock and Die. The screw-cutting die in its holder. See *f*, Fig. 4739.

Stock-board. 1. (*Music.*) The board above the arrangement of register slides by which is regulated the access of air to the respective systems of pipes or reeds which form the *stops* of an organ. The *stock-board* is pierced with holes, in which set the lower ends or *feet* of the pipes.

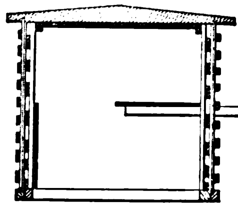
2. (*Brick-making.*) The board over which the brick-mold slips, and which forms the bottom of the latter while the brick is molding.

Stock-brush. For whitening and distempering. The tufts are on each side of a long head.

Fig. 5834.



Stock-car. A railway-car for carrying cattle, horses, sheep, hogs, etc. Some have but one deck, specially adapted for cattle and horses; others have two decks, for smaller stock.

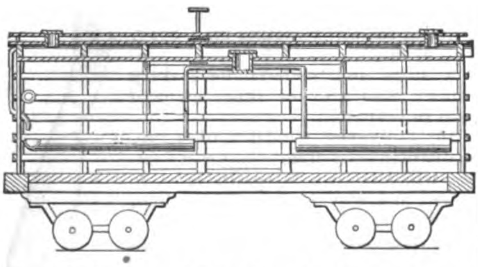


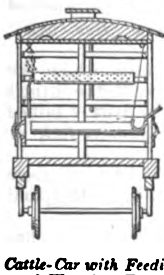
Convertible Stock-Car.

Fig. 5834 is an example of a convertible car. The deck consists of two sections, hinged respectively to the opposite sides of the car. When raised into a horizontal position they meet at the center, and are sustained by a beam or beams inserted in sockets beneath, to form a platform.

Fig. 5835 has an elevated reservoir and a pipe for leading water to the troughs to which the animals have access. Partitions in the reservoir prevent the surging of the water when the train is in motion. A feed-board is used in connection with the troughs, which latter are turned down out of the way when not in use.

Fig. 5835.





Cattle-Car with Feeding and Watering Trough.

Other cars have arrangements for converting the cattle-car into one for ordinary freight, the stalls folding away against the roof and sides, or unshipping, to be laid on the floor.

Stock'er's-saw. A small saw, specifically constructed for the use of the armorer or gun-stocker.

Stock-feed'er. A device for automatically supplying feed to stock in limited quantities at certain times. An ingenious but not commonly adopted device attached to some mangers.

Stock-fowl'er. A *blunderbuss.* A short gun with a large bore.

Stock-gang. An arrangement of saws in a gate, by which a log or balk is reduced to boards at one passage along the ways. The term *stock* is as distinguished from *slabbing ;* the latter reducing the log to a *balk* and to *slab-boards.* (See SLABBING-GANG.) The *stock-gang* makes *stock-lumber*, or regular market lumber, as distinguished from dimension lumber, which is sawn to a specific size, as ordered.

Stock-hole. (*Puddling.*) The opening through which the crude metal, or *stock*, is inserted. It is closed by a door which is counterweighted or raised by a lever.

Stock'ing. 1. A knit covering for the foot and leg.

2. (*Farriery.*) A device for remedying injuries to the tendons, varicose veins, etc., occurring in the lower part of a horse's leg. It has upright braces, to maintain a tension on the part; is perforated, to permit a certain degree of ventilation; and is secured by laces.

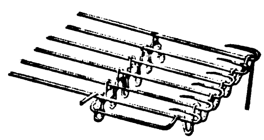
Fig. 5836.

Horse-Stocking.

Stock'ing-frame. The English term for a stocking-knitting machine. The term *frame* is there common, as *spinning-frame*, *warping-frame*, etc.

The stocking-frame was invented by William Lee, of Cambridge, England, 1589. In this machine the thread is first pushed down between each alternate needle of a set by a series of levers with plates, termed *jack-sinkers*, which are depressed successively by a sort of carriage on rollers, the *slur*, operated by the *slur*-bar. Another series of levers with plates, called *lead-sinkers*, is then depressed by a *sinker-bar*, forming a loop between each pair of needles. The loops are then pushed back out of the way of the sinkers and another set formed in the same way, which are then pushed into the open elastic hooks at the ends of the needles; the points of these hooks are then depressed by a *presser-bar*, holding the loops between them, and while thus closed the loops first made are drawn over them. A third set of loops is then formed and the second set drawn through them, and so on, the whole fabric being knit by forming successive series of loops and interlocking them with other loops in this way. See KNITTING-MACHINE.

Fig. 5837.



Stocking-Frame.

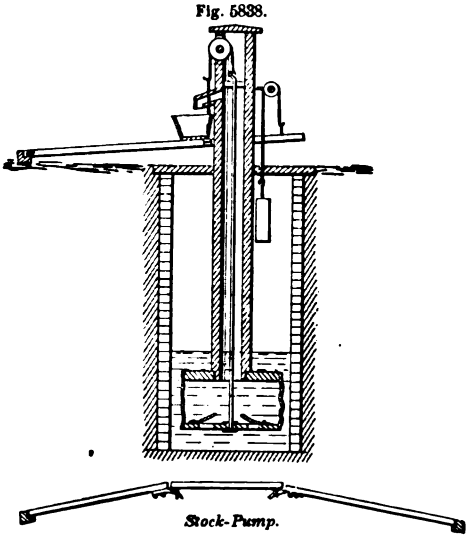
Stock'ing-ma-chine'. See STOCKING-FRAME; KNITTING-MACHINE.

Stock-lock. A lock adapted to be placed on an outer door. It is inclosed in an outer wooden case, and is opened and locked from the outside by the key, and bolted only inside.

Stock-pump. An arrangement in which the weight of the animals coming to drink is made to operate the pump.

In the example, the animal seeking water steps upon the pivoted platform at either side, and by depressing the same

Fig. 5838.



Stock-Pump.

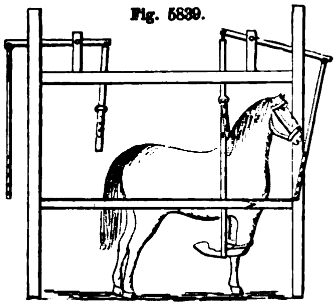
raises the pump-rod, together with the bottom board of the bellows. Water is thus forced into the tub from which animals drink. The flow continues until the bellows is depleted or the animal steps off the platform; in the latter case, the platform being raised by the weight, and the bottom board sinking so as to again fill the bellows.

Stocks. 1. (*Shipwrighting.*) A frame of blocks and shores on which a vessel is built. It declines down toward the water. It is usually a timber frame, which, as the building proceeds, assumes the form of a cradle. The *cradle* rests on ways, on which it eventually slides when the vessel is *launched.* The vessel is laterally supported by *shores;* the cradle is held by *struts* and *chocks.* In launching, the *shores* are removed, so that the vessel rests altogether in the *cradle;* the *ways* are greased or soaped; the *struts* are knocked away; the *chocks* knocked out, and the ship slides down the *ways* into the water, where the *cradle* becomes detached and floats away. See LAUNCH.

2. (*Farriery and Manege.*) A frame in which refractory animals are held for shoeing or veterinary purposes.

In the example, the straps are hitched to the limb of the animal and then attached to the frame above.

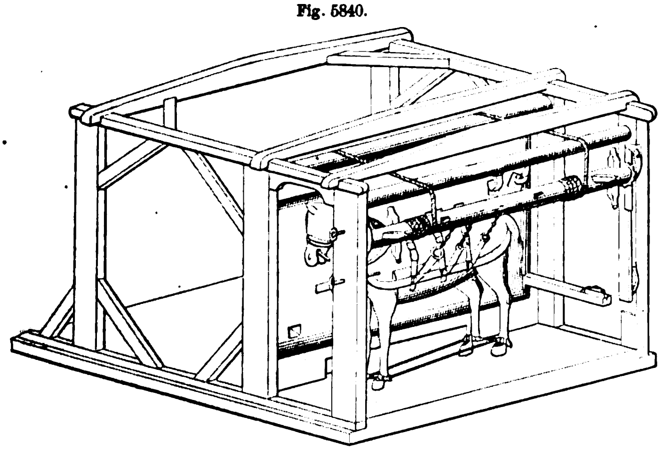
Fig. 5839.



Farrier's Stocks.

In Fig. 5840, the horse is strapped to a shutter, which is then lowered to a horizontal position, the feet being secured by bands. For treating broken limbs, the horse is slung by a belly-blanket and straps, which pass over a roller.

Fig. 5840.



Veterinary Stocks.

Stock-saw. A saw specifically used in gangs for sawing the staple market lumber. Those used in the Ottawa Mills, Chaudiere Falls, are No. 11 gage (Stub's wire-gage), and 4½ feet long.

Stock-shave. A form of shave used by block-makers.

Stock-shears. A shears used in shearing cloth.

Stock-stone. A rubbing-tool used by curriers on the grain side of leather to stretch and straighten it before currying.

Stock-tack'le. (*Nautical.*) A tackle applied to the stock of an anchor, when fished, to rouse it perpendicular.

Stock'trail. This term is applied to gun-carriages which have a *stock* between the cheeks supporting the gun, and the *trail* at the end of the stock rests upon the ground when the gun is in position for firing. When *limbered up,* a loop on the extremity of the trail is passed over the pintle-hook of the limber.

Field and siege gun-carriages are made in this way which have been in use since about 1830, having superseded the Gribeauval pattern (1765), in which the cheeks rested on the ground, and served the purposes of the stock in the stocktrail carriage.

Stock-yard. An inclosure for cattle on the way to or at market.

The Union Stock-yard at Chicago connects with ten different railways. It lies half an hour by rail from the center of the city, contains 345 acres of land, has a capacity for 21,000 head of cattle, 75,000 hogs, and 22,000 sheep, with stalls for 350 horses, — in all, for 118,350 animals. When all the ground is covered with pens, it will accommodate 210,000 head of cattle. The value of the live-stock received and forwarded during the year 1874 was nearly $ 80,000,000. There are now 100 acres of pens for cattle, all floored with three-inch plank, besides a great area in which the cattle stand on the ground. There are 50 miles of underdrainage, 17 miles of streets and alleys, all paved with wood; 5 miles of water-troughs; 15 miles of feed-troughs; 2,800 gates; 1,500 open pens; 800 covered sheds for hogs and sheep; 22,000,000 feet of lumber were used on these structures, and 500,000 pounds of nails; 17 miles of railroad track, with 60 switches and frogs, connect with the stock-yard, by a special track, every railway which runs into Chicago. The water is supplied by two artesian wells, one dug to the depth of 1,082 feet, and another to the depth of 1,190 feet. These send water into tanks 45 feet high, whence it is distributed in all the pens and sheds, there being a hydrant in each of these. The water can be shut off from any or all the divisions at pleasure, and, to guard against loss by fire, 14 fire-plugs are distributed over the grounds, and 1,000 feet of three-inch hose are at hand.

Stoke-hole. 1. (*Furnace.*) *a.* The place beneath the level of a boiler or oven where the furnace fire is fed and tended.

b. The hole in a furnace at which the poker, stirrer, rabble, paddle, or other tool is introduced to stir the charge, as in *puddling, calcining,* or *refining.*

2. (*Nautical.*) A scuttle in a steamer's deck for the admission of fuel.

Stom'ach-piece. (*Shipbuilding.*) A compass-timber fayed to the stem and keel. An *apron.*

Stom'ach-pump. (*Surgical.*) A suction and force pump for withdrawing the contents of the stomach in cases of poisoning, etc., and also used as an injector.

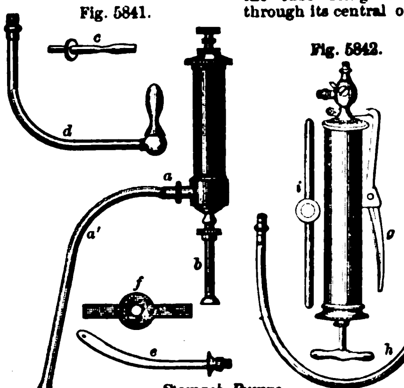
A flexible suction-pipe is attached to the lower opening *b*, and by working the handle the contents of the stomach are withdrawn and ejected through the branch *a*. A quantity of warm water should be first pumped into the stomach. *a' c d e* are tubes for making injections; *f* is a gag or mouth-piece, placed between the teeth, through which the flexible pipe is inserted.

Fig. 5842 is an improved form, having a lever *g* which operates a valve closing either the induction or eduction passages as the instrument may be required for use as a stomach-pump or enema-syringe.

In the former case the flexible tube *h* is screwed to the lower end, and in the latter to the side branch of the instrument.

The mouth-piece *i* is held between the jaws of the patient, the tube being introduced through its central opening.

Fig. 5841. Fig. 5842.



Stomach-Pumps.

Sto-mat'o-scope. (*Surgical.*) *a.* An instrument to keep the mouth open. A mouth-speculum.

b. An instrument invented by Professor Burns, of Breslau, to make critical examinations of the mouth and jaws.

A platinum spiral wire (inclosed in a boxwood cup, to prevent the transmission of heat), brought to a red heat by the passage of an electric current from two of Middeldorpe's elements, is placed in the mouth behind the teeth. The light reflected by a very small mirror is sufficiently intense to render the jaw transparent, so as to allow of the vessel proceeding to the roots of the teeth, the smallest specks of caries, etc., becoming visible. By reason of the transparency, even the labial coronary artery may in some subjects be seen at the level of the commissure, and its course followed.

Stone, Ar-ti-fi'cial. Many kinds of material have been used for the production of artificial stone. That which has been used on the largest scale, and, until a comparatively recent period, exclusively, was cemented by a calcareous substance, as Roman, or, still better, Portland cement, which hardens after being mixed with water. Ordinary *concrete* and Béton (which see) are of this class. *Terra-cotta*, employed for architectural ornaments, statuary, etc., is in the nature of a fine brick.

Cement stones have been largely employed for constructions in the sea, especially for harbor dams, breakwaters, and quay walling. We may cite the moles of Dover and Alderney, in England, of Port Vendre, Cette, La Ciotat, Marseilles, and Cherbourg in France, Carthagena in Spain, Pola in the Adriatic, of Algiers and Port Said in Africa, and Cape Henlopen at the mouth of the Delaware. For the breakwater at Cherbourg artificial stone blocks of 712 cubic feet each were immersed.

The fortifications before Copenhagen are made of a concrete of broken stone and hydraulic mortar. The sluice of Francis Joseph on the Danube, in Hungary, is built entirely of concrete. This work forms a reservoir, the bottom and the sides of which consist of one piece. Its length is 360 feet, and width 30 feet. Its construction, begun in 1854, was completed within 90 days, the work being pushed forward both night and day.

M. Coignet's béton aggloméré was used in the erection of the aqueduct of La Vanne, which now carries pure water from the river of La Vanne in the department of the Aube and of the Yonne to the city of Paris. The distance from Paris to La Vanne is over 135 miles. The section which traverses the forest of Fontainebleau comprises three miles of arches, some of them as much as 50 feet in hight, and 11 miles of tunnels, nearly all constructed of the material excavated on the spot. The monolithic test-arch at St. Denis, Paris, has a span of 196 feet, and an elevation of 19 feet. See Fig. 666.

Coignet's béton is compounded of sand 5, lime 1, and say .25 of hydraulic cement, mixed with an unusually small quantity of water, considerable mechanical exertion, followed by heavy ramming when the concrete is placed in the mold. The reduction of the volume by the ramming is 1.7 to 1, and the weight of a cubic foot becomes 140 pounds. The blocks soon harden in the air, and the resistance to compression is 5,000 pounds to the square inch. An ordinary mortar of the same material will be crushed by a pressure of 500 pounds. See Béton.

Recent French inventions in this line embrace: compacting the particles of which the stone is formed together by the action of a rammer upon successive layers while in a plastic state; forming monolithic buildings of a stone paste, the heating and ventilating flues and also the gas and water pipes being formed within the mass by the introduction of cores, which are afterward withdrawn; a modification of this for wharves, dams, abutment walls, etc., consists in making the walls hollow or honeycombed, and filling in the spaces or cells with earth or other cheap material; iron scraps may be incorporated with the material to bind it together, or a skeleton metallic framework may be imbedded in the walls while being made.

Orsi's *artificial lava* consists of

Stone or gravel	48
Pulverized chalk	32
Tar	16
Wax	1

The solid ingredients are added to the melted tar and wax, and the mixture poured into molds.

Metallic lava consists of

Ground flint	2
Broken marble	3
Resin	1

with small quantities of wax and coloring matter to imitate stone. It is used for tesselated pavements, the slabs being backed with concrete.

Artificial stone, having silica as the cementing material, was first introduced by Ransome.

He originally made this stone by boiling flints, under a pressure of about 60 pounds to the inch, in a solution of soda, to which lime was added to render it caustic. The soluble glass thus obtained, about the consistency of treacle, was mixed in the proportion of about 1 part to 10 of sand, 1 powdered flint, 1 clay; forming a paste which was molded into blocks, afterward dried in a steam-bath, to prevent the formation of a coating of silicate on the outside, which would prevent the escape of the vapor from the interior, and afterward burned in a kiln.

As at present made, the stone consists of clean sand and silicate of lime. It resists boiling, roasting, freezing, pickling in acids, fumigating with gases, soaking and freezing, heating to redness, and then plunging into ice-water.

Flints are digested by boiling in a caustic solution of soda under pressure, giving a silicate of soda (see Soluble Glass). This is added at the rate of one gallon to each bushel of well-dried sand, whose interstices are partially filled with dust of carbonate of lime. After careful mixing, the plastic mass is rammed and molded. The block is immersed in a solution of chloride of calcium. A reaction takes place; the silicate of soda and the chloride of calcium mutually decompose each other and reunite as silicate of lime and chloride of sodium, the former practically indestructible in air, the latter; common salt, perfectly deliquescent and removable by washing, although the stone, *after* the washing, is impermeable to water.

The tensile strength of this, by experiment, was, for a piece 2¼ bore, from 870 to 1,200 pounds. Crushing strength, cubes of 4 inches square, 44 to 48 tons. It has been used for grindstones with excellent effect. The same process forms the basis of several United States patents.

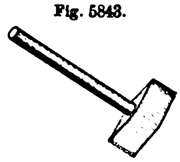
A "silicious varnish" (so called by the narrator) was used to give sharpness and permanency to the tri-lingual cruciform inscriptions on the scarp of a limestone mountain at Besitun, on the Tigris. It has been partially detached by the action of the elements during 23 centuries, and lies in scales at the foot of the precipice. It was cut by the orders of Darius Hytaspes, about 516 B. C., to celebrate a victory over the Magians. We are indebted to Rawlinson for the deciphering of the inscription.

In Sorel's process, natural magnesite — carbonate of magnesia — is first calcined, which reduces it to the oxide of magnesium. In this state it is mixed dry in the proper proportion, by weight, with the powdered marble, quartz, sand, or whatever material forms the basis of the stone. It is then wetted with bittern water, which converts the oxide of magnesium into the oxychloride. The now semi-plastic mixture is rammed into molds, where it speedily hardens, sufficiently to be taken out and laid on skids. In two hours' time the stone will resist rain, and in two weeks the stones may be used. See also Scagliola.

Patent 163,676, May 25, 1875, proposes to render artificial stone impervious to moisture and to prevent efflorescence thereon by mixing with the ordinary constituents in the process of manufacture soluble earthy or metallic sulphates in the form of a powder, and then a solution of the fatty acids.

McMurtrie and Chambers, May 25, 1875, treat the surface of the stone with a solution of earthy or metallic sulphates, and then with a solution of the fatty acids.

Fig. 5843.



Stone-Axe.

Stone-axe. An axe with two somewhat obtuse edges, used in spawling and hewing stone.

Fig. 5844.

Stone-Boat.

Stone-boat. A flat-bottomed sled for hauling

heavy stones for short distances, as in clearing them off the surface of tillable ground.

Planks are sawn from a log having a natural crook, and are united by cleats and bolts. The rise in front enables the stone-boat to ride over small obstacles. See also STONE-VESSEL.

Stone-bow. A cross-bow for shooting stones.

Stone-break'er. A machine for crushing or hammering stone. See ORE-CRUSHER; ORE-MILL.

Stone-break'er's Ham'mer. A hammer having a head of an oblately spheroidal form, with the handle in line of its axis.

Fig. 5845.

Stone-Breaker's Hammer.

Stone Bridge. Stone bridges appear to have originated among the Romans, who were the first to employ the arch on an extended scale. One with six arches, commenced by Augustus and finished by Tiberius, as its inscription indicates, still exists at Rimini. Others, some of which are yet in service, constructed by that remarkable people, are found, touched to a greater or less degree by the hand of time, in different parts of the former Roman Empire. Their stability, no doubt, was in great part due to the massive character of their foundations, as the builders, not employing the coffer-dam, used immense quantities of stone. (See COFFER-DAM.) Trajan (A. D. 105) built a magnificent bridge across the Danube at Gladova; it was 4,770 feet long, and consisted of 22 wooden arches, resting on 23 stone piers. It was destroyed by Hadrian, to prevent the incursions of the Dacians. See *b*, Fig. 924.

The first stone bridge in England was Bow Bridge, built in 1118.

The bridges of the Middle Ages also possess great durability, as those remaining attest. Their piers were founded on piles, the spaces between which were filled in with stone, necessitating, after a time, the driving of other piles outside these, until the substructure frequently, as in the case of Old London Bridge, seriously obstructed the water-way and impeded navigation.

This was built by Peter of Colechurch, 1176 - 1200, with houses on each side, connected by arches of timber, which crossed the roadway. This was burned in July, 1212, and 3,000 persons perished. It was restored in 1300; again partially burned in 1471, 1632, and 1725. The houses were pulled down in 1756, and finally the bridge itself, to make way for New London Bridge, constructed by the Rennies, opened in 1831. On this occasion the original piles, mostly of elm, were found to be but partially decayed, some portions being even used for making articles of utility or curiosity. The new bridge cost £506,000. The daily travel in 1859 was about 20,498 vehicles, carrying 60,836 persons, and 107,074 foot-passengers. This is the spot from which Macaulay's "New-Zealander" is supposed to view the ruins of the old city once known as London.

At a later, though comparatively recent period, the plan of sinking caissons (a kind of wooden case filled with stone) to form pier foundations, was introduced. The coffer-dam succeeded these, to be itself succeeded by the pneumatic caisson, a vast improvement on the unwieldy structure formerly used. See CAISSON.

In the construction of a stone bridge, when the coffer-dam or the pneumatic caisson is used, the river-bed is excavated until firm, hard bottom is reached, the abutments and piers of masonry are built up to the springing points of the arches, which are then turned upon the wooden centerings, which at once serve as a former for the arch and a support for its weight until the keystone course is laid. They thus perform a function of great importance, and great care and skill are required in their construction. When the masonry is complete, the centerings are removed, and the amount of subsidence, when this is done, affords a test of the skill of the architect and the faithfulness of the workmanship. If the piers have been solidly built on a firm foundation, and the arch-work accurately and strongly laid, there should be little or no subsidence. The bridge of Neuilly, by Perronet, settled two feet; Waterloo Bridge but five inches. The spandrels are afterward built up, the spaces between the arches filled in, the roadway and parapet completed. See ARCH; CENTERING; BRIDGE.

The following table embodies some facts in relation to a number of the most remarkable stone bridges in the world.

Name.	River.	Place.	Number of Arches.	Widest Arch. Span. Ft.	Span. In.	Rise. Ft.	Rise. In.	Curve.	Architect.	Date.
Washington Aqueduct	Cabin John Creek	Maryland	1	220	0	90	0	Segment	Meigs	1861
Chester	Dee	Chester		200	0	42	0	Segment	Harrison	1820
Vielle Brionde	Allier	Brionde	1	183	8	70	8	Segment	Grennier	1454
Ulm	Danube	Ulm		181	2	22	8	Segment	Wiebeking	1806
Castle Vecchio	Adige	Verona		159	10	55	8	Ellipse	Unknown	1354
Lavour	Agont	Lavour		159	10	64	8	Ellipse	Sager	1775
London	Thames	London	5	152	0	29	6	Ellipse	Rennie	1832
Claix	Drac	Grenoble		150	2	62	8	Segment	Unknown	1611
Alma	Seine	Paris		141	0	28	0	Ellipse	De la Gourniere	1857
Pont y Prydd	Taaf	Glamorgan	1	140	0	85	0	Segment	Edwards	1755
Neuilly	Seine	Near Paris	5	127	10	81	10	Ellipse	Peronnet	1774
Mantes	Seine	Mantes	8	127	10	38	8	Ellipse	Peronnet	1765
Waterloo	Thames	London	9	120	0	32	0	Ellipse	Rennie	1816
Blackfriars (Old)	Thames	London	9	100	0	41	6	Ellipse	Mylne	1771
Rialto	Canal	Venice		96	10	20	7	Segment	Antonia del Ponte	1591
Jena	Seine	Paris		91	6	10	9	Segment	Lamande	1815
Ponte Molo	Tiber	Rome		77	8	38	10	Semicircle	Unknown	100 B.C.

Fig. 5846.

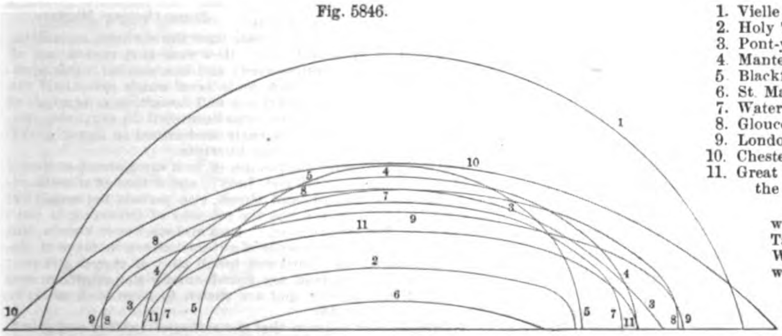


Diagram of European Bridges, showing the Forms and Proportions of Arches.

1. Vielle Brionde, over the Allier.
2. Holy Trinity, over the Arno.
3. Pont-y-Prydd, over the Taaf.
4. Mantes, over the Seine.
5. Blackfriars, over the Thames.
6. St. Mascence, over the Oise.
7. Waterloo, over the Thames.
8. Gloucester, over the Severn.
9. London, over the Thames.
10. Chester, over the Dee.
11. Great Western Railway, over the Thames at Maidenhead.

A remarkable bridge (3) was built in 1751 across the Taaf, in Glamorganshire, Wales, by William Edwards, a country mason. He had previously erected two bridges on the same spot: the first was carried away by a sudden and extraordinary flood;

the second by the crowding up of the crown of the arch by overloading its haunches before the parapet was finished. Peronnet could have taught him better, but Edwards was a skillful and persevering man, and ultimately succeeded.

The present bridge has a span of 140 feet, rise of 35 feet, and is a segment of a circle 175 feet in diameter. To avoid the subsidence of the haunches, Edwards made cylindrical openings through them, 3 in each haunch, the lower opening being 9 feet in diameter, the next 6, and the upper one 3 feet. The bridge is widest at its abutments by the amount of 1 foot 9 inches. The width of the bridge at the crown is 11 feet.

The longest bridge in England is that built by Bernard Abbot of Burton, over the Trent at Burton, in the twelfth century. It is all of squared freestone, is strong and lofty, is 1,545 feet in length, and consists of 34 arches.

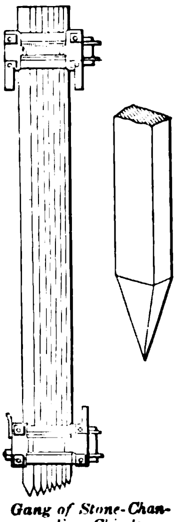
Most of the 339 bridges of Venice are of stone.

The "Union Arch" of the Washington Aqueduct over Cabin John Creek has 220 feet span, is 450 feet long, 20 feet 4 inches wide; the elevation of the roadway above the bed of the stream is 100 feet. Cost to May, 1872, $237,000.

Stone-cem'ent. A hard composition of the nature of mortar, which will harden and form a water-tight joint.

A mineral compound for uniting stone and resisting water is made by mixing 19 lbs. of sulphur with 42 lbs. of powdered glass or stone ware. Over a gentle heat the sulphur melts, and the whole is stirred till a homogeneous mass is obtained, when it may be run into molds. It melts at 248° Fah., and becomes hard as stone, and will resist boiling at 230° Fah. It may be re-formed indefinitely by remelting. See HYDRAULIC CEMENT, page 1144; MORTAR, *b*, pages 1477, 1478; and other compositions under various sub-heads: *Alabaster*, *Granite*, *Hydraulic*, *Marble*, *Mastic*, *Mortar*, *Slate*, *Stone*, article CEMENT, pages 507, 508. See also ARTIFICIAL STONE, where a number of compositions are cited which form good mortars and cements.

Fig. 5847.



Gang of Stone-Channeling Chisels.

Stone-chan'nel-ing Ma-chine'. A machine for cutting gains or grooves in stone, usually in the quarry, but also applicable to dividing large blocks.

The gang of chisels is operated by steam, and moves automatically on a track over the rock to be channeled.

Fig. 5847 shows the gang of chisels, and also, on an enlarged scale, one of the points.

Fig. 5848 shows the machine with its gang of chisels in place. A gang of cutters is applied on each side of the frame of the machine, outside the track on which it moves, in such a manner that the cutters may be inclined at any angle. There are devices for feeding the machine up to its work at any desired degree of speed, for stopping and starting the machine, for moving the machine without operating the cutters, and also for elevating and supporting the gangs of cutters when detached from their working-beams. See also Fig. 3054.

Stone-crush'er. A mill for grinding stone or ore. See ORE-CRUSHER; ORE-MILL.

Fig. 5848.

Stone-Channeling Machine.

Hitchcock's quartz-crusher (Fig. 5849) is on the principle of the Chilian mill, but has three wheels instead of two, traveling around in an annular trough. At the top of the frame is a hopper for receiving rock or other heavy material, to give

Fig. 5849.

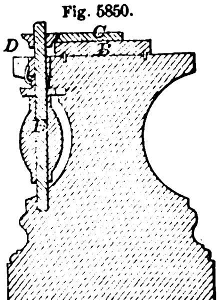
Hitchcock's Quartz-Crusher.

increased weight to the machine. The rotative power is applied outside of the machine instead of at its center, as has always been the case in mills of this class, adding greatly to the crushing force, which may be developed by the application of an equal power.

Stone-cut'ter. A machine for working a face on a stone or ashlar; in other words, a machine for *shaping* stone. It differs from the *stone-dresser*, which may be said to begin its duty after the surface is fairly flattened, or brought approximately to shape. The duty of the *stone-polisher* then commences, being to polish the fair surface left by the *stone-dresser* or *grinder*. The operations are successive, and some machines may be adapted to several, according to the character of the tool employed, or the relative coarseness or fineness of the abradant. In point of mechanical construction, the distinction cannot always be maintained between the stone DRESSERS, GRINDERS, PLANERS, and POLISHERS (which see). See also figures on pages 1391, 1392.

Fig. 5850 is a machine for cutting the molding edge of mantels, tablets, etc. The cutter *D* has the converse of the molding required, and revolves with its vertical shaft *E* operating upon the edge of the slab *C*, which moves with its sliding bed *B*.

Fig. 5850.



Stone-Cutting Machine.

Fig. 5851 is for circular and other curved work. The adjustable spindle, carrying the cutting-tool, is arranged so as to operate on any part of the top or sides of the stone. A pointer is attached to the slide which carries the spindle, and a grooved pattern to the rotating portion of the table, by which the movement of the tool is directed. See also Fig. 3055.

The earliest buildings of stone to which we can assign a date are the pyramids of Ghizeh.

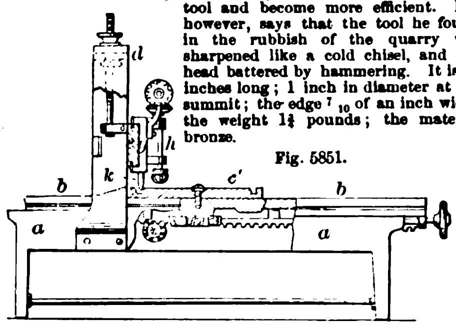
Few of the memorials of bygone ages have excited more surprise or given rise to more debate than the obelisks, monoliths, and colossi of ancient Egypt. How were they carved out of the mountain; how transported; and how erected? Our predecessors of 18 centuries since, an interval which spans half the time separating us from Osertasen and Joseph, were as much at fault as we; and Herodotus, who flourished 23 centuries ago, says that the art was apparently understood in Egypt 10,000 years ago as well as at the time he wrote.

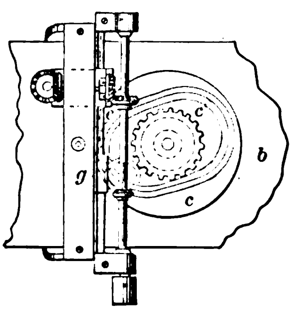
The early indications of the use of iron are glanced at under that caption in this work (see IRON); and a cluster of authorities, Egyptian, Syrian, and Greek, cite periods between 1350 and 1537 B. C.; but how was the colossus of Osymandyas cut? (2100 B. C. LENGLET, USHER) Iron and steel were known, but the inference and the balance of authorities are in favor of the more general use of a hard and tough alloy of copper and tin; bronze tools of this kind are found among the clippings and rubbish of the quarries, and are shown to have been used by the masons of that day.

Wilkinson is of opinion that the action of cutting and grinding the faces and making the ornaments in relief or intaglio was with emery; for which purpose a softer metal than steel

would answer better, as the emery would imbed itself in the tool and become more efficient. He, however, says that the tool he found in the rubbish of the quarry was sharpened like a cold chisel, and the head battered by hammering. It is 9½ inches long; 1 inch in diameter at the summit; the edge 7/10 of an inch wide; the weight 1¾ pounds; the material bronze.

Fig. 5851.

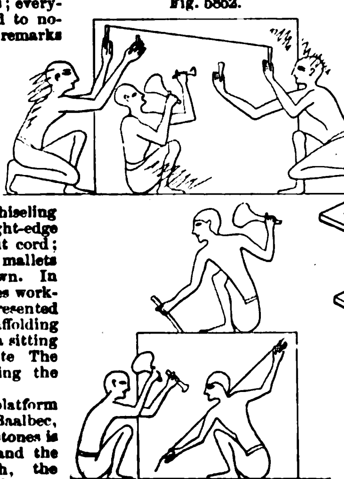




Stone-Cutting Machine.

The obelisks transported from the quarries of Syene, at the first cataracts, to Thebes and Heliopolis, vary from 70 to 93 feet in length. Wilkinson calculates the largest monolithic obelisk in Egypt, that at Karnak, at 297 tons. This was brought 138 miles, from its quarry to its site, and those at Heliopolis were transported over 800 miles. The statues of Amunoph III. are 47 feet in hight, and each made of a single stone, transported from its native quarry. That of Remeses II., when entire, weighed over 887 tons, and was brought from E'Sooan to Thebes, 138 miles. The pedestal of Peter the Great's statue in St. Petersburg is estimated to weigh 1,200 tons. Herodotus describes a block of stone brought from Elephantine to Saïs by Amasis. The exterior dimensions, as stated by him, and, converted into our terms, are 31½ feet × 22 feet × 12 feet. Its interior measured 28¼ × 18 × 7½ feet. Herodotus gives the dimensions of another which would figure out 5,000 tons; everybody feels bound to notice it, but the remarks are always given with a reserve, and often with a ?

Fig. 5852.

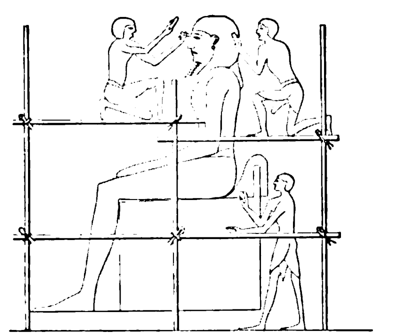


Egyptian Masons.

The annexed representation from paintings at Thebes illustrate the operations of leveling, squaring, and chiseling stone. The straight-edge seems to be a taut cord; the chisels and mallets much like our own. In a tomb at Thebes workmen are represented mounted on scaffolding and working at a sitting Colossus of granite. The men are polishing the figure.

In the large platform of the temple of Baalbec, the first tier of stones is 12¼ feet thick, and the same in width, the length being much greater. In the next tier are three stones, respectively 64 feet, 63 feet 8 inches, and 63 feet long: the hight about 13 feet, and the width no less. One of the same class lies at the quarry, about a mile distant; it is 14 by 17 feet, and 69 feet long. These stones are fitted so that a knife-blade cannot be thrust between. Drs. Robinson and Thompson carefully measured these monsters. See page 1404.

Fig. 5853.



Egyptian Sculptors.

Stone-dress'ing Ma-chine'. A machine for reducing to shape or working the surface of the stone ready for the final operations of grinding and polishing.

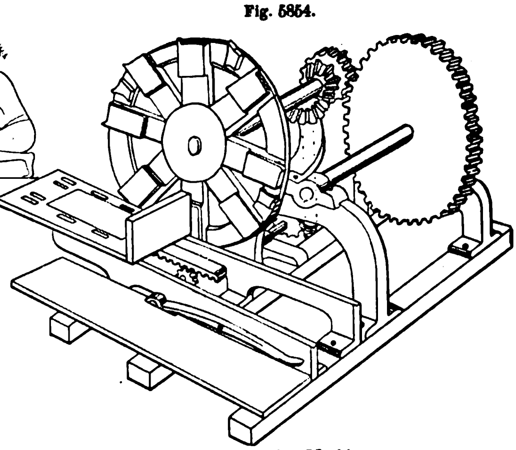
In Fig. 5854, the cutters are attached to a rotating-wheel, and act upon the face of the stone, which rests upon a traversing-table, and is fed along to the cutters by gearing from the main driving-shaft.

In another machine, a frame travels over the stone, being carried on wheels with rubber tires, and may be moved by a hand-crank, which is connected to either the moving or dressing devices. The cutters are clamped at the lower end of a rod, which has adjustable springs to limit its action, and is raised by radial revolving arms, which engage a lever that comes in contact with its tappet.

A machine for working moldings, figures, or ornamental devices upon stone is shown in Fig 5855. A circular tool carrying a number of diamond points is employed. This is journaled vertically in a pivoted frame, admitting a movement of translation in any desired direction, and has rapid rotation by pulleys and belting. The work, with the model or pattern, is clamped upon a table beneath, which may be raised or lowered, and held at any hight, and the tool is, by means of handles, elevated or depressed, as required, to suit the inequalities of the work, while a jet of water is conveyed to the point where it is acting.

Fig. 5856 is a machine for facing grindstones. The carriage slides on horizontal ways, carrying a bar of iron at right angles to its path of movement, the alternating movements and feeding being effected by bevel gears and a screw. The turning of the crank causes the tool to traverse from right to left across the periphery of the stone, and *vice versa*. The carriage is advanced by a sliding tubular shaft.

Fig. 5854.



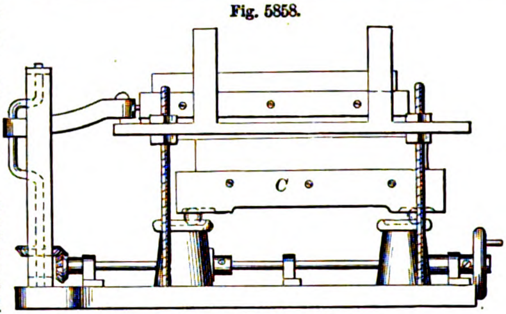
Stone-Cutting Machine.

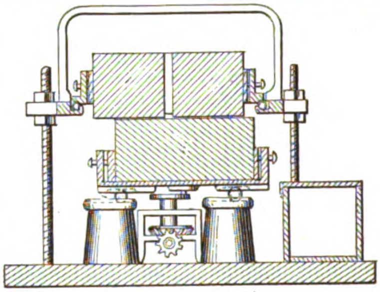
In Fig. 5857, the cutter-wheel is placed in a case which only

allows a segment to protrude, and excludes grit. The traverse sliding surfaces and the long journal-bearings are also encased. The rests of the journal are adjustable toward and from the stone, while the traverse is effected by rack and pinion.

In Fig. 5858, the bed *C* is supported upon friction rollers, and has a rotary reciprocating motion beneath the stones above, which are secured in a frame which has a longitudinal reciprocation.

Fig. 5858.



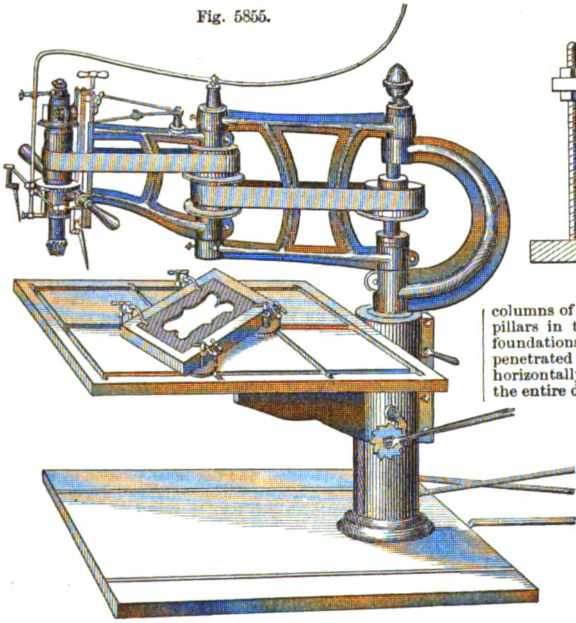


Stone-Facing Machine.

Stone-drill′ing Ma-chine. A machine for drilling holes in stone.

Fig. 5859 shows a hand-machine with one drill. The frame has adjustment on the crank-shaft as a center, and is held in position by the side plates, which have trunnion bearings for the shaft and curved slots as guide-ways for the feet of the frame. The drill-rod is raised by anti-friction rollers upon studs projecting from the fly-wheels; and is adjustable by a screw-sleeve, which is turned upon it by a hand-wheel. The anti-friction rollers act upon the connecting-bars, each of which is pivoted at one end to the sleeve, and at the other end has a cross-pin sliding in the horizontal slot of a fixed frame.

Fig. 5855.



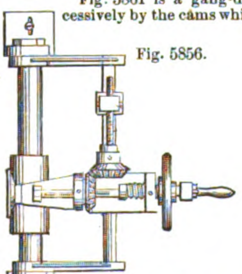
Gear Stone-Dressing Machine.

The application of steam to stone-drilling has worked a revolution in these machines, as in other departments of work.

The drill is now usually placed on the end of the piston-rod, which is reciprocated by steam or compressed air, as in Fig. 5860. See Rock-drill, pages 1956-1958. See also Diamond-drill, page 697.

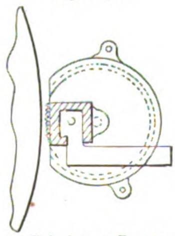
Fig. 5861 is a gang-drill. The drills are raised successively by the cams which are set spirally on the rotary-shaft. On a lower bar are a series of water-cans, whose contents trickle through a spout to the drill-bars. When not in use or moving, a supporting plate is slipped beneath each drill-bar.

Fig. 5856.



Machine for Facing Grindstones.

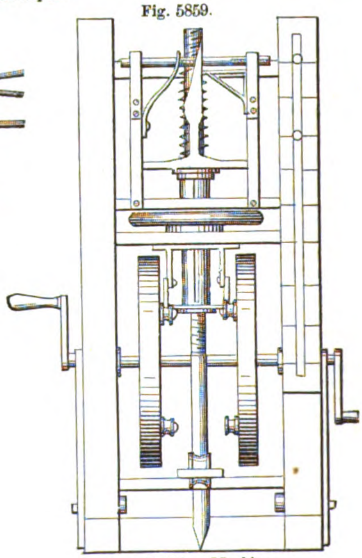
Fig. 5857.



Grindstone-Dresser.

The American Diamond Rock-Boring Company, of Providence, lately finished the job of taking a 24-inch core out of the columns of the State Capitol at Columbus, Ohio, the immense pillars in their solid state being considered too heavy for the foundations. By the use of this annular drill strata can be penetrated 800 to 1,000 feet through solid rock, vertically or horizontally, and perfect samples of ore or mineral taken out the entire depth.

Fig. 5859.



Stone-Drilling Machine.

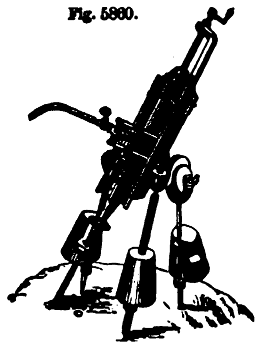
Stone Fou-gasse′. (*Military Engineering.*) A mine covered with stones.

Stone-gath′er-er. A machine for picking up loose surface stones in fields.

Fig. 5862 has a rectangular frame mounted on rollers near the front end of the frame. At about the center of the frame is a cross-bar, having journals which have their bearings in the side pieces of the frame. Curved teeth are secured to this cross-bar, and run upon the ground for the purpose of gathering the stones. When the teeth are loaded, they are thrown back by means of a lever, and the stones deposited upon a platform in the rear.

Fig. 5863 has a revolving toothed cylinder and an endless apron, connected with a stone-receiving box suspended from a mounted frame and provided with a hinged tail-board and hinged bottom, with fastening operated from the driver's seat.

Fig. 5860.

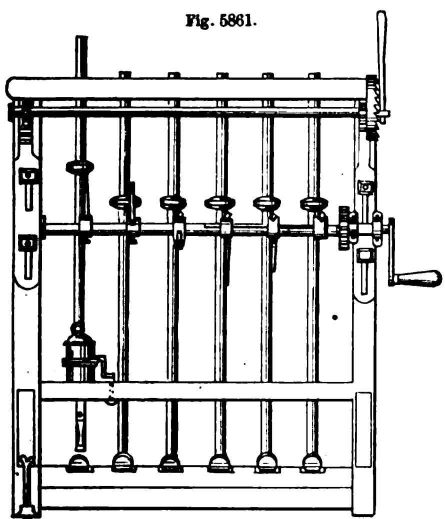


Steam Stone-Drill.

Stone-grind'ing Ma-chine'. One in which the action is due to an abradant or mutual attrition, usually with sand or other grit between the two surfaces. Only distinguishable from the stone-polishing machine by the greater fineness of the abradant used in the latter, and the smoother quality of the resulting surface.

Fig. 5864 is a hand-machine which has a horizontal disk, which, with its holder and standard, is pushed about over the surface of the stone. The hollow standard has a chamber in which

Fig. 5861.

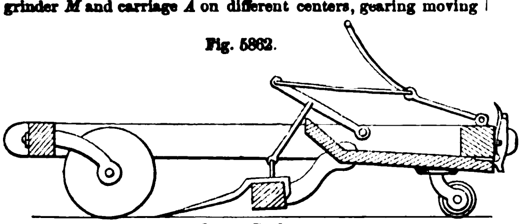


Stone Gang-Drill.

is a beveled pinion. In the standard is a shaft having a universal joint at its lower end for connecting with a rubbing disk or a circular saw. The machine is pushed over the face of the stone as the work progresses, the operator turning the crank with one hand.

In Fig. 5865 an eccentric motion is obtained by placing the grinder *M* and carriage *A* on different centers, gearing moving

Fig. 5862.



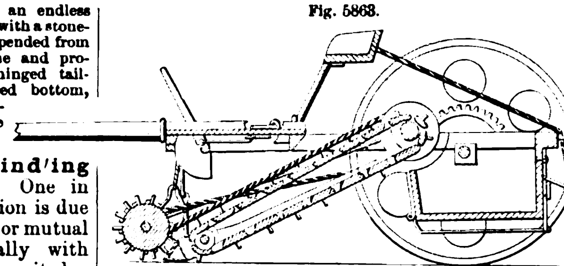
Stone-Gatherer.

the carriage along longitudinally, so as to expose different portions of the length of the stone to the action of the rubber *M*.

In Fig. 5866, the upper and lower stones are made to dress each other by a system of gearing by which the upper stones receive a rotary and the lower one a longitudinal movement.

The details of the invention have reference to the arrangement for adjusting the stones to be dressed so as to hold them steadily in the proper relative position to ensure a perfectly plane surface; the method of supplying sand and water; a peculiarly shaped scroll-grinder; a self-adjusting frame, and manner of raising and lowering the same at will; and an arrangement for relieving the grinders of all weight in excess of that required for grinding purposes.

Fig. 5863.

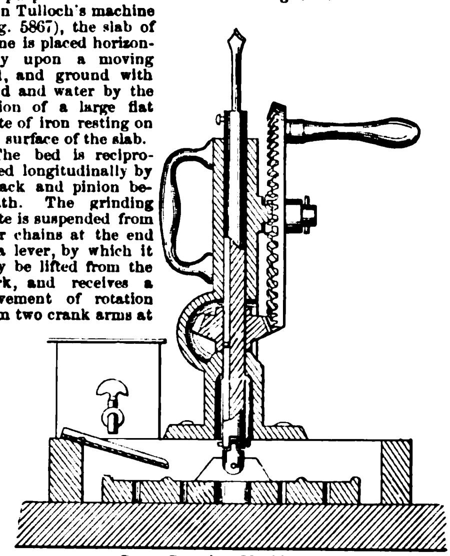


Stone-Gatherer.

In Tulloch's machine (Fig. 5867), the slab of stone is placed horizontally upon a moving bed, and ground with sand and water by the action of a large flat plate of iron resting on the surface of the slab.

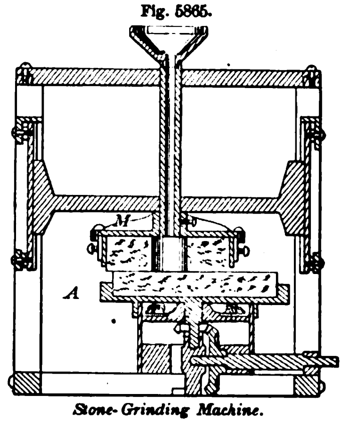
The bed is reciprocated longitudinally by a rack and pinion beneath. The grinding plate is suspended from four chains at the end of a lever, by which it may be lifted from the work, and receives a movement of rotation from two crank arms at the lower extremities of two shafts rotated in opposite directions by spur gears at their upper ends engaging with an intermediate wheel. This, combined with the reciprocating motion of the bed, causes different parts of the two surfaces to be brought in contact at every instant, and ensures the equal grinding of the stone. See also Fig. 3056.

Fig. 5864.



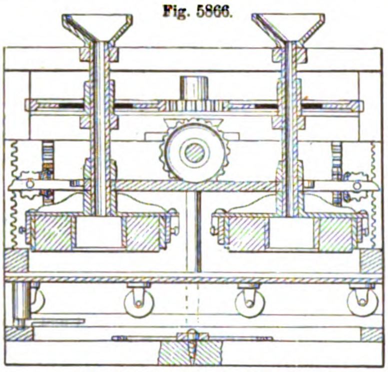
Stone-Scouring Machine.

Fig. 5865.



Stone-Grinding Machine.

Fig. 5866.



Machine for Grinding Stone.

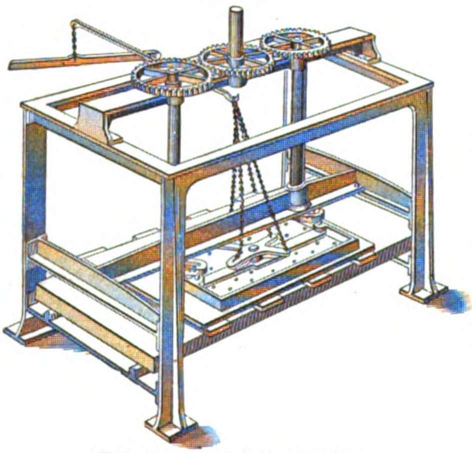
Stone-ham'mer. A chipping hammer used by stone-masons in rough-dressing stone. See STONE-AXE.

The *acisculis* or stone-hammer of the Romans had a rounding head, like an adze (*ascia*); a square face and pointed *peen*.

Stone Har-mon'i-con. A musical instrument consisting of a number of bars or slabs of stone, supported on strips, bundles of straw, or what not, and played like the *dulcimer*. See page 760; see also LAPIDEON, pages 1253, 1254.

Among the ancient musical instruments of the Chinese is the *pien king*, which is an assortment of sixteen stones arranged on strings in two series of eight each, one above the other, and each giving out, when struck successively, a system of sounds employed by the ancient Chinese in their music. The size and shape of these stones have been very carefully determined by

Fig. 5867.



Tulloch's Stone-Grinding Machine.

them after a minute analysis of the sounds peculiar to each one. In order to render the sound graver, the thickness of the stone is diminished to the right amount, and to render it more acute, something is cut off from the length. The stones thus arranged remind one in effect of a series of steel bars, as exhibited in acoustic apparatus to illustrate the fact that vibrations above a certain pitch are inaudible to the human ear. Frequent endeavors have been made to decide what kind of stones are employed in the fabrication of the *pien king*, since they were customarily paid as tribute-money more than two thousand years before Christ by certain provinces of China. Certain authors have thought that they recognized in them a kind of black marble, and the editor of the works of Father Amiote asserts that the *king* or musical stone constructed in France with the black marble of Flanders was quite as sonorous as those of China. Lately a discovery was made at Kendal, in England, of some musical stones, which, when struck with a piece of iron or another stone, gave out sounds of very different pitch, and with eight of which it would be possible to attain a very distinct octave. See also XYLOPHONE; STICCATO.

Stone'head. (*Mining.*) The rock immediately below the alluvial deposit.

Stone-mill. A machine for breaking or crushing stone. See STONE-CRUSHER; ORE-CRUSHER.

A machine for facing stone. See STONE-CUTTER; STONE-GRINDER; etc.

Stone-mold'ing Ma-chine'. A machine employed for working moldings in stone. Its general construction is that of one form of stone-saw, except that the frame carrying the revolving grinders may be adjusted by a screw beneath, to adjust it to the thickness of the slab being worked.

The grinders *a b c* (Fig. 5868) are turned from solid cylinders of cast-iron to the desired shapes. Each has a central hole fitted to the axis of the driving-pulley, and is secured thereto by

Fig. 5868.

Stone-Molding Machine.

a key or a side-screw. The grinder is made to revolve, so as to cut upward toward the surface, and is kept constantly supplied with moist sand. Moldings on the edges of narrow slips are sometimes wrought in pairs, the two pieces being cemented together at their sides, as shown at *c*. See STONE-CUTTER; STONE-PLANING MACHINE. See also Fig. 3055.

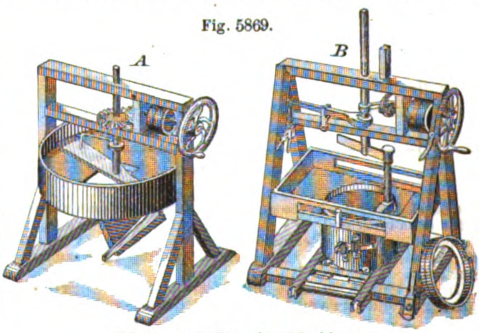
Stone Pipe. Stone pipes have been made by annular drills, being made in concentric nests. The water-pipes of the Flavian amphitheater were hewn from stone blocks.

What are now usually known as *stone* pipes are made of concrete or some other form of artificial stone.

Stone-pipe Ma-chine'.

Fig. 5869 illustrates a stone-pipe machine. It has a rotary-mixer *A* and tamping-machine *B* employed in making artificial

Fig. 5869.



Mixing and Tamping Machines.

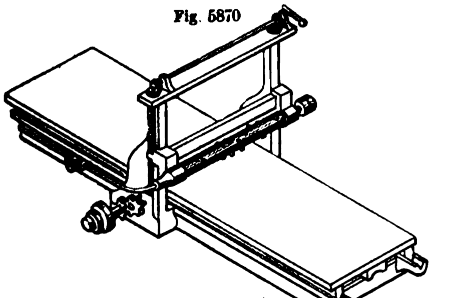
stone pipe. The cement and sand are incorporated together in the former and transferred to a two-part circular mold, having a core, at the lower part of the latter. As each layer of the mixture is placed in the latter, it is compacted by blows from a rammer carried by an arm on a vertical rod, which has a rotary motion and is gradually lifted as the formation of the pipe progresses.

Stone-plan'ing Ma-chine'. A machine in which the surface of a stone slab or block is cut or dressed by tools which act upon it while the stone passes beneath it on a reciprocating bed.

Fig. 5870 has a series of cutters arranged upon a hollow revolving cylinder, which latter is provided with small perforations, opening near each cutter, and also with a stuffing-box and pipe, through which hot or cold water, or steam, may be conducted to the stone, which traverses on a table beneath, in the manner of a planing-machine.

In Fig. 5871, the cutting or dressing wheel has slits across its

Fig. 5870

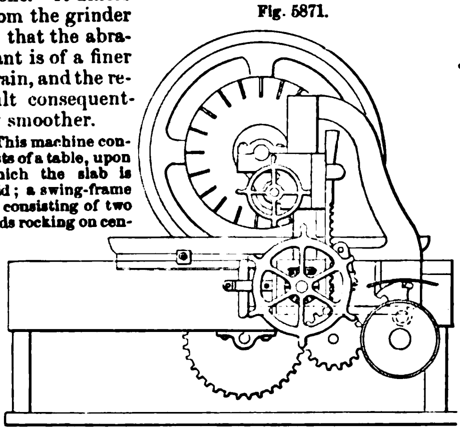


Stone-Planing Machine.

periphery to hold sand, which acts as a cutter upon the stones dogged to the bed which traverses beneath.

Stone-pol'ish-ing Ma-chine'. A machine for giving the final dressing and gloss to the surface of stone. It differs from the grinder in that the abradant is of a finer grain, and the result consequently smoother.

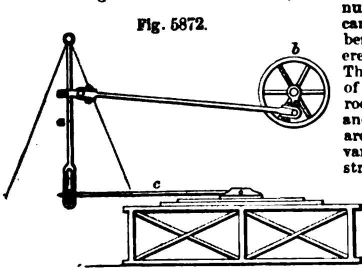
Fig. 5871.



Stone-Cutting Machine.

This machine consists of a table, upon which the slab is laid; a swing-frame *a*, consisting of two rods rocking on centers above, and operated by a rod connected to a crank on the fly-wheel *b*. At the lower end of the swing-frame is a horizontal bar extending the width of the table, and having attached a number of rods *c*, carrying flat rubbers of wood covered with felt. The attachments of the connecting-rods to the crank and rocking-frame are adjustable, to vary the length of stroke. See also page 1393.

Fig. 5872.



Stone-Polishing Machine.

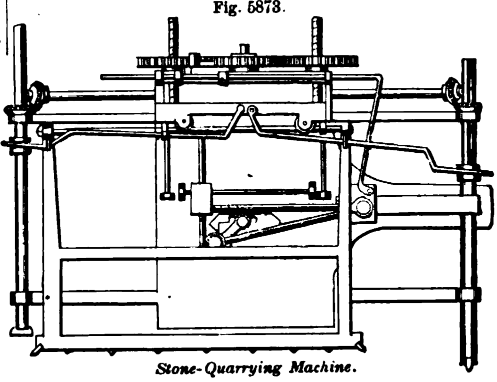
Perhaps the most perfectly polished piece of architecture in the world is the Taj, on the west bank of the Jumna, about 8 miles from Agra. The buildings of the Taj are erected on a platform about 20 feet high, and occupy a space of about 350 feet square. They consist of the tomb itself, which is an octagon, surmounted by an egg-shaped dome of about 70 feet in circumference, and of four minarets, about 150 feet high, which shoot up like columns of light into the blue sky. One peculiar feature is its perfect purity, for all portions of the Taj — the platform, the minarets, the building proper — are of pure white marble. The only exception is the beautiful ornamented work, of an exquisite flower pattern, which wreathes the doors and wanders toward the dome, — one huge mosaic of inlaid stones of different colors.

The screen of the tombs is divided into several compartments and panels; it sweeps around marble cenotaphs that lie within it, and represent the real tombs seen in the vault beneath. It is of purest marble, so pierced and carved as to look like a high fence of exquisite lace-work, but is really far more refined and beautiful; for everywhere along those panels are wreaths of flowers composed of lampis, lazuli, jasper, heliotrope, chalcedony, carnelian, etc., so that to make one of the hundreds of these bouquets a hundred stones are required. The Florence mosaic work does not surpass it.

The father of the builder of the Taj, Jehanghir, was the first ruler in India who received an ambassador from England, Sir Thomas Roe, in the reign of James I. Jehanghir married a famous beauty, Niher-ul-Nissa, the widow of Sher Afgan, who four years previously, had been assassinated by this same Jehanghir. Her name was changed first into Noor Mahal, "the light of the harem," — celebrated by Moore in his "Lalla Rookh," — and afterward to Noor Jehan, "the light of the world." Jehanghir, it may be mentioned, had *impaled* eight hundred of the race of Timour, who were in his way to the throne.

Shah Jehan succeeded him, having murdered his own brother in order to do so. He married Arzumund Banoo, the niece of the "light of the harem," the daughter of her brother. She was a good wife, and brought to her husband several children, among whom was Aurungzebe, who was the last ruler of the united empire of the great Akbar, his grandfather. After 20 years of married life, and burying his wife in the Taj, Shah

Fig. 5873.



Stone-Quarrying Machine.

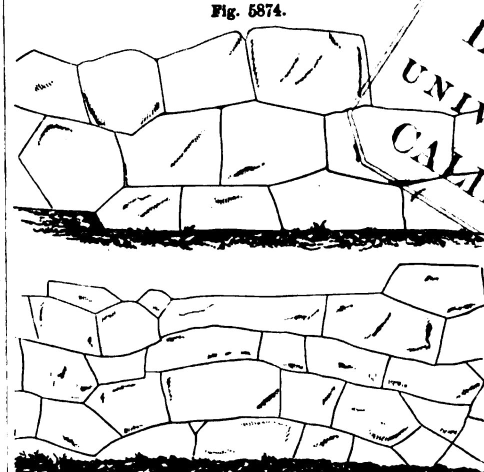
Jehan became a miserable debauchee. He was buried beside Arzumund Banoo, beneath the marble dome.

The cost of the Taj was upward of three millions of pounds sterling. Thousands of workmen were engaged upon it for years.

Stone, Pres-er-va'tion of. A process or composition for facing stone or impregnating it, to prevent its destruction by atmospheric influences.

Szerelmey's plan is to saturate with a silicate and apply asphaltum varnish. It has been adopted on the new Parliament Houses of London.

Fig. 5874.



Cyclopean Masonry.

Ransome's is to saturate with silicate of soda and then with chloride of calcium. The chemical reaction produces insoluble silicate of lime, and chloride of sodium which washes out.

Hibble's plan is to paint with a compound of ground lime, turpentine, flaxseed oil, silicate of lead, and burnt copperas.

Davies proposes sulphur and flaxseed oil.

Barff and Sullivan: treatment with alumina, carbonate of zinc, and silicate of potash.

Hardwicke: potash, alum, fish-oil, and flaxseed oil.

Quarm: oil.

Bernays: fluo-silicic acid, washed with alkaline solution.

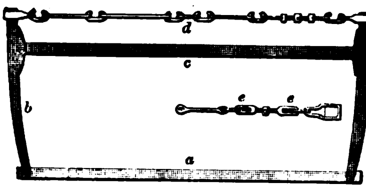
Rust and Mossop: solution of caustic barytes, washed with fluo-silicic acid.

Gros: a paint of wax 10, oil 30, litharge 1, heated to 212° Fah.

Spiller: superphosphate of lime, followed by ammonia (for magnesian limestone).

Crookes: fuller's earth in a dilute solution of hydrofluoric acid.

Fig. 5875.



Stone-Saw.

Stone-quar'ry-ing Ma-chine'. A machine for channeling stone in the quarry, making vertical cuts and grooves, which will enable it to be split off in layers.

Fig. 5873 has a reciprocating saw, armed with diamond points, so formed as to cut from the terminal holes formed by the drills, both saw and drills operating simultaneously. See STONE-CHANNELING MACHINE.

Stone-saw. Sesorthus was called Asclepias by the Egyptians, on account of his medicinal skill. The Greeks derived the name and attributes of their Æsculapius from him. According to Manetho, Sesorthus introduced the art of building with hewn stone. Heavy masonry, previous to his time, is presumed to have been Cyclopean; that is, the heavy blocks were fitted together by adapting to each other in the wall such faces as they already possessed.

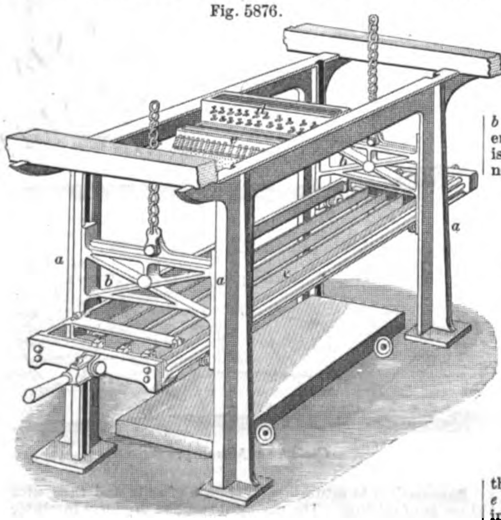
After Sesorthus, if indeed we make this exception, the Phœnicians are entitled to the credit of the use of the stone-saw, for these skillful navigators and mechanics erected the temple of Solomon of stone sawed within and without. This was in advance of the instances which we find described by classic authors.

Pliny informs us that he knew of no building faced with marble of greater antiquity than the palace of Mausolus, king of Caria, described by Vitruvius. This was erected 350 B. C. According to one authority, Crassus was the first Roman who embellished his house with marble, about 90 B. C., but it soon afterward became common, and several of the palaces of the Cæsars were made of it. Cornelius Nepos states that Mamurra (at a little later date) was the first to use marble in this way. Artemisia of Caria antedates both of them several hundred years.

In the time of Henry I. the choir of Canterbury Cathedral was paved with marble. In the sixteenth century marble became common in English architecture.

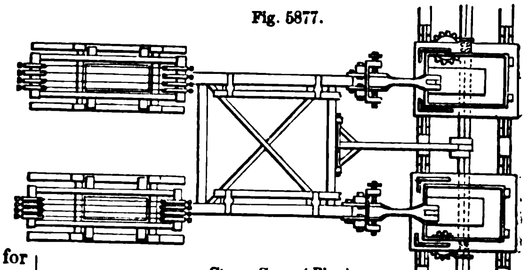
Pliny gives an account of cutting marble with the saw, and states the different kinds of sand used; "for it is the sand," says he, "that does the work, and not the saw." The blocks were cut from the marble quarries of Paros by means of saws. Such is indicated by the sharpness of the edges.

Fig. 5876.



Tulloch's Stone-Saw.

Fig. 5877.



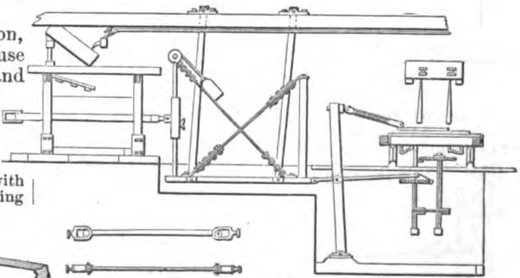
Stone-Saws (Plan).

The first account of staining marble to imitate the variegated varieties is by Kircher. The ancients admired the white, and regarded the veins as a detriment.

Oliver Evans of Philadelphia, in 1803, had a double-acting high-pressure steam-engine at work grinding plaster and sawing stone. He drove with it "twelve saws in heavy frames, sawing at the rate of one hundred feet of marble in twelve hours."

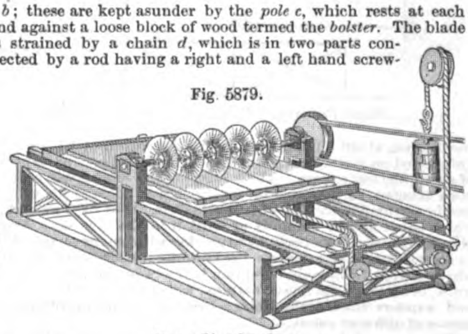
The common stone-saw (Fig. 5875) has a blade *a* of soft iron, $\frac{1}{8}$ to $\frac{1}{6}$ of an inch thick, having a hole at each end for the reception of pins, which fit into notches at the ends of the *heads* *b b*; these are kept asunder by the *pole c*, which rests at each end against a loose block of wood termed the *bolster*. The blade is strained by a chain *d*, which is in two parts connected by a rod having a right and a left hand screw-thread cut upon it, which enter the hollow screws in the nuts *e e*. The screw has holes, into which a lever may be inserted in order to tighten the chain.

Fig. 5878.



Stone-Saws (Elevation).

Fig. 5879.

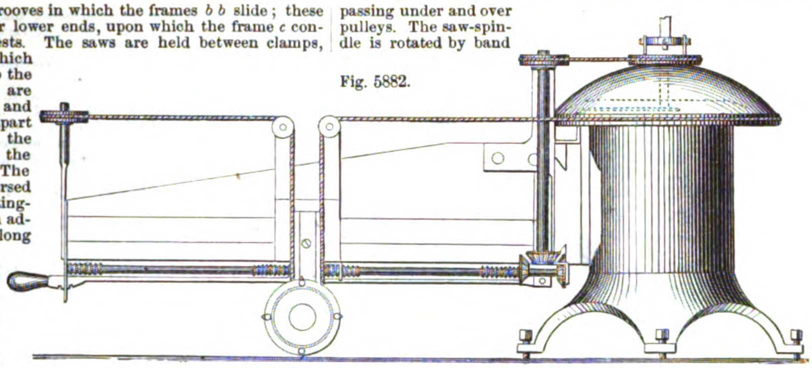


Stone Circular-Saw.

Tulloch's stone-saw (English) has a framework of iron; the

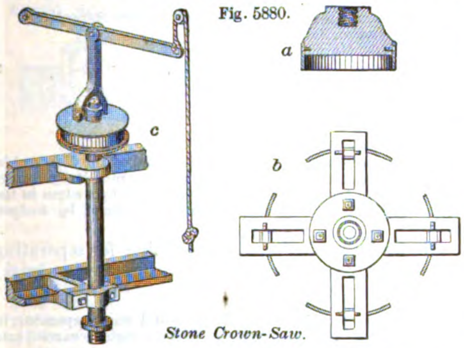
uprights *a a* have grooves in which the frames *b b* slide; these carry rollers at their lower ends, upon which the frame *c* containing the saws rests. The saws are held between clamps, having hooks, by which they are attached to the frame *b*; they are strained by wedges, and kept equidistantly apart by iron blocks of the exact thickness of the slabs to be sawn. The saw-frame is traversed by a jointed connecting-rod, attached by an adjustable loop to a long vibrating pendulum kept in motion by a pair of connecting-rods, one above the other, leading from two cranks driven by the engine.

Fig. 5882.



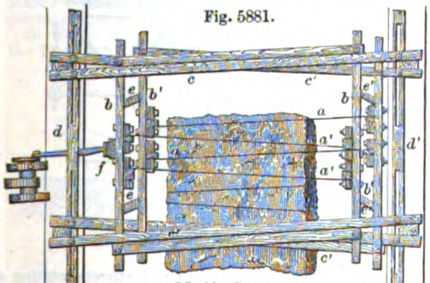
The frames *b b* are suspended by chains, and are counterpoised, they and the saw-frames having sufficient preponderance to descend as the cutting proceeds. The trough *d* contains water, which flows through a number of apertures into the sand-box *e*, where it is conducted through curved channels conveying the sand to openings, whence it may drop into the kerfs made by the saws.

Fig. 5880.



Stone Crown-Saw.

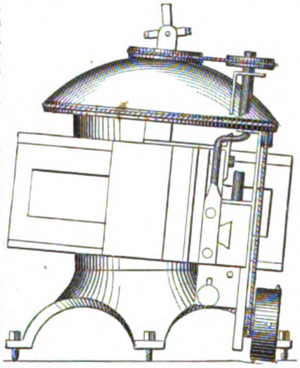
Fig. 5881.



Marble-Saw.

In Figs. 5877, 5878, the saws are arranged in gangs, being adjustable as to distance according to the thickness of slabs required. Each saw is strained between stirrups at the respective ends, attached to the frame, which is suspended by rods in such a manner as to admit of a free horizontal reciprocation. The saw-frame is attached to a cast-iron box, which is movable upon a vertical post, from whence it receives its reciprocating motion. Two sets of saws are shown in the illustration, moved by means of a crank through the intervention of a swinging frame. To the same frame are attached two polishing-blocks, which reciprocate upon the tables, to which is imparted a motion in a direction at right angles to the former. This prevents the *worker* from wearing the marble into grooves. The saws are guided between vertical posts, and receive sand and water from a reservoir and apron above.

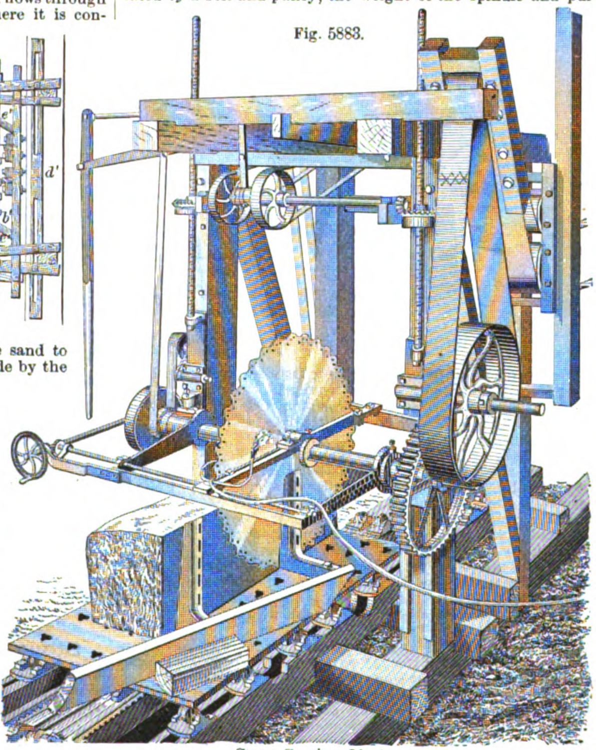
Fig. 5879 shows a gang of circular stone-saws mounted on a bench having rails, upon which a carriage is traversed by a weight and cord passing under and over pulleys. The saw-spindle is rotated by band and pulley in such a direction that the saws may have an upward cut, acting against the end of the stone as it is pressed against them by the forward movement of the carriage.



Gilmore's Millstone Saw-Drill.

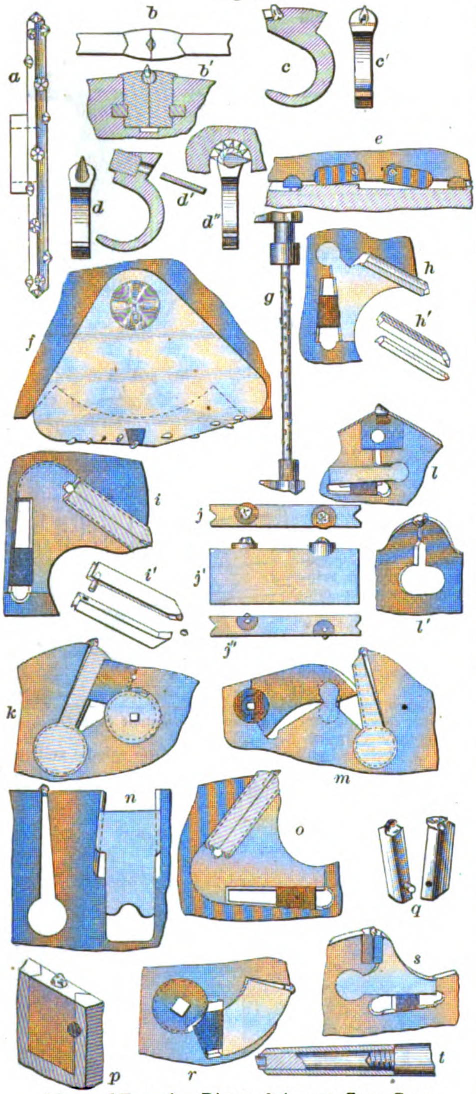
For circular work, such as the tops of circular tables, disks for bosses or ornaments, lamp-bases, etc., a cylindrical saw is employed, similar in principle to the crown-saw. For small work, hollow cylinders of sheet-iron *a* are employed. For large circles, segmental cutters, adjustably fixed upon the arms of a cross piece, are used. In either case, the vertical spindle *c* is rotated by a belt and pulley, the weight of the spindle and pul-

Fig. 5883.



Stone-Sawing Machine.

Fig. 5884.



Modes of Fastening Diamonds in or to Stone-Saws.

ley being relied on to keep the saw to its work, and a cord and lever are employed to lift it when required.

The machine, Fig. 5881, is designed for sawing taper slabs by means of two sets of saws operated from a single crank.

The saws *a a a′ a′* are secured to the fender-bars *b b b′ b′*, and those of the one set are adjusted at any angle with those of the other by the lateral movement of the fender-bars corresponding to the relative inclinations of the guides *c c c′ c′*, which may be secured in the required position by bolts near their ends passing through slots in the rails *d d′*. The two sets of fender-bars are connected by links *e e e′ e′*, so that the adjustment of one determines that of the other, and at the same time motion is imparted to both by the connection of the crank with a post *f* attached to the first set of fender-bars.

Stone-sawing machines of the highest class are made by furnishing the blade with CARBON-POINTS (which see). These saws are usually circular, but some are made reciprocating.

James T. Gilmore of Painesville, Ohio, No. 38,670, May 20, 1863, has a circular revolving plate or disk, armed with diamonds or other hard cutting-points, and used for dressing millstones. A portion of the machine is shown in Fig. 5882. It is described as adapted to leveling the surface of, and cutting the furrows in buhr-stones, dressing building-stones, fluting columns, and making moldings. The view shows side and end elevations.

Diamond-drills are described in Hermann's French patent, March 31, 1855. See DIAMOND-DRILL.

Fig. 5883 shows a stone-sawing machine having a circular blade in a frame, which may be raised or lowered, to bring the saw to cut at the required depth. The stone is dogged upon a reciprocating bed beneath, in the manner of a planing-machine. The various adjustments will be easily understood from the figure.

Fig. 5884 shows a number of ways of fastening the black diamonds to the steel blade.

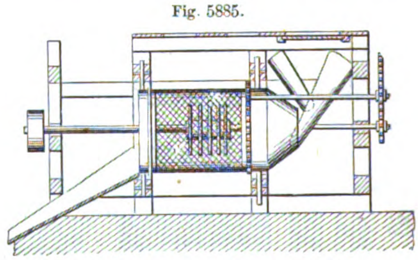
a shows Drake's patent, April 11, 1865.
b b′ are Young's patent, June 8, 1869.
c c′, Young's patent, October 12, 1869.
d d′ d″, Young's patent, February 1, 1870.
e, Young's patent, September 27, 1870. This has a reciprocating motion.
f, Young's patent, October 18, 1870. This also reciprocates.
g, Gear's patent, April 16, 1872. This is a gig-saw, having vertical reciprocation.
h h′, Emerson's saw, April 25, 1871.
i i′, Emerson's, June 4, 1872.
j j′ j″, Smith's, May 27, 1873.
k, Husbands's, January 20, 1874.
l l′, Emerson's, for circular and straight saws respectively.
m, Husbands's, January 20, 1874.
n, Branch's, March 3, 1874.
o, Emerson's, May 26, 1874.
p, Husbands's, June 2, 1874.
q, Emerson's.
r, Husbands's, June 23, 1874.
s, Emerson's.
t, Dickinson's, August 11, 1874.

It will be perceived that some of these imbed the diamond in the saw by sockets, rings, or solder; others grasp it by fingers which are clamped in sockets; others grasp it by wedges in the slot, or by clamps which are themselves jammed by wedges, etc.

Stone-sep′a-ra′tor. A machine for separating stones from clay or sand; for concrete or brick-making.

Fig. 5885 shows a dry-clay pulverizer and stone-separator, in which the ground clay from the mill at the right is carried into

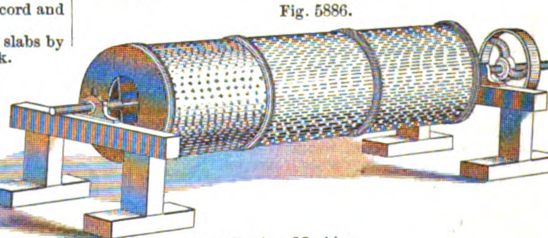
Fig. 5885.



Clay-Pulverizer and Stone-Separator.

a revolving screen, in which is a shaft with stirrers rotating at a different speed. While material of a given fineness passes through the holes in the screen, the stones are discharged at an end spout.

Fig. 5886.



Stone-Sorting Machine.

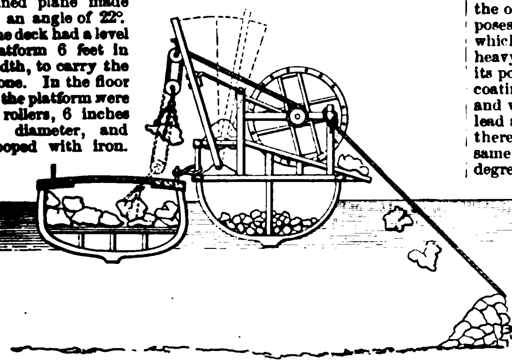
Stone-sort′ing Ma-chine′. A machine having an inclined iron cylinder perforated to allow stones of given sizes to escape. The machine has three sections of varying fineness of mesh, the crushed stone being fed in at the fine end, in the manner of a flour-bolt, and sorts into three sizes the pieces not too

large to fall through. These larger pieces pass all the way through, and are discharged at the end of the cylinder.

Stone-ves'sel. The breakwater of Cherbourg, France, was commenced in 1786, and was never completed according to the original design by De Cessart, but during the nine following years, 100,000,000 cubic feet of stone had been deposited in and around the 18 timber cones which formed the nuclei for the stone piles.

De Cessart's machine for throwing large stones into the sea consisted of a pontoon carrying an inclined plane made at an angle of 22°. The deck had a level platform 6 feet in width, to carry the stone. In the floor of the platform were 8 rollers, 6 inches in diameter, and hooped with iron.

Fig. 5887.



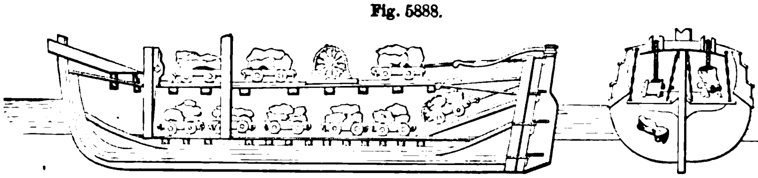
De Cessart's Stone-Boat.

A gib, moving on a pivot and furnished with hoisting-tackle, was employed to hoist the stones from the lighter which carried them to the spot. Two wheels and axles worked the rope. The wheels were 12 feet in diameter, the axles 1.

Iron grapplers and chains first lifted the stone from the lighter, and when the necessary hight was obtained, the gib was swung back into the position shown in dotted lines. By loosening the tackle a little, the stone was deposited on the platform rollers, along which it traveled until it reached the discharging-chute, which precipitated it into the sea.

In transporting and depositing the stones used in making the Plymouth Breakwater, vessels were employed having a pair

Fig. 5888.



Plymouth Stone-Boat.

of longitudinal tracks on each side of the ship, on each deck. On these tracks were trucks which held the stone, which were dumped at the stern, to which the trucks were conducted, one at a time, and tilted by tackle. At the stern of the boat was an inclined plane, by which the loaded trucks reached the lower deck, and another inclined plane led from the upper deck to the opening in the stern, which was exposed when the shutters were lowered. These shutters were supported by chains, and formed chutes.

Stone'ware. A grade of ceramic ware of great hardness and value.

The stoneware of London is made of pipe-clay from Dorsetshire and Devonshire, calcined and ground flint from Staffordshire, and sand from Woolwich and Charlton. The dry clay is pulverized and sifted. The ingredients are compounded in different proportions, according to the fineness of the ware, its size, and purpose. The round articles are turned on a wheel, dried, and shaved in a lathe. Articles of other shapes are molded. The articles are then stacked in the kiln, with pieces of well-sanded clay placed between them, to prevent their adhering. A slow fire dissipates the moisture, and the heat is then raised until the flame and ware have the same color.

The glaze is then added by pouring 20 or 30 ladlefuls of common salt into the top of the kiln. This is volatilized by heat, becomes attached to the surface of the ware, and is decomposed, the muriatic acid flying off and leaving the soda behind it to form a fine thin glaze on the ware, which resists ordinary acids.

The labors of Wedgwood date from about 1762, and the art attained great excellence under his fostering care, ingenuity, and taste. We quote from Aiken: —

"With a liberal ambition far above the mere love of gain, his ruling object was to carry the art that he practiced to the utmost perfection of which it was capable. For this he spared neither time, nor labor, nor expense; and his splendid success, inciting others to follow in the same track, has secured to his country a most important branch of internal and foreign commerce, and has placed his name forever among the worthies of the British nation.

"He perceived that the defects of the delft-ware, at that time the only species of pottery employed for common domestic purposes, were the softness and looseness of texture of its body, which obliged the potter to make it thick and clumsy and heavy, in order to ensure to it a moderate durability; and that its porousness, as well as its dirty gray color, required a thick coating of white enamel, which added still farther to its bulk and weight, and which, containing a large proportion both of lead and arsenic, was hardly safe for culinary use. He began, therefore, by inventing a body for earthenware, which at the same time should be white and capable of enduring a very high degree of heat without fusion, well knowing that the hardness of the ware depended upon the high firing to which it had been subjected. For this purpose, rejecting the common clays of his neighborhood, he sent as far as Dorsetshire and Devonshire for the whiter and purer pipe-clays of those counties. For the silicious ingredient of his composition, he made choice of chalk-flints calcined and ground to powder.

"It might be supposed that white sand would have answered his purpose equally well and have been cheaper; but being determined to give the body of his ware as great a degree of compactness as possible, it was necessary that the materials should be reduced to the state almost of an impalpable powder; and calcined flints are much more easily brought to this state by grinding than sand would be. The perfect and equable mixture of these two ingredients being a point of great importance, he did not choose to trust merely to the ordinary mode of treading them together when moist; but having ground them between stones separately with water to the consistence of cream, he mixed them together in this state by measure, and then evaporating the superfluous water by boiling in large cisterns, he obtained a composition of the most perfect uniformity in every part. By the combination of these and other ingredients in different proportions, and exposed to different degrees of heat, he obtained all the variety of texture required, from the bibulous ware employed for glazed articles, such as common plates and dishes, to the compact ware not requiring glazing, of which he made mortars and other similar articles.

"The almost infusible nature of the body allowed him also to employ a thinner and less fusible glaze, that is, one in which no more lead entered than in common flint-glass, and therefore incapable of being affected by any articles of food contained or prepared in such vessels. With these materials, either in their natural white or variously colored, — black by manganese, blue by cobalt, brown and buff by iron, — he produced imitations of the Etruscan vases and of various other works of ancient art, such as the world had never before seen, such as no subsequent artist had ever attempted to rival.

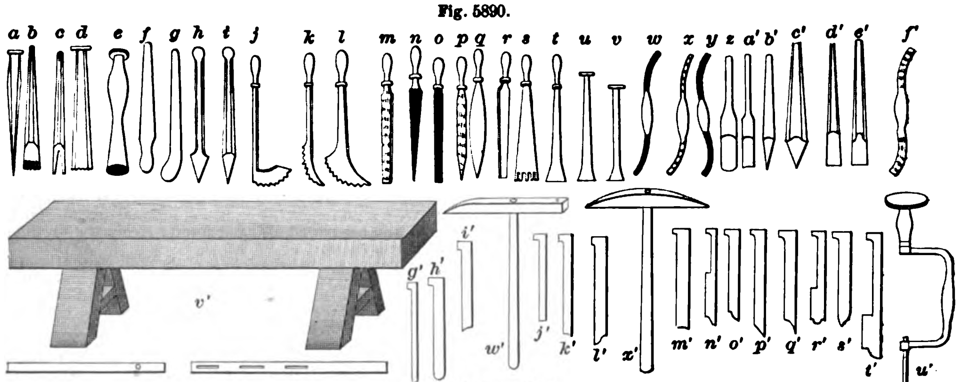
"In table ware, for many years he led the way almost without a rival; but the immense demands occasioned by the successive improvements of this article, which first put down the use of delft, and then of pewter, gave ample room to men of capital and skill to enter the field of profit and competition. Much good has hence resulted; many subordinate improvements have been effected and are almost daily making; but it is to be regretted that many of the most modern ones have reference rather to cheapening the price than improving the quality of the ware or even keeping it up to the original standard."

Fig. 5889.

Stoneware Filter.

Stone'ware Fil'ter. A sim-

Fig. 5890.



Stone-Workers' Tools.

ple filter consists mainly of two stoneware vessels, the one being placed on the other, and the lower on a stand or table. The water is placed in the vessel *a*, and thence percolates through the sponge *b*, which detains large impurities, thence through a perforated earthenware plate, 6 inches of charcoal, and a second plate, reaching the lower vessel, whence it is drawn as required, by means of the faucet.

Stone-work'ing Tools.

Figs. 5890, 5891, show groups of stone-workers' tools.
a, square etching-needle.
b, marteline-chisel.
c, toothed chisel.
d, marteline-chisel.
e, puncheon.
f, *g*, scrapers for sinking flutings.
h, *i*, etching-needles, called *houguettes*, partly flattened, and sharp.
j, hook for leveling cavities.
k, round-nose chisel, for leveling cavities.
l, sharp-edged notched scraper, for sinking flutings.
m, half-round rasp.
n, round file.
o, flat file.
p, German half-round rasp.
q, *r*, safe-side rasps.
s, *t*, marteline-chisels.
u, *v*, puncheons.
w, *x*, *y*, parting-tools, with curved ends in rasp or file.
z, *a'*, gravers and *burins*.
b', *c'*, houguettes, or etching-needles.
d' e', gravers and *burins*.
f', parting-tool, with curved rasps.
g' to *t'*, molding-chisels and scrapers having edges, of varying patterns.
u', *wimble*, for drilling.
v', stone-worker's bench.
w' x', marteline-hammers.
y', square.
z', triangle.
a'', bevel.
b'' c'' d'', rules and straight-edges.
e'' f'' g'', saws of various sizes and construction.
h'' i'' j'' k'', compasses of various sizes and forms.
l'', *sebilla*, or wooden bowl for holding sand and water.
m'', hand-saw.
n'', level.
o'', mallet.
p'' q'', sledges.
r'' s'' t'' u'', chisels of various sizes.
v'', ladle for feeding sand and water to the saw.
w'' x'', hand-saws.

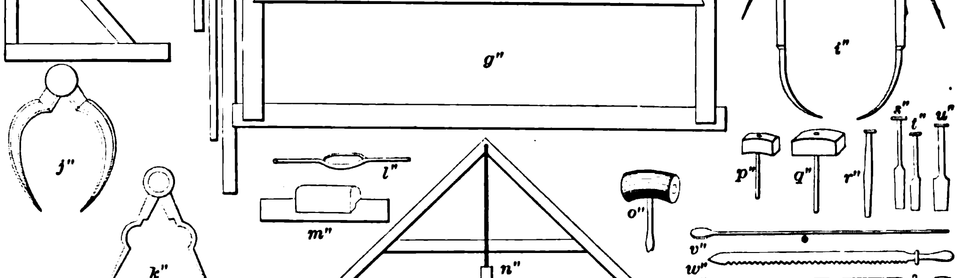
Stook. (*Husbandry.*) A collection of sheaves set up together so as to be mutually supporting. The more usual word in the United States is a *shock*. See SHOCK.

Stool. 1. (*Furniture.*) A kind of seat; usually a circular block supported on three or four legs.

Stools are known by construction, as *folding*; or by purpose, as *camp*, *night*, *foot*, *piano*, etc.

2. (*Agriculture.*) A frame of four growing corn-

Fig. 5891.



Stone-Working Tools.

stalks, tied together to form a support for a corn-shock.

3. (*Shipbuilding.*) *a.* (*pl.*) Chocks beneath the transoms for the attachment of the fashion-pieces.

b. A piece of plank fastened to a ship's side to receive the bolting of the gallery.

c. A small channel on a ship's side for containing the dead-eyes of the back-stays.

4. The sill of a window.

5. A decoy-bird.

Stop. 1. (*Music.*) *a.* A device for changing the tone of a wind-instrument by directing the wind to certain optional series of pipes or reeds of different tones; such as *principal*, *flute*, *diapasm*, etc.

b. A set of pipes in an organ, of given quality and embracing all the tones and semitones within the range for which they are constructed. By means of a variety of stops the organist can change the quality of tone, the power of sound, and the compass of the instrument.

Stops, so called, were first introduced into harpsichords about the middle of the eighteenth century. They were worked by pedals, and known as the *forte*, *soft*, and *buff*. The first lifted the dampers; the second partly stopped the vibrations of the strings; the third interposed a piece of cloth or *buff* leather between the strings and the jacks. This was apparently the origin of pedals.

The *stops* of an organ are *mouth* and *reed*. The *mouth*-stops are divided into *foundation* or *octave* stops and *mutation*-stops. The *foundation*-stops are *open* or *closed*; the latter, called *bourdons*, are an octave above the open pipes of the same size.

The *mutation*-stops have this peculiarity that they give above each sound its third, its fifth, its tenth, in such a way as to represent by the action of several small pipes the aliquot parts or harmonics of the large pipe

The names of the stops of each class, *mouth* and *reed*, and their sub-classes, are numerous. See Rimbault, "On the Organ."

As different stops vary in *pitch* and in *timbre*, a key will sound different notes and tones according as different *stops* are drawn.

The stops which sound the fundamental note are denominated *unison*, and agree in pitch, although they differ in *timbre*.

Stops sounding an octave above the unison are termed *octave*, and those sounding an octave below it are called *double*; as *diapason*, *double diapason*, etc.

Stops with open or closed pipes are so denominated, as *open diapason*, *closed diapason*.

Principal is a stop whose name indicates that it is the first stop tuned, the other stops being tuned from it.

Diapason-stops extend through the whole scale of the instrument, as the name implies.

Some stops are known by the interval which any note of the given stop makes with the fundamental note corresponding to the key struck, as *twelfth*, *fifteenth*, etc.

The following stops are those in common use: —

1. *Open diapason:* has metallic mouth-pipes, open at the upper end.
2. *Stopped diapason:* wooden mouth-pipes, in unison with 1, and having tompions in the upper end.
3. *Double diapason:* wooden mouth-pipes, open, pitched an octave lower than 1.
4. *Principal:* metallic mouth-pipes, pitched an octave higher than 1.
5. *Dulciana:* an open metallic mouth-pipe, tuned in unison with 1, and having relatively long and narrow pipes.
6. *Twelfth:* metallic mouth-pipe, tuned a twelfth above 1.
7. *Fifteenth:* metallic mouth-pipe, tuned an octave above *principal*.
8. *Flute:* wood *or* metal mouth-pipes, in unison with *principal*.
9. *Trumpet:* reed-pipes of metal in unison with 1.
10. *Clarion*, also called *octave-trumpet:* metallic reed-pipes, tuned an octave higher than *trumpet*.
11. *Bassoon:* reed-pipes in unison with 1, but extending only a part of the scale.
12. *Cremona* (krum-horn): reed-pipes in unison with 1.
13. *Oboe:* reed-pipes in unison with 1.
14. *Vox humana:* reed-pipes in unison with 1.

Many others might be mentioned of peculiar tone, as *clarinet*, *cornet*, *vox celeste*, etc.

Compound stops consist of several sets of stops aggregated to form harmonic combinations. Such are the *sesquialtera*, *cornet*, *mixed*.

It will be noticed that a number of the above are described as *reed-pipes in unison with* 1. The cause of the difference in *timbre*, or quality of tone, may be partially in the tongue, but is mainly produced by varying the form of the tube. The tubes have varying lengths and proportions, more or less elongated, with swells and other peculiarities which affect the character of the tone emitted.

Some large church-organs have numerous stops not here enumerated, such as the *tierce*, *larigot*, *nineteenth*, *twenty-second*, *twenty-sixth*, *twenty-ninth*, *thirty-third*, tuned at these intervals above *open diapason*.

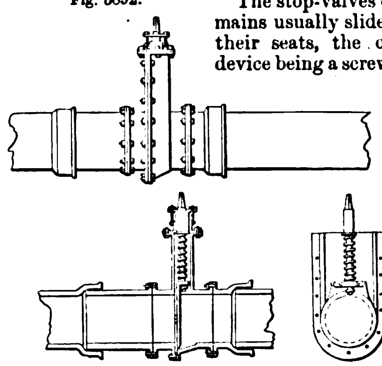
The organ of the church of S. Alessandro, in Colonna at Bergamo, built by Serassi in 1782, has 100 stops and 4 banks of keys. The Boston organ has 120 stops. See ORGAN.

2. (*Nautical.*) A projection at the upper part of a mast, outside of the cheeks.

3. (*Optics.*) A perforated diaphragm between two lenses, to intercept the extreme rays that might disturb the perfection of the image.

Stop-cock. A faucet in a pipe, to open or close the passage.

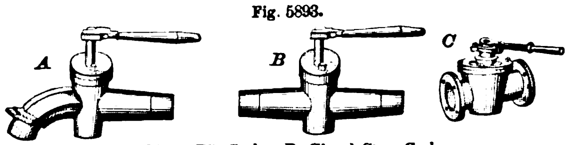
Fig. 5892.



Stop-Valve.

The stop-valves of water-mains usually slide against their seats, the operative device being a screw, turned by a handle. A turnkey inserted from above fits over the square of the screw, whose thread traverses in a nut formed by a projecting flange on the back of the valve. See STOP-VALVE.

Fig. 5893.



A, Gland Bib-Cock. B, Gland Stop-Cock.
C, Smith and Rowe's Patent Stop-Cock.

Stop-cyl'in-der Press. (*Printing.*) One in which the impression-cylinder is stationary during the return of the bed. While the bed returns the next sheet is adjusted. See CYLINDER-PRESS; also LITHOGRAPHIC PRESS, Fig. 2977.

Stope. (*Mining.*) A horizontal bed. To stope; to excavate horizontally layer after layer.

Stop-fin'ger. A device in a silk-doubling machine for stopping the motion of the bobbin if the thread break. See FALLER-WIRE.

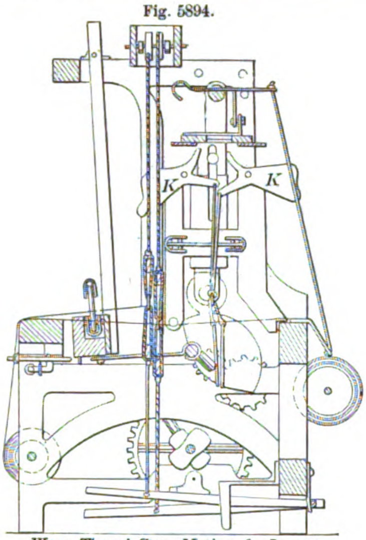
Stop-mo'tion. An arrangement in a machine by which the breakage of material in transitu, or the failure of supply of the material under treatment, causes an arrest of the motion.

Such, for instance, is the attachment in power-looms and knitting-machines, designed instantly to arrest the movement, if at any time the spool become exhausted in the shuttle, or the yarn happen to break. A delicate metallic finger feels for the yarn at the very instant the shuttle completes its course. If the yarn is in its place it rests there, and the work goes on; if not, it makes an electric contact, and the power is paralyzed in an instant. In pattern work the advantage of such an attachment will easily be understood. No time is lost in studying to find where the pattern began to be interrupted, and no trouble is necessary to set backward the Jacquard guides.

Fig. 5894 is a stop-motion for warps of looms.

It has a series of pivoted wings *K K* from which warp-supporting rods or threads are suspended. So long as the warp-supporting rods or threads are kept tense by the warp-thread, they hold the wings in such a position that the same do not in-

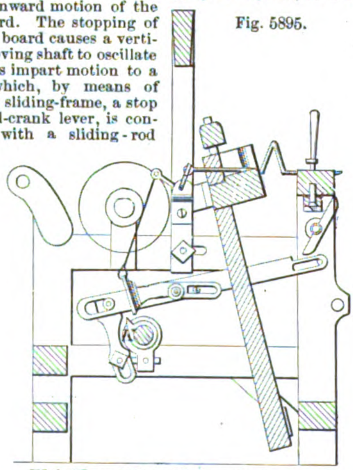
Fig. 5894.



Warp-Thread Stop-Motion for Looms.

terfere with the motion of a rising and falling flat board; but as soon as a warp-thread breaks, it will cause the release of a warp-supporting rod or cord, whereupon the wing from which the same is suspended will swing upon its pivot, so as to arrest the downward motion of the flat board. The stopping of the flat board causes a vertically moving shaft to oscillate and thus impart motion to a lever, which, by means of cords, a sliding-frame, a stop and bell-crank lever, is connected with a sliding-rod

Fig. 5895.



Weft-Thread Stop-Motion for Looms.

which operates the belt-shifting lever. As soon as the rod is released by the withdrawal of the stop, it is moved by the action of a spring, so as to shift the belt to a loose pulley and thus stop the loom, the batten being simultaneously arrested by a stop on said rod.

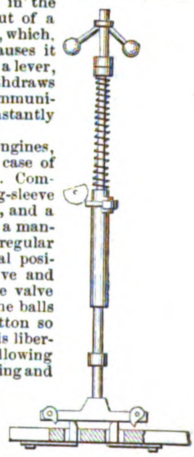
Fig. 5895 shows a set of devices designed to stop the loom when the weft-thread breaks or gives out; in this case the bars of the grid on the lay are allowed to pass the weft-fork, and a lever is thus allowed to drop so low as to be struck by the wiper *K*, which pushes it and the bar forward until the shoulder strikes a lever, and by the intervention of another lever unlocks the shipper.

Stop-motions are also used in *roving*, *spinning*, and *working machinery*. See Fig. 5900.

The stop-motion of *drawing*-machines is contrived to arrest the motion of the machine when a sliver breaks. This is accomplished by causing the slivers from the finishing carding-engine to pass over weighted guide-levers, termed *spoons*, mounted so as to be capable of turning upon centers, and kept in a certain position by the tension of the fibers while being drawn. Should one of the slivers break, or a can become empty, the spoon falls, and a part projecting from its under side intercepts the motion of a vibrating bar, and this acts upon other apparatus which shifts the driving strap from the fast to the loose pulley. See STOPPING MECHANISM.

The electric stop-motion for fabric-machines is so arranged that, on the breaking of a single thread, the emptying of a bobbin, the accidental bending of a needle, or on holes being caused in the work by the knotting or thinning out of a thread, an electric circuit is completed, which, passing through an electro-magnet, causes it to attract an armature, and so releases a lever, which, actuated by a strong spring, withdraws a clutch through which motion is communicated to the loom, and the machine is instantly stopped.

Fig. 5896.



Stop-Motion for Engine.

Fig. 5896 is a stop-motion for steam-engines, to come into action automatically in case of the failure or breakage of the governor. Combined with the governor is a coupling-sleeve with a dog let in crosswise of the same, and a supporting-spring and button in such a manner that when the engine runs at its regular speed and the balls occupy their normal position, the connection between the valve and governor-rod is not disturbed, and the valve remains open; but if from any cause the balls drop down, the dog will strike the button so that it is thrown back, and the sleeve is liberated from the rod of the governor, allowing the same to follow the action of the spring and close the valve, and thus stop the motion of the engine.

Stop'per. 1. (*Nautical.*) A short piece of rope having a knot at one end, with a laniard under the knot; applied to shrouds, cables, etc., for various purposes.

a. Of the anchor; a rope attached to the cathead, and, after passing through the anchor-ring, made fast to a timber-head.

b. Of the cable; a *deck-stopper* is a rope attached to a ring on the deck, and lashed to the cable to prevent the veering of the latter. The cable-stopper has a hook and thimble at one end, and a laniard at the other.

A *dog-stopper* is clinched around the mainmast and secured to the cable.

A *wing-stopper* is clinched to a beam.

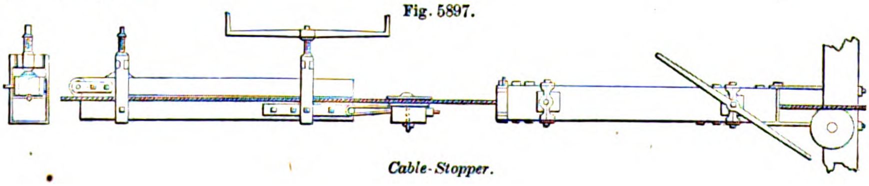
A clamp or stopper is used to secure a cable while *fleeting* it on the capstan, especially in hoisting heavy weights.

The illustration shows the stopper by which the rope was clamped when hoisting the chains of the Menai Suspension Bridge. One end of the chain was carried over the strait, and attached to that which hung perpendicularly from the opposite pier. The hoisting power was 4 capstans, each worked by 32 men, and assisted by powerful tackle. Each chain weighed 242,299 pounds, over 121 tons. As the rope coiled upon the capstan, it was necessary to *fleet* it back every 3 rounds, and the stopper was to prevent the fall of the rope from surging back. See also CABLE-STOPPER.

c. Of rigging; a rigging-stopper secured to standing rigging above and below an injured part, so as to make the piece secure. It may be done by lashing dead-eyes to each part, and then hauling taut by laniards.

d. A piece of rope with a knot at one end and a hook at the other, for various purposes about the deck.

Fig. 5897.



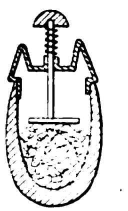
Cable-Stopper.

2. (*Railway Engineering.*) A trailing-brake formerly used on inclined planes. It was in the rear of the last wagon in ascending, and was thrown into action by the pressure of the cars, if the rope broke. It penetrated the ground and stopped the descent. Also called a *trailer* or *cow.*

3. A plug to condense tobacco in a pipe. Fig. 5898 shows a stopper attached to a spring-rod.

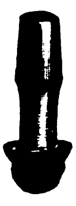
4. A cork or plug for closing a bottle. Many materials and forms have been used. See BOTTLE-STOPPER; FRUIT-JAR.

Fig. 5898.



Tobacco Stopper.

Fig. 5899.



Bottle Stopper.

Fig. 5899 is Matthews's bottle-stopper for aërated liquids. It is of glass, with a gasket of caoutchouc, and was perhaps the first gravitating stopper longer than the internal diameter of the bottle, so that it cannot tip over.

The gasket may be compressed in one direction, but not in the other, so that it may be forced in, but not blown out.

Stop'per-bolt. (*Nautical.*) A large ring-bolt driven in the deck of a ship before the main-hatch, for securing the stoppers to.

Stop'per-hole. (*Puddling.*) A hole in the door of the furnace through which the iron is stirred, and the operation observed; it is sometimes stopped with clay: hence the name.

Stop'ping. 1. (*Mining.*) *a.* A door in a drift or gallery which *stops* the passage of air at a certain point, being a part of the artificial ventilation system of a mine.

b. Cutting down mineral ground with a pick.

2. (*Dental Surgery.*) Material for filling carious teeth. The holes are cleared of carious matter by instruments called *burs, excavators, drills, chisels,* etc. Among the filling materials may be cited: —

Gold.
Silver.
Tin.
Amalgams of silver, tin, or cadmium.
Os artificial: oxychloride of zinc mixed with a liquid.
Foil: gold or tin.
Hill's stopping: india-rubber and silex.

3. (*Engraving.*) Covering with varnish such parts of an etched plate as may have been sufficiently *bitten in* with acid; the remaining portions are then again exposed to acid to deepen the lines. See ETCHING.

4. Patching incomplete work with cement, such as gaps made by the spalling of marble or stone, of veneer, etc. *Badigeon.*

5. (*Farriery.*) A pad or ball occupying the space within the inner edge of the shoe, around the *frog* and against the *sole.* Its object is to keep the parts in a moist condition, similar to that which they possess in a state of nature, where the hoof is not lifted clear of the ground by a shoe, but the *sole* and *frog* come in contact with the damp earth and verdure.

Dickenson's English patent, some 50 years since, consisted in placing a piece of stout leather over the whole bottom of the foot, and nailing the shoe thereupon. An angular plate of iron is riveted to the outer surface of the leather, over the frog, whose form it imitates. Beneath the leather is packed a quantity of sponge which absorbs and retains moisture.

A common practice with horses habitually stabled, and where great care is exercised, is to stop the feet after coming from work, a composition of cow-dung and clay being used. Several devices for *stopping* the feet of horses have been suggested, and a number patented. Pads of india-rubber, felt, sponge, cork, etc.

Stop'ping-brush. 1. (*Hat-making.*) A brush used by hat-makers when working at the *battery,* to sprinkle boiling hot water upon the napping and the hat body to assist in uniting them as they are worked, pressed, and rolled by the hand, the *glove,* and the rolling-pin.

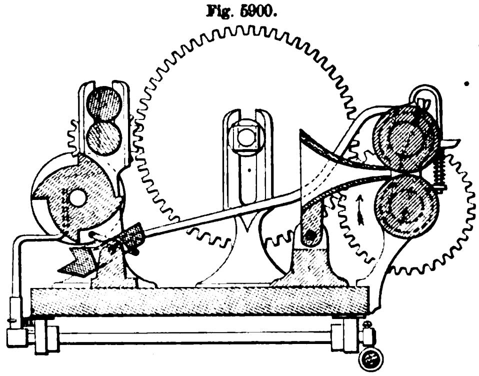
2. (*Engraving.*) A camel's-hair brush, used by engravers in *stopping* out portions of etched plates. See ETCHING.

Stop'ping-knife. The glazier's putty-knife.

Stop'ping-mech'an-ism. An automatic device in machinery by which the motion is stopped if a thread (for instance) should break. Automatic stopping-mechanisms are applied to looms to arrest the motion of the machine if the weft-yarn break or the shuttle be emptied; to spinning-machinery, if the roving or thread should break. See STOP-MOTION.

Fig. 5900 is a stop-mechanism for railway-heads of spinning-machines, designed to shift the belt and stop the machine when the sliver passing between the condensing or delivering rolls is above or below a given thickness. A rise or fall of the upper roller above or below a certain point moves a lever and raises a tripping-dog into contact with a ratchet-wheel.

Fig. 5900.



Stop-Mechanism for Spinning-Machines.

Stop'ping-off. (*Founding.*) A term applied to the filling up with sand of a portion of a mold, when the casting is desired to be smaller than the pattern from which the mold is formed. It is in opposition to cutting out, when a portion of sand is removed, so as to enlarge the mold to represent an addition to the size of the pattern.

Stop'ping-out. (*Engraving.*) Covering with varnish any portion of an etched plate which has been corroded to a sufficient extent; after the *stopping-out,* farther portions are deepened by a repetition of the process called *biting-in.* See ETCHING.

Stop'ping-up Pie'ces. (*Shipbuilding.*) Timbers placed on the middle part of the *bilge-ways,* to meet and support the bottom of the ship. They form a part of the *cradle.*

Stop-plank. (*Hydraulic Engineering.*) One of a set of planks to occupy vertical grooves in the wing wales of a lock or weir, to hold back water in case of temporary disorder of the lock-gates.

Stop'ple. A stopper, cork, or bung, for a bottle, jar, keg, or cask. See STOPPER; BOTTLE-STOPPER.

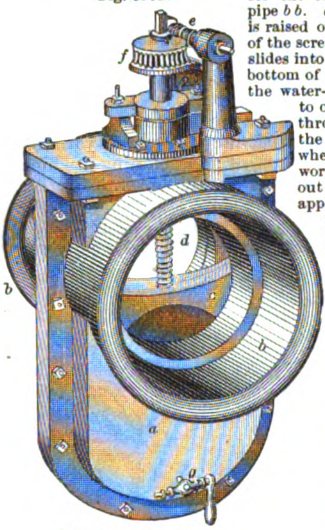
Stops. (*Nautical.*) The square projections or shoulders left on the outsides of the cheeks at the upper parts of the hounds.

Stop-valve. 1. (*Hydraulics.*) A valve which closes a pipe against the passage of fluid. The large valve used in water-mains is known by this name. It is usually a disk which occupies a chamber above the pipe when the passage-way through the latter is open, and is driven down by a screw to *stop* the aperture, its face being pressed against the seat by the contact of the rear with wedging abutments.

The smaller device, with a spigot, is called a Stop-cock (which see). See also Three-way Valve.

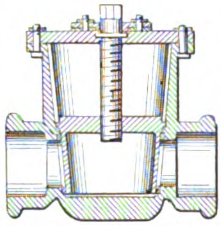
In Kearney's stop-valve for water-mains (Fig. 5901), the casing *a* has a circular opening for the ends of the supply-pipe *b b*. *c* is the valve, which is raised or lowered by means of the screw *d*. When open, it slides into the chamber at the bottom of the casing, leaving the water-way clear; in order to open it the worm *e* is thrown into gear with the worm-wheel *f*, and when it is started the worm may be thrown out of gear and power applied directly to the screw. This lessens the labor of opening and closing the valve under great pressure, and the opening being effected very gradually at first, avoids the danger of bursting the pipe by sudden pressure. *g* is a cock for drawing off or forcing out any foreign matters which may collect at the bottom of the valve-casing.

Fig. 5901.



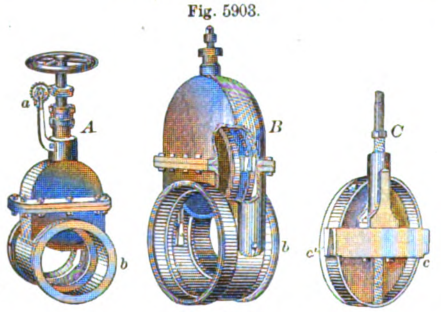
Kearney's Stop-Valve.

Fig. 5902.



McClelland's Stop-Valve.

Fig. 5903.

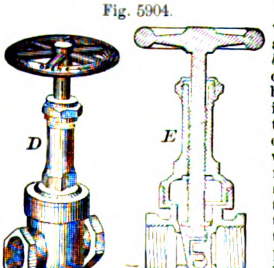


Stop-Valve.

Fig. 5902 is the McClelland valve. It is a hollow cone, the hollow being of a diameter greater than the bore of the pipes. The body of the valve is cast upon and within bronze rings, which serve for bearings.

Fig. 5903, *A*, *B*. The gate when raised is received in a box above the pipe-joint *b*. In *A*, the screw which operates the gate is turned by a hand-wheel, and an indicator *a* shows its position in the pipe. *B* has a double gate, shown at *C*, with one of the faces removed; when the gate is shut down, wedges within the casing *b* enter between the two wedges *c c'*, forcing the two faces against their proper bearing surfaces, to prevent leakage.

Fig. 5904.

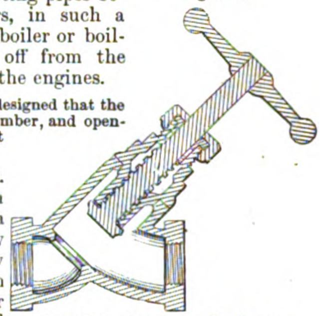


Stop-Valve.

Fig. 5904, *D*, *E*. A perspective and section of a small stop-valve having a wedge-shaped valve, whose form renders it self-packing.

2. (*Steam-engineering.*) Stop-valves, or *communication*-valves, are fitted in the steam-pipes where they leave the several boilers, and in the connecting-pipes between the boilers, in such a manner that any boiler or boilers may be shut off from the others, and from the engines.

Fig. 5905.



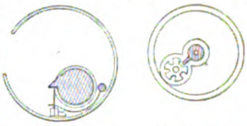
Stop-Valve for Steam-Enginery.

In Fig. 5905, it is designed that the bore of the pipe, chamber, and opening in the valve-seat shall be the same.

Stop-watch. A watch in which the works (or a part of them) may be stopped by pressing in an exterior pin. Used in timing races, etc. The most improved form is the independent-seconds watch. See Independent-seconds Watch.

Stop-work. A device attached to the barrel of a watch, musical-box, or spring-clock, to regulate the winding of the spring and prevent over-winding. The middle turns of the spring are most equably efficient, and it is better to so organize the stop that the strongest and weakest powers of the spring be rejected. This is particularly necessary in watches destitute of the *fusee*, which is a conical wheel, whose office is to regulate the action of the *spring* on the *train*.

Fig. 5906.

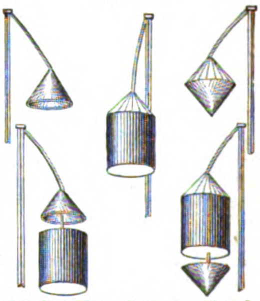


English Stop. *Swiss Stop.*

Storm-drum. A signal. *a*. A painted canvas drum, distended by hoops.

b. A semaphoric device of Admiral Fitzroy, consisting of a hollow cylinder and cone, either of which, or both simultaneously, may be suspended from a mast or staff; their positions denoting the probable direction of the wind in an approaching storm. Thus: Cone point upward, to the right of the staff, northerly gale. Cone point downward, to the left of the staff, southerly gale. Cylinder above: expect dangerous winds from both quarters successively. Upright cone above cylinder: dangerous wind expected from north. Reversed cone below cylinder: dangerous wind expected from south.

Fig. 5907.

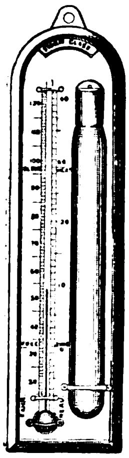


Admiral Fitzroy's Storm-Signal.

It took some time to inspire the sailors with confidence in the storm-signals of Admiral Fitzroy, but in 1864 it was found in England that fifty per cent, at least, of all the storm-warnings had proved correct, and in 1865 that seventy-three per cent had been fully verified. In France, during the years 1865, 1866, out of one hundred warnings sent, seventy-one were realized the first year, and seventy-six in the second year; and out of one hundred storms which occurred, eighty-nine were signaled during the first winter, and ninety-four during the second. The North German "Seewarte" mentions that out of thirty storm-warnings hoisted at Hamburg, ninety-four per cent were correct. The system in the United States is gaining the confidence of navigators, and is yearly growing more correct. A number

of disastrous storms have been predicted with marvelous precision from Washington, and our daily weather-forecasts very seldom fail to express the general atmospheric conditions, and usually fore-announce the changes to within an hour or two of their occurrence.

Fig. 5908.



Storm-Glass.

Storm-glass. A tube containing a liquid holding a solution which is sensible to atmospheric changes. In clear weather the substance is said to settle near the bottom of the tube, the liquid remaining comparatively clear; previous to a storm the substance rises, causing the liquid to present a turbid and flocculent appearance. It is sometimes, as in the illustration, mounted on a back and associated with a thermometer. A thin bladder is tied over the top.

The solution is: —

Camphor................2 dr.
Niter....................1½ dr.
Sal. am. ....1 dr.
Proof spirit.............2¼ fluid oz.

Storm-kite. A contrivance for sending a rope from a stranded vessel to the shore. An *anchor-ball* is frequently used from the shore to the vessel. See ANCHOR-BALL.

Storm-pane. A supplementary, framed sheet of glass, to substitute, in an emergency, for a broken pane in a lighthouse.

Storm-pave'ment. (*Hydraulic Engineering.*) The sloping stone paving which lines the sea-face of piers and breakwaters. The breakwater glacis.

Storm-sail. (*Nautical.*) A sail of reduced dimensions and extra heavy canvas, for heavy weather. Thus we speak of a *storm-jib*, *storm-trysail*, etc.

Storm-sig'nal. See STORM-DRUM.

Sto'ry. (*Architecture.*) The space between two floors of a building.

Sto'ry-post. (*Building.*) One occupied in supporting the *bress-summer* when a window occupies the whole front of the ground floor.

Sto'ry-rod. (*Building.*) A rod equal in length to the hight of the floor, and having the hights of the several steps of the stairs marked upon it.

Stove. 1. A close fireplace for warmth or cooking.

In Asia and some parts of Europe stoves are made of brick, or even of clay. In Germany they are frequently of tile, which is but a form of brick. In England and in the United States iron is preferred, though steatite (soapstone) is sometimes used. For burning hard coal, stoves are lined with fire-brick.

Stoves are made specifically for wood or for coal; they are also heated by charcoal, coal-oil lamps, or by gas, the construction being agreeable thereto. See HEATING-APPARATUS; HEATING-STOVE; FURNACE; and also under the various heads in the following list of stoves and heating appliances: —

Andiron.
Air-heater.
Air-stove.
Arnott's stove.
Asbestus-stove.
Ash-pit.
Athanor.
Autoclave.
Bagasse-dryer.
Baker.
Balneum.
Banking-up.
Bark-stove.
Barrel-dryer.
Base-burner.
Base-burning furnace.
Base-burning range.
Base-burning stove.
Bath-furnace.
Bath-heater.
Battery.
Blower.
Blow-up pan.
Boiler. Domestic
Boiler. Steam
Boilery.
Bone-black retort.
Bookbinder's stove.
Brazier.
Broiler.
Calcination.
Caliduct.
Calorifere.
Calorimeter.
Calorimotor.
Camp-stove.
Car-heater.
Car-stove.
Carving-table.
Censer.
Chafer.
Chafing-dish.
Charcoal-furnace.
Check-bridge.
Chimney.
Chimney-cap.
Chimney-jack.
Chimney-valve.
Clinker-bar.
Coal-oil stove.
Coal-stove.
Cockle.
Coffee-pot.
Coffee-roaster.
Comb-pot.
Condenser.
Confection-pan.
Cooking-range.
Cooking-stove.
Corn-popper.
Coving.
Cowl.
Cresset.
Cross-bearer.
Crucible.
Cucurbit.
Cupel.
Cupola.
Curling-iron.
Damper.
Dead-plate.
Deflagrator.
Digester.
Dish-heater.
Draft.
Drum-stove.
Dryer.
Drying-house.
Drying-machine.
Dry-stove.
Dutch-oven.
Eccalobion.
Egg-boiler.
Electrical heater.
Elevated oven.
Evaporating-cone.
Evaporating-furnace.
Evaporating-pan.
Evaporator.
Feather-renovator.
Fender.
Fire-back.
Fire-bar.
Fire-basket.
Fire-box for locomotives.
Fire-brick.
Fire-bridge.
Fire-cage.
Fire-dog.
Fire-guard.
Fireplace-grate.
Fire-pot.
Fire-screen.
Fire-top.
Fire-tube.
Firing-iron.
Flat-iron heater.
Flue.
Flue-brush.
Flue-cleaner.
Fluting-machine.
Foot-stove.
Foot-warmer.
Fruit-dryer.
Frying-pan.
Fumigator.
Funnel.
Furnace.
Furnace-grate.
Galley.
Gas blow-pipe.
Gas-heated furnace.
Gas-heater.
Gas-retort.
Gas-stove.
Gauffering-machine.
Glue-boiler.
Glue-pot.
Goose.
Grain-dryer.
Grate.
Grate-bar.
Grid.
Griddle.
Gum-pot.
Hastener.
Hearth.
Heat-engine.
Heating-apparatus.
Heating-furnace.
Heating-pipe.
Heating-stove.
Heat-regulator.
Hob.
Hot-air apparatus.
Hot-air furnace.
Hot-air stove.
Hot-flue.
Hot-house.
Hot-press.
Hot-wall.
Hot-water heating-apparatus.
Hot-water pump.
Hot-well.
Hydrocarbon-furnace.
Hydrocarbon-stove.
Hypocaust.
Incubator.
Ironing-machine.
Kettle.
Kindler.
Lamp-stove.
Lard-boiler.
Laundry-stove.
Lumber-dryer.
Lumber-kiln.
Magazine.
Magazine-stove.
Malt-kiln.
Manure-desiccator
Mercurial heater.
Muffle.
Norwegian stove.
Nursery-lamp.
Nut-roaster.
Oast.
Offal-dryer.
Oven.
Paint-burner.
Pan.
Petroleum-burner.
Petroleum-stove.
Plate-warmer.
Popper.
Portable boiler and furnace.
Portable furnace.
Portable stove.
Pyrometer.
Pyroscope.
Radiator.
Railway car-heater.
Railway car-stove.
Range.
Range-stove.
Reel-oven.
Reflector.
Regenerator.
Register.
Rendering-apparatus.
Reredos.
Reservoir-stove.
Retort.
Retort-stand.
Sad-iron.
Sad-iron heater.
Salamander.
Saltern.
Sand-bath.
Set-pot.
Shovel.
Skillet.
Skimmer.
Slice.
Smoke-consuming furnace.
Smoke-house.
Smoke-stack.
Smoothing-iron.
Smoothing-iron heater.
Soap-boiler.
Soap-kettle.
Sorghum-evaporator.
Spark-arrester.
Spider.
Stack.
Stalk.
Steam-chest.
Steam-cooking apparatus.
Steamer.

Fig. 5910.

Roasting-Stove.

The *laconicum*, or heating-stove, used by the Romans in the fourth apartment of their Thermæ, was so called because introduced from Laconia. It sent forth a dry heat, and was of a cylindrical shape. It was placed in one of the angles of the apartment, and was heated by the flames of the *hypocaustum* beneath. It had a cupola, open at top, and the heat admitted from the *hypocaustum* was regulated by a brazen damper in the shape of a shield, according to Vitruvius, but of a globular shape in some cases, as in the baths of Titus, erected after the death of that useful compiler.

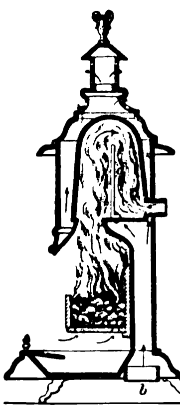
The apartment in which it was used was frequently called the *laconicum*, after the name of the stove.

The bathers here took their sweat, and then, after oiling themselves, plunged into the cold bath of the adjacent *frigidarium*. The heat of the stove modified the temperature of the adjacent *tepidarium*.

The *laconicum*, in some cases, was provided with niches, which were occupied by those requiring a dry bath. These niches were known as *sudationes*, or sweating-places.

Stoves on the Continent of Europe have a double casing which surrounds the fuel-chamber. Into the interval between the casings air is admitted from the outside of the building, and from this space the heated air is conducted to the room. The stoves are generally of earthenware, being made round or square, and are frequently constructed mainly of tiles. Some of them are like a small *hypocaustum*, in which the ceiling of the fuel-chamber is supported by earthen pipes, which conduct air to the chamber above. The fire is made around these pipes, heating their contents as well as the ceiling above it.

Fig. 5909.



Stove.

In the stove shown in section (Fig. 5909), the back and top of the fire and smoke chamber are surrounded by a metallic drum. The fire-chamber is open in front, at once radiating heat directly into the apartment and admitting the air to support combustion. The products of combustion, after passing over a bridge *a*, are deflected downward and carried away by a flue passing through the back of the drum. Air from the apartment enters the drum through an opening *b* in its bottom, and, becoming heated, is again returned through apertures in its top. The combustion-chamber should, of course, be made perfectly fire and smoke tight.

The stove, Fig. 5910, has a roasting-chamber at front, provided with doors, by opening which the meat may be exposed directly to the rays of the fire. Doors above allow the heated air from this chamber to pass into the flue.

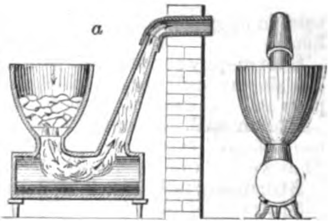
The magazine-stove has been considered under several heads. The ATHANOR (page 175) is the earliest on record, having been used by the alchemists of the Middle Ages to keep up a constant fire, the fuel in the elevated chamber settling into the fire as that in the grate was consumed. It was thus a base-burner, though its magazine was not central, like the modern. A base-burner stove (*a*) was shown in 1685 at the fair of St. Germain, in France, by M. Delasme (Fig. 5911). See pages 242 and 2225.

The first magazine and base-burning stove of modern form was that of David Riz, English patent of April 28, 1770. It is shown at *b*, Fig. 5912. The fuel-reservoir has a cover, the stove is self-feeding, the grate is arched, the bottom layer of fuel only being permitted to burn. The heated products pass up outside the fuel-chamber to the chimney. Between this up-cast space and the outside of the stove is a chamber in which air is heated. The fuel is prevented, by the grated side of the fuel-chamber, from spreading laterally.

This latter feature is shown in Walker's English stove, 1842 (*c*, Fig. 5912), and Littlefield's, 1853, 1854 (Fig. 5913).

Next to Riz may be cited the Watt patent of 1785 for a fuel-reservoir steam-boiler furnace, in which the base of the fuel only was directly exposed to combustion (Fig. 5914).

Fig. 5911.



Delasme's Base-Burner (1685).

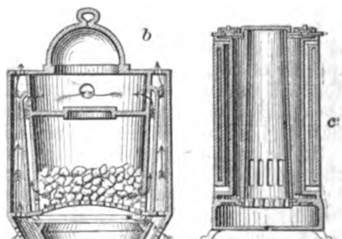
The first illuminated stove it would be difficult to determine, that is, one with mica windows, to enable the fire to shine through. The uses of mica are very ancient, the *lapis specularis* of Pliny being probably sheet-mica.

The first instance at hand occurs in the English patent of Pollok, 1807 (Fig. 5915). It is shown in two forms; one as a projecting door to an outstanding stove, and one as a fireplace-stove, with three mica windows.

Stratton, 1817 and 1822 (Fig. 5916), are other instances; the latter being much like James Watt's device.

Eliphalet Nott's stove, Schenectady, New York, in use before 1830, is shown at *i*, Fig. 5917. It was known as the *Saracenic grate*, probably in reference to the Athanor, or alchemist's stove, which has not passed entirely out of knowledge, although the writer has failed to find an illustration of it. Even the ordinary dictionaries recognize it, and it is described in Hebert's "Engineer's Cyclopædia," London, 1850, Vol. I. p. 109; Francis's "Dictionary of Arts"; Partington's Dictionary, 2 vols.; Weale's "Dictionary of Terms in Art."

Fig. 5912.



Base-Burning Stoves.
(*Riz*, 1770.) (*Walker*, 1842.)

The Nott stove was patented in England in 1830, 1831. It is a base-burning illuminated stove, without an internal fuel-chamber.

The Mott stove is shown at *j*, Fig. 5917, and had a suspended magazine, and mica doors to the fire-chamber.

The Harper and Walker stove (*k*, Fig. 5917, English) of 1839 is a magazine base-burner, with a mica door to the fire-chamber.

The Walker stove of 1842 had a tall central magazine with grated openings at its lower portion.

The Cantelo stove (English patent) of 1846 (*l*, Fig. 5918) was made for keeping a constant heat in the inventor's *incubator*. It had a central magazine with lid.

Walker's French patent of 1849 (*m*, Fig. 5918) has the central magazine and mica door.

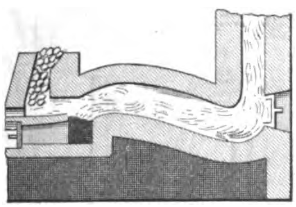
Fig. 5913.

Magazine-Stove.
(*Littlefield*, 1853.)

Grant's English patent, 1850 (Fig. 5919), has the magazine projecting into the fireplace.

Liddel in 1852 (*o*, Fig. 5920) shows a bulged combustion-chamber, a flaring fire-pot, a sheet-iron outer cylinder, and a central magazine base-burner.

Fig. 5914.



Base-Burning Furnace.
(*Watt*, 1785.)

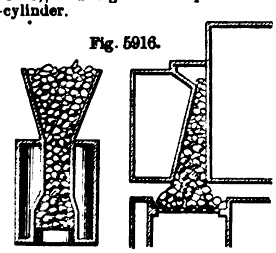
He was the first to ventilate his magazines on top by allowing the gases to escape into the chimney.

Littlefield, in 1853 (Fig 5913), had a grated fire-pot at the lower part of the magazine-cylinder.

Fig 5915.

Mica-Front Stove.
(*Pollok*, 1807.)

Fig. 5916.

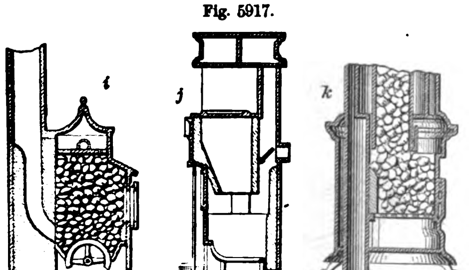


Magazine-Furnaces.
(*Stratton*, 1817 *and* 1822.)

Saxton, in 1856 (*p*, Fig. 5920), had a covered fuel-cylinder in the fire-chamber.

Cantelo's U. S. patent in 1859 (Fig. 5921) shows a petticoat fuel-cylinder projecting downward into the fire-pot.

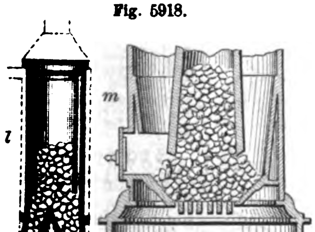
Fig. 5917.



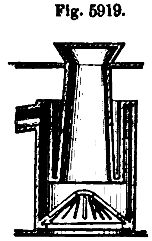
Magazine-Stoves.
(*Nott*, 1830.) (*Mott.*) (*Harper and Walker*, 1839.)

Roney, in 1861 (Fig. 5922), had a grated fire-pot of larger diameter than his magazine.

Fig. 5918. Fig. 5919.

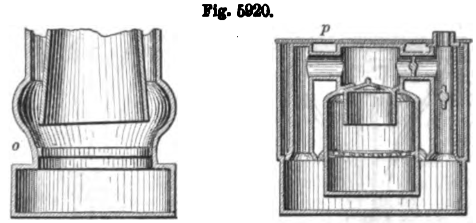


Magazine-Stoves.
(*Cantelo*, 1846.) (*Walker*, 1849.)



Base-Burner.
(*Grant*, 1850.)

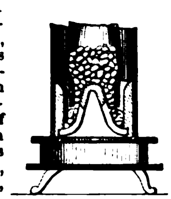
Fig. 5920.



Magazine-Stoves.
(*Liddel*, 1852.) (*Sexton*, 1856.)

There are in the United States about 350 foundries engaged in the manufacture of stoves and furnaces, using annually 500,000 tons of iron. Of stoves alone it is estimated that the 275 foundries engaged in the business in 1871 produced 2,200-200 stoves. This, of course, does not include heating-furnaces. In 1830, the estimated number of stoves made in this country was 25,000; in 1840, 100,000; in 1850, 375,000; in 1860, 1,000,000; in 1870, 2,100,000, — valued at $ 37,600,000. The value of heating-furnaces annually made in the country will amount to $ 20,000,000.

Fig. 5921.



Magazine-Stove.
(*Cantelo*, 1859.)

Fig. 5922.

Grated Fire-Pot Stove.
(*Roney*, 1861.)

2. A room artificially heated to a high degree, as, —

The room in which scoured cloths are dried before *burling* and *fulling*.

The room in which packaged starch is dried.

In many trades, articles are artificially dried by a high heat, as bent wooden stuff; figures of plastic clay; crucibles; enameled or varnished metal-work, etc.

3. (*Founding.*) The usual contraction for the *drying-stove* for cores and molds.

4. The *hot-house* of the florist. The furnace which heats the *forcing-house*.

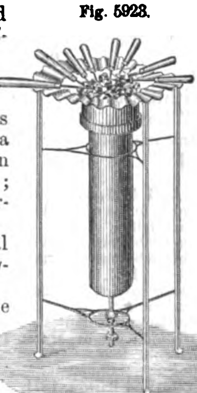
5. (*Pharmacy.*) A chamber used in drying plants, extracts, etc.

6. (*Surgical.*) A heated dry-air bath. The *laconicum* or *calidarium* of the Romans.

A vapor bath. The *tepidariam* or *vaporarium* of the Romans.

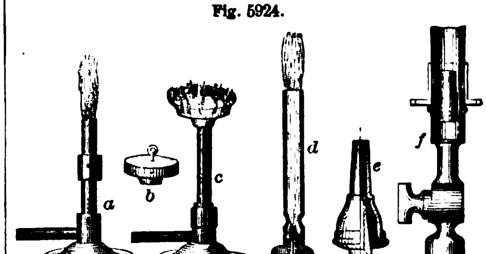
7. (*Bookbinding.*) A small gas-stove used for

Fig. 5923.



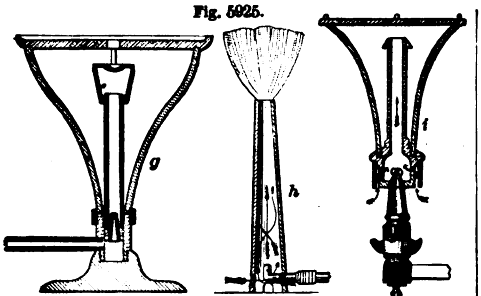
Bookbinder's Stove.

Fig. 5924.



Bunsen Burners.

Fig. 5925.

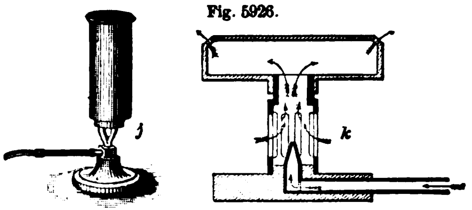


Bunsen Burners.

heating the tools with which the covers of books are lettered and ornamented (Fig. 5923).

Stove-burn'er. A gas-burner specially arranged for heating. The Bunsen burner is preferred, as it gives a blue, smokeless flame, with great heat. Its due performance depends upon the proper admixture of gas and air. If gas be in excess, the flame gives light and smoke and little heat. If air be in excess, the mixture explodes, and the gas takes

Fig. 5926.

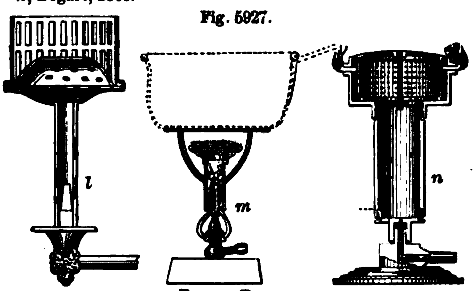


Bunsen Burners.

fire within the tube. See Griffin's "Chemical Handicraft," London, 1866, pages 96, 97. See also "Die Spectralanalyse," Schellen, Braunschweig, 1870, page 18.

Figs. 5924, 5925, 5926, 5927, show the mode of application, and several forms of the device.
a, from Griffin.
b, Rosette-burner (Griffin).
c, Rosette-burner (Griffin).
d, Bogart, 1867.
e, Allen; patent, September 7, 1869.
f, Bradley, 1865.
g, McGlensey; patent, June 19, 1860.
h, Osmond; patent, March 14, 1865.
i, Griswold, 1868.
j, Bloxam's "Chemistry."
k, Webb and Parkin, 1871.
l, Lasear and Sharp, 1868.
m, Hamilton; patent, April 26, 1870.
n, Bogart, 1866.

Fig. 5927.



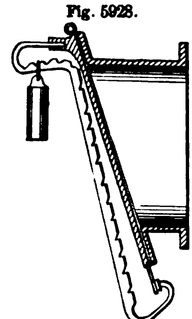
Bunsen Burners.

Stove-damp'er. A shutter or valve to regulate the size of an opening at which air is admitted to a stove, or at which smoke passes off. See DAMPER.

Fig. 5928 shows a hinged damper applied to the draft-hole of a furnace. The in-rushing air tends to close it, the gravity of the damper and the slip-weight to open it. By adjusting the position of the slip-weight, the quantity of air admitted to the fire can be regulated.

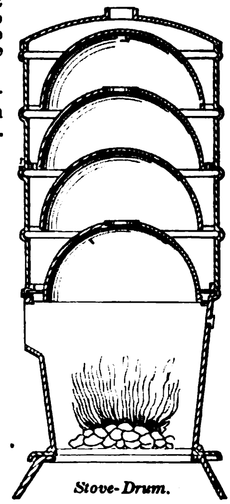
Stove-drum. A chamber above a stove in which the heated products are disseminated, in order that their heat may be more perfectly abstracted.

Fig. 5928.



Furnace-Damper.

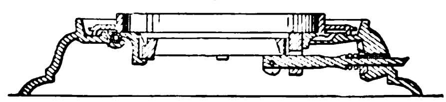
Fig. 5929.



Stove-Drum.

In Fig. 5929, the caloric current is deflected by domed plates, each alternate one having an aperture in the apex, and all having passages around their sides. The side passages of the centrally perforated deflectors are governed by an annular register-damper. See DRUM.

Fig. 5930.



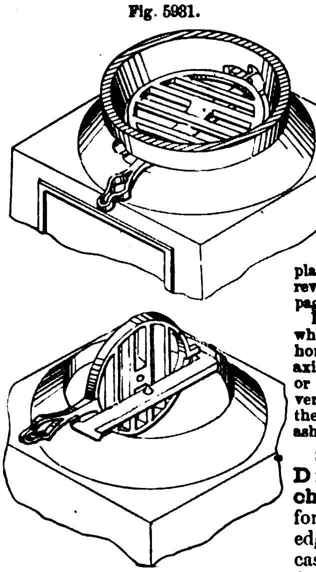
Shaking Stove-Grate.

Stove-grate. The grid or series of bars on which the fuel rests in a stove.

Fig. 5930 shows a shaking-grate in which the bed-plate rests on balls moving in slots in the base of the stove. A lug extends down on one side of the bed-plate, to which one end of the grate is pivoted, while the other is supported by an arbor in a loop on the opposite side, by which the bed-plate is rotated and grate revolved. See GRATE, page 1013.

Fig. 5931 is a grate which may be shaken horizontally about its axis to remove the ashes, or may be tilted into a vertical position to dump the spent fuel into the ash-pit.

Fig. 5931.



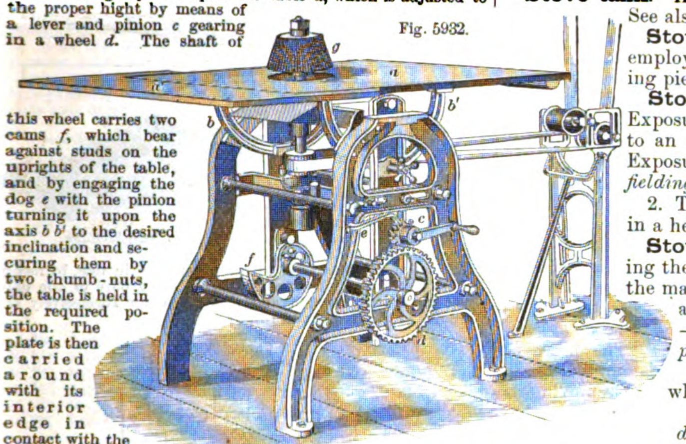
Dumping Stove-Grate.

Stove-plate Dressing-machine'. A machine for dressing off the edges of stove-plate castings, so as to form tight joints,

smoothing out the interior of the holes, etc. The operation is far neater and more rapid than filing.

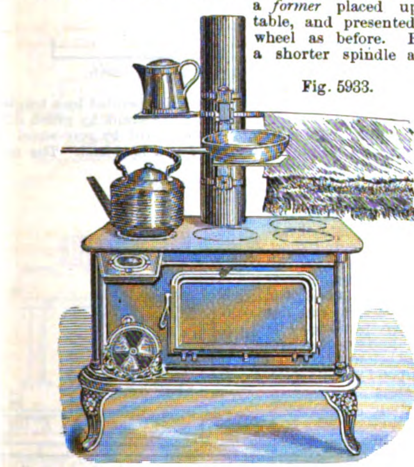
The casting is placed upon the table *a*, which is adjusted to the proper hight by means of a lever and pinion *c* gearing in a wheel *d*. The shaft of this wheel carries two cams *f*, which bear against studs on the uprights of the table, and by engaging the dog *e* with the pinion turning it upon the axis *b b′* to the desired inclination and securing them by two thumb-nuts, the table is held in the required position. The plate is then carried around with its interior edge in contact with the emery-wheel *g*, rapidly rotated by a pulley on its upright shaft, polishing this part of the plate. For dressing the outside edges, an additional table *a′* secured to the front of the main table is used. The plate is laid upon a *former* placed upon this table, and presented to the wheel as before. By using a shorter spindle and cup-shaped wheel, the machine may be employed for surface-grinding.

Fig. 5932.



Stove-Plate Dressing-Machine

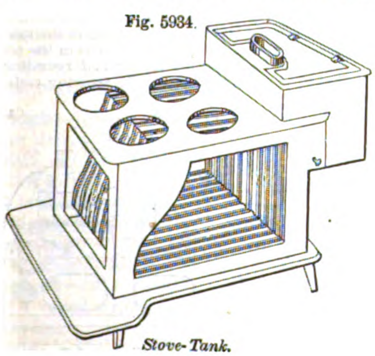
Fig. 5933.



Stove-Shelf.

Stove-shelf. An attachment to a stove to hold vessels, cloths, and what not. It has a collar encircling the stove-pipe, and is hinged, so as to project in any desired direction.

Fig. 5934.



Stove-Tank.

Stove-tank. A reservoir attached to a stove. See also Figs. 4268, 4269.

Stove-truck. (*Founding.*) A truck employed in cannon-foundries for moving pieces of ordnance.

Stov′ing. 1. (*Vinegar-making.*) Exposure of *malt-wash* (*gyle*) in casks, to an artificial heat in closed rooms. Exposure in the open air is termed *fielding*.

2. The exposure of printed fabrics in a heated room to fix the color.

Stow. A raised structure containing the furnace and set of pots used in the manufacture of tin-plate. The pots are arranged in a series of five, — *tin-pot*, *wash-pot*, *grease-pot*, *pan*, *list-pot*. See Tin-plate.

Stow′board. A place into which rubbish is put.

Stowce. (*Mining.*) *a.* The *drawing-stowce* is a small windlass.

b. Stowces. Pieces of wood of particular forms and constructions placed together, by which the possession of mines is marked; a pair of *stowces* possess a *mear* of ground.

Stow′ing. (*Mining.*) Rubbish (*attle*) put into old workings (*goafs*) to fill them up.

Stra-bis′mus-for′ceps. A straight or curved pinchers, with fine rat-tooth extremities for holding the muscles to be divided in correcting strabismus.

The operation for strabismus was first performed by Diffenbach in 1839, by dividing one of the six small muscles which rotate the eye.

Fig. 5935.

Strabismus-Forceps.

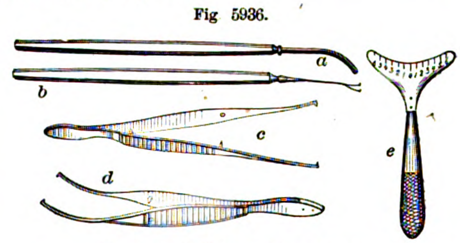
Stra-bis′mus-in′stru-ments. (*Surgical.*)

a, half-curved strabismus-hook.
b, strabismus double-hook.
c, straight strabismus-forceps.
d, curved strabismus-forceps.
e, strabometer. See also Scissors.

Stra-bis′mus-scis′sors. Scissors with straight or curved blades, for dividing the contracted muscles causing strabismus.

Stra-bom′e-ter. (*Surgical.*) An instrument for measuring the want of concordance of the optic axes. See *e*, Fig. 5936.

Fig 5936.



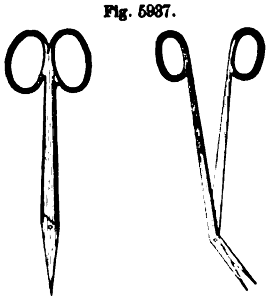
Tiemann's Strabismus-Instruments.

Stra′bo-tome. (*Surgical.*) A knife for operating for strabismus.

Strad′dle-pipe. (*Gas.*) A bridge-pipe connecting the retort with the hydraulic main. The lower figure shows one usual form, in which the eduction end of the pipe dips below the surface of the water in the hydraulic main. See Dip-pipe.

The upper figure is an improved form, in which the trap is formed in the head of the pipe without the necessity of carrying its exit aperture down into the hydraulic main.

Fig. 5937.



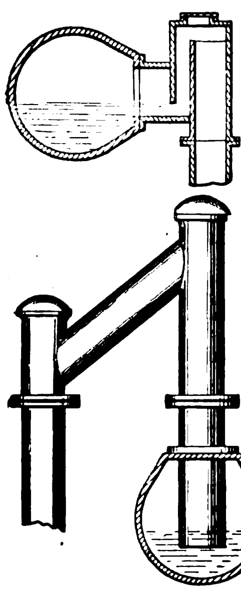
Strabismus-Scissors.

Strad'dle-plow. A plow with two triangular, parallel shares, a little distance apart, and used for running on each side of a row of dropped corn, to cover the seed.

Strad'dling. (*Vehicle.*) Applied to spokes when they are arranged alternately in two circles in the hub. Also said to be *staggered.*

Strag'gling. (*Stone-working.*) The process of working down the face of a grindstone to a regular shape, or of removing metallic particles which have become imbedded therein. The grindstone is turned as usual, while a ½-inch square piece of soft iron is applied to it as a turning-tool, a rocking or wriggling motion being imparted to the iron, which causes it to bite upon the stone. Also known as *ragging.*

Fig. 5938.



Straddle-Pipe.

Straight-arch. (*Architecture.*) A kind used for the heads of doorways and windows. It is formed of *voussoirs,* but has a level *intrados.*

Straight-arm Pul'ley. One with radial arms or spokes, like *m l n*, Fig. 3999, page 1819, and not curved like that at *v*, same figure.

The straight-armed pulley can be made with the least possible metal and the greatest possible strength for the metal. Its form is the best able to transmit the peculiar strains brought to bear upon it, and at the same time it is the most pleasing form to the eye.

Pulleys must be high on face for a belt not shifting, and straight on face for a shifting belt. A pair of fast and loose pulleys require that both pulleys should have faces high in center.

Straight-edge. A strip of metal or wood of proved rectitude, used to test the flatness of a surface or the straightness of an edge.

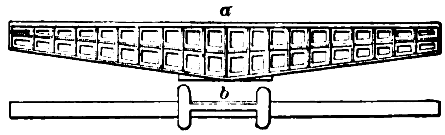
By a combination of 3 straight-edges, their absolute truth or incorrectness may be established; being tried in three binary combinations and shifted end for end and top and bottom, no fault common to them all can escape notice.

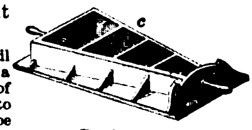
In Fig. 5939, *a b* is an elevation and top view of one of Whitworth's long straight-edges; these are from 6 to 10 feet or more in length, made of cast-iron, and ribbed at the back to prevent flexure of the fiducial edge.

c is a surface-plate, for verifying plane-surfaces. See PLANE-SURFACE, page 1726.

Straight'en-ing-ma-chine'. (*Metal-working.*) One for taking the twist or bend out of rails, shafting, bars, rods, and tubes; or the kink and bend out of hoop-iron or wire; or the buckle out of plates.

Fig. 5939.

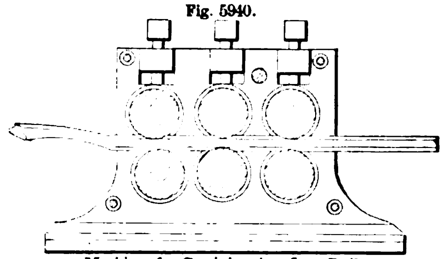




Straight-Edge.

Fig. 5940 is a railway-rail straightener. It consists of a suite of three or more pairs of rolls, each pair being grooved to correspond in size and shape with the rail to be straightened. The rolls are so arranged that the grooves of the several pairs are perfectly in line, by means of which the rail, after having entered the groove of one pair, will be drawn through and made to enter successively the grooves of the second and third pairs.

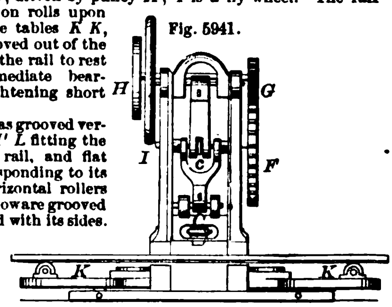
Fig. 5940.



Machine for Straightening Iron Rails.

In Fig. 5941, the sliding press-drop *C* is operated by a toggle-joint *c*, whose central pin is connected to a crank by which it is actuated. The toggle-joint crank is operated by gear-wheel *F* and pinion *G*, driven by pulley *H*; *I* is a fly-wheel. The rail is supported on rolls upon the vibratable tables *K K*, which are moved out of the way to allow the rail to rest upon intermediate bearings in straightening short bends.

Fig. 5941.



Drop-Press for Straightening Railroad-Rails.

Fig. 5942 has grooved vertical rollers *I' L* fitting the head of the rail, and flat rollers corresponding to its bottom; horizontal rollers above and below are grooved to correspond with its sides. As it passes between these its curvatures are rectified.

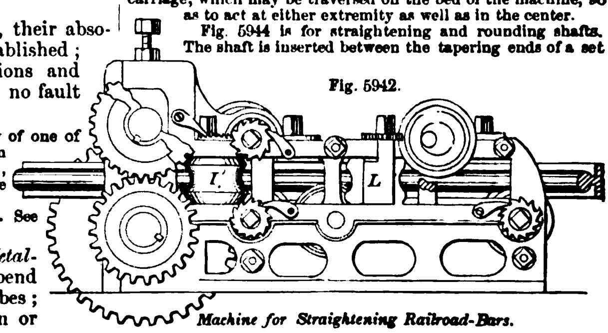
See also patents: —

Anderson, Au. 29, 1848. 85,917. Downing, Jan. 19, 1869.
39,876. Bolton, Sept. 15, 1863. 124,867. White *et al.* March 19, 1872.
47,208. Johnston, Apr 11, 1865.
62,669. Nelson, March 5, 1867. 125,055. Knisel, March 26, 1872.

Fig. 5943 is for straightening shafts or bending iron of round or other section. The shaft is supported on two rests, and pressure applied by means of a lever and screw mounted on a carriage, which may be traversed on the bed of the machine, so as to act at either extremity as well as in the center.

Fig. 5944 is for straightening and rounding shafts. The shaft is inserted between the tapering ends of a set

Fig. 5942.

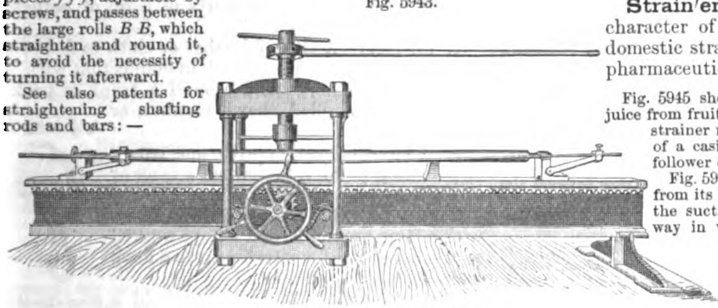


Machine for Straightening Railroad-Bars.

of guide-rolls *C*, is fed forward by the obliquely arranged feed-rolls *a′ b′ c*, journaled in pieces *f f f*, adjustable by screws, and passes between the large rolls *B B*, which straighten and round it, to avoid the necessity of turning it afterward.

See also patents for straightening shafting rods and bars: —

Fig. 5943.

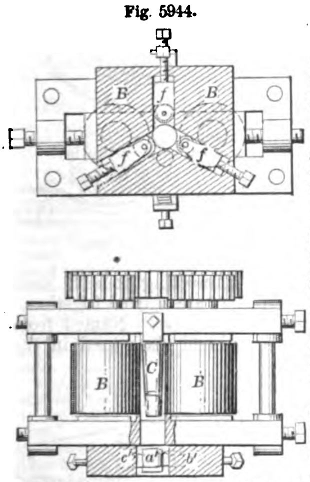


Shaft-Straightening Machine.

41,806. Lauth...Jan. 19, 1864.	98,256. Warr...Aug. 3, 1869.
42,051. Sellers..Mar. 22, 1864.	102,916. Cheney, May 10, 1870.
60,260. Safely....Dec. 4, 1866.	128,335. Tasker, June 25, 1872.
65,242. Lander..May 28, 1867.	149,065. Robertson, March 31, 1874.
65,832. Reese...June 18, 1867.	155,760. Seaman, Oct. 6, 1874.
76,781. Lafarge *et al.* April 14, 1868.	

The straightening of metallic plates is performed with the hammer or by rolling. In the former case the work is the reverse of that of *raising*, in which the plate is stretched at the center and caused to assume a concave form. In straightening, each cockle or protuberance is treated as a rise, which is to be obliterated by an equal tension upon or stretching of all other parts, resulting in a plane.

Fig. 5944.



Machine for Straightening and Rounding Shafting.

In straightening by the roller, the plate is passed twice between the rollers, each side alternately upward, and is bent in each trip to the limit of its elasticity; the result, under favorable circumstances, is to reduce all outlying irregularities and reduce it to a plane. This is similar in principle to the action in wire-straightening.

The practice as to thick and thin plates differs, as it is possible, with a thick plate, to stretch the concave side of a protuberance to such an extent as to balance the tension or stretched condition of the convex side, and thus make a plane. The blows of the hammer are delivered inside the concavity.

See also patents: —

40,899, Bell, December 15, 1863 (angle-iron and bars).
30,322, Hughes, October 9, 1860 (hoop-iron).
111,941, Hunter, February 21, 1871 (bolts).
125,892, Hammer, April 23, 1872 (cylinders).
125,996, Walkin, April 23, 1872 (tubing and bars).
152,095, Scofield, June 30, 1874 (tubing and bars).

See also WIRE-STRAIGHTENER.

Straight-joint. 1. A joint which does not curve or depart from a straight line.

2. Said of the junction line of flooring boards when the joints at the butting ends of the boards form a continuous line.

Straight-line Chuck. A peculiar chuck fitted to a rose-engine when the patterns are required to follow a straight instead of a curved direction.

Straight-of-breadth. (*Shipbuilding.*) That part of a vessel where her cross-sections are vertical at the sides.

Straight-stall. (*Mining.*) An excavation made into the thick coal, having the solid coal left on three sides of it.

Strain′er. A device partaking of the character of a *sieve* or of a *filter*. The domestic strainer is like the former; the pharmaceutical, like the latter.

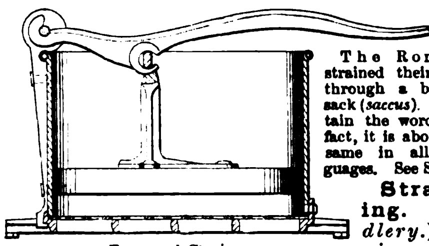
Fig. 5945 shows a domestic filter for pressing juice from fruit, water from vegetables, etc. The strainer rests upon a grating in the bottom of a casing, and articles are pressed by a follower operated by a lever. See FILTER.

Fig. 5946 is a *mushroom-strainer*, so called from its form. It screws on to the end of the suction-pipe of the pump. From the way in which the water enters, it is decanted, as it were, not disturbing the sediment on a lower level.

The *Hippocrates sieve* is a simple and very ancient form of filter. It may be made by folding diagonally a square of flannel or muslin and sewing it along the meeting edges, so as to make it of a funnel shape.

Another form is a pouch, made by uniting the opposite angles of a square piece of cloth.

Fig. 5945.



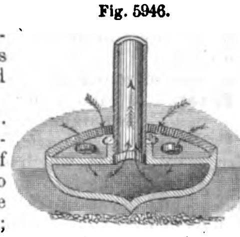
Press and Strainer.

The Romans strained their wine through a bag or sack (*saccus*). We retain the word. In fact, it is about the same in all languages. See SACK.

Strain′ing. (*Saddlery.*) A piece of canvas or leather, which, being drawn tightly over the *tree*, forms the foundation for the *seat* of the saddle.

This is covered by *cross-straining*, the *ground seat*, the *set* or *filling*, and the latter by the *top-seat*.

Fig. 5946.



Suction-Pipe Strainer.

It is called the straining, because the *stretch* is taken out of it by repeated *wettings* and *stretchings*.

Strain′ing-beam. The piece situated between the upper end of the *queens* of a frame to resist the thrust of the rafters. See ROOF; QUEEN-POST.

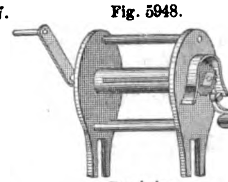
The *straining-sill* is at the feet of the queen-posts.

Strain′ing-fork. (*Saddlery.*) A tool used in straining the webbing over saddle-trees. The prongs pass through the webbing and catch against the tree, the tool being used as a lever to strain the damp webbing as tightly as possible while it is secured by tacks.

Fig. 5947.

Straining-Fork.

Fig. 5948.



Straining-Reel.

Strain′ing-leath′er. (*Saddlery.*) A kind of web forming the seat of a hussar-saddle.

Strain′ing-reel. (*Saddlery.*) A tool for *taking the stretch out* of webbing before putting it on the tree, as a foundation for the saddle-seat.

Strain′ing-sill. (*Carpentry.*) A piece of timber

on the *tie-beam*, between the feet of the *queen-posts*, to hold them against the thrust of the struts. See QUEEN-POST.

Strake. 1. (*Shipbuilding.*) A continuous line of planking or plates on a vessel's side; reaching from stem to stern.

Wales, in merchant-vessels, are strakes below the *sheer-strakes*.

Sheer-strakes are those between the main-deck ports and the *plank-sheer*, which rests on the top timbers of the frame.

Channel-wales (*in two-decked ships of war*) are the strakes between the ports of the lower and main decks. In three-deckers, they are those between the middle and main-deck ports.

Middle-wales (*in three-deckers*) are the strakes between the gun-deck ports and those of the middle deck.

The planking between the ports, fore and aft, is called *short-stuff*.

The *main-wales* are four strakes of planking, or the corresponding breadth of plating immediately below the *black*-strake.

The *black*-strake is the one next below the lower or gun-deck ports.

The *bilge*-strakes are upon the broad and flatter portion of the vessel's bottom.

The *garboard*-strake is next to the keel.

The *limber*-strakes are a part of the inner skin, and are next to the keelson, from which they are separated by spaces called the *limbers*, which are passages for bilge-water, and covered by movable boards.

The other portions of the inside skin are the *ceiling* or *foot-waling*.

The strakes immediately below the *shelf-pieces* which support each tier of deck-beams are called *clamps*.

A *binding*-strake is a longitudinal plank half notched into the beams of a ship. Sometimes called a *letting-down* strake.

A *sheer*-strake (in a boat) has its upper edge flush with the top of the gunwale, and its lower edge overlapping the *landing*-strake.

A *landing*-strake is that immediately below the gunwale.

The *binding*-strake is next below the *landing*-strake.

A *wash*-strake is above the gunwale, and is removable.

Strakes are divided by *seams*.

The *joints* formed by *planks* in a *strake* are called *butts*.

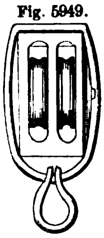
2. (*Mining.*) An inclined trough for separating ground ore according to gravity, by means of a flow of water. A *launder*. The process is known as *tying*.

3. (*Vehicle.*) A band on the fellies; in sections, and not continuous like a tire.

Strand. An assemblage of several twisted yarns wound together. Hemp is twisted into a *yarn*; and several of the latter are twisted together, or, as it is called, *laid up* into a rope. Three strands thus laid are said to be *hawser-laid*, the twist being the reverse of the individual yarns. Four strands thus twisted constitute the *shroud hawser-laid*.

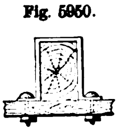
Strap. A band of leather or metal forming a fastening.

Fig. 5949.



Block-Strap.

Fig. 5950.



Strap.

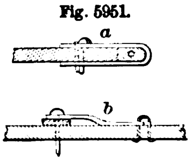
1. (*Nautical.*) *a.* One of the rudder bands, which also holds a *pintle*, which hooks into an *eye* on a *brace* bolted to the stern-post.

b. A band of rope or metal around the *shell* of a tackle-block, by which its *hook*, *eye*, or *tail* is attached thereto.

2. (*Carpentry.*) A band of iron around a beam at a scarf-joint or elsewhere. See some of the instances in Fig. 4660, SCARF.

3. (*Machinery.*) A band over the end of a rod to hold a connecting-pin or wrist. The example has a key and wedge to tighten the parts together.

Fig. 5951.



a, Rod-Strap.
b, Hammer-Strap.

4. (*Vehicle.*) *a.* A plate on the upper side of the tongue and resting upon the double-tree, to assist in holding the wagon-hammer.

b. A clip, such as that which holds the spring to the spring-bar or to the axle.

c. The stirrup-shaped piece of a clevis.

5. (*Harness.*) A leathern thong, provided with a buckle, by which separate parts of a set of harness are connected together.

6. (*Wear.*) A slip of leather or cloth to fasten a boot, a valise, or trunk; used in connection with a buckle. A girth or band around a trunk or package, such as a rolled shawl, blanket, or coat.

Fig. 5952.

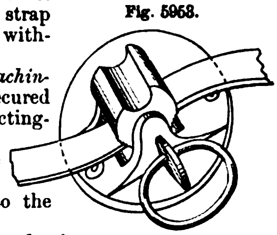
Strap-Block.

7. A piece of leather with fine emery or polishing-powder, to sharpen a razor or knife. A *strop*.

Strap-block. (*Nautical.*) A block with a strap around it, and an eye worked at the lower end for attachment to a hook upon deck for a purchase.

Strap-clamp. A device to hold a hitching-strap. The cam, being free to turn upon its pivot, bites the strap and holds it firmly when it is pulled upon in either direction. By holding the cam in its middle position, the strap may be inserted or withdrawn.

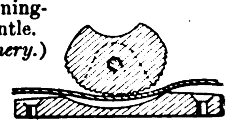
Fig. 5953.



Strap-head. (*Machinery.*) A journal-box secured by a strap to a connecting-rod. See STRAP, 3.

Strap-hinge. One with long flaps, by which it is secured to the door and post.

Fig. 5953 has strengthening-lips, and a spring on the pintle.



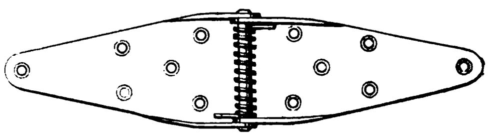
Strap-Clamp.

Strap-joint. (*Machinery.*) A connection by strap, key, and gib, as on the end of a pitman. See STRAP.

Strap'ping-plate. (*Mining.*) One of the straps or bands which bind the connecting rods to each other at the points where they are scarfed together.

Strass. 1. (*Glass.*) Fr. *Strasse.* Named from its German inventor. A pellucid glass used in the manufacture of artificial gems. It contains a large quantity of oxide and borate of lead. It is easily fused, is soft and very refractive.

Fig. 5954.



Strap-Hinge.

2. (*Silk.*) The refuse of silk in the process of working into skeins.

Stra-tom'e-ter. An instrument for determining in what manner geological strata press upon each other. *Mayne.*

Straw. 1. The stalk of wheat or other small grain; or of some descriptions of grass. The principal use of this material in the industries of this country and Europe is in *thatching*, *plaiting*, and *paper-making*.

2. (*Mining.*) A fine straw filled with powder, and used as a fuse.

Straw-board. Thick paper-board made altogether or principally from straw; usually that of wheat or rye.

The first process consists in boiling the straw with quicklime, in a wooden digester, which takes steam from a boiler. The

straw is packed in layers with lime between them, and the whole boiled for from 10 to 12 hours, according to circumstances. (See PULP-DIGESTER.) Straw is composed of a tube of woody fiber and cellular tissue, having upon its outer surface a cuticle composed of silicates of potassa and soda with some free silica. The woody fiber also contains some silica. To the silicious cuticle the straw of grain or grass owes in great part its strength. In the boiling process, the lime and the silica combine, which leaves the straw in a soft and pulpy state. The mass is now ground into pulp, and then drawn into a vat, which contains water, and kept constantly agitated by a series of revolving arms. A wire-gauze cylinder is so adjusted that it will revolve partially beneath the surface of the fluid mass. The pulp adheres to the gauze, and is carried around to another cylinder, around which an endless belt of felt runs. The latter cylinder presses upon the gauze, and by this means the pulp is made to adhere to the felt, and condensed so as to give it enough consistency to be taken up by another cylinder, called the *forming* cylinder. This is one of a pair made of polished metal, and by them the pulp is strongly compressed. The pulp is wound around the *former* until the proper thickness is reached; this is determined by an indicator. Along the forming cylinder there is a groove planed out, through which the operator now rapidly passes a wooden knife, thus severing the soft board; and at the same time he unwinds the sheet and removes it. These sheets are cut so as to form other sizes, and then dried, which completes the process. Woolen rags are sometimes ground and mixed with the straw pulp. This makes a much darker colored and heavier board, which is worth considerably more than the pure straw-board. The boards, as thus manufactured, are applicable to a great variety of useful purposes, among which book-binding, button-making, and paper-box manufacture are most prominent

Until lately, the white lining of these boards was pasted on by hand, but now the white paper is put on by a machine at the rate of 20 sheets a minute. This machine is automatic in its movements; it pastes the boards, lays on the white paper from a continuous roll, dries, presses, and calenders them, so that when the boards leave the machine they are immediately ready for the box-manufacturer.

Straw-boil'er. A vessel for macerating straw to form paper-stock. See Figs. 4008, 4009, and following cuts.

Straw-braid.

Rye-straw is commonly used for braid in this country. It should be cut when the grain is in the milk, tied up in small bundles, the heads cut off, and the straw dipped in boiling water. It is then dried in the sun, being taken in at night to avoid exposure to dew. For hats the whole straw is used. For bonnets it is split, and the part under the husk removed. The tool used for splitting straw is a piece of wood five inches long, having a series of sharp spurs near the end, and a wooden or metal spring at one side to press down the straws as they are drawn through. The straw is wetted previous to braiding to make it pliable.

A nicer method of splitting, practiced in Europe, is by means of a wire having four, six, or eight sharp edges, which is pushed up the hollow of the straw, dividing it into an equal number of parts. The varieties of braid are very numerous, depending on the size and kind of straw, whether split or whole, and the patterns formed by the different methods of interweaving.

The Leghorn, or Italian straw-braid is made from a variety of wheat cultivated for this purpose. The straw is harvested in the mountainous regions of Prato, Empoli, etc., where the vegetation is poor and stunted, the soil being light and sandy.

The fields are worked and weeded by hand. 14 bushels of seed are usually sown to the acre; two bushels being "broadcast" at each time, and each sowing made at a different angle to the first. The effect of this is to produce a very close, compact growth, and only one elongated stem rises from each seed sown.

The straw is harvested while green, and before the ear is fully developed. It is gathered into small sheaves, weighing about half a pound each, which are at first placed upright in the field to dry, one acre bearing about three thousand of them. Next day these bundles of straw are spread out over rocks and pebbles in the dry bed of water-courses, where they are submitted to the action of sun and dew. At night they are covered up to protect them from rain. The straw is then bleached by means of sulphuric-acid gas.

The ear is next taken below the first joint, the lower useless portion separated, and the straw cut into lengths of four inches. Each blade of straw usually furnishes three such lengths. It is then bleached again.

At this point the straws are sorted according to their various sizes, — an operation performed by women who acquire, through long habit, a most remarkable tact in distinguishing the smallest variation in diameters, as may be inferred from the fact that in front of each operator are placed goblets numbered from 30 to 180, each of which is the receptable for a special size of straw.

The braids are plaited with from 11 to 13 straws each. Their length is from 300 to 320 feet, their width and the quantity of straw entering into them varying according to quality. With No. 30 straw the braid is coarse and wide, and weighs two pounds and a half. It takes, however, a whole month to plait a single bonnet from such straw. With Nos. 120 to 180 it takes about one pound and a half of straw to a braid. With extra straw (No. 180) the braids are not more than 0.039 of an inch in width, and it takes six months' labor to make a sufficiency for a single bonnet for a lady.

The braids are cleaned, exposed to the sun for a short time, and then sent to the manufacturer to be sewn into shape. This last operation is performed with the very greatest care, the stitches being nearly invisible and yet strong, and not liable to unravel during the pressure to which the hats are often subjected after being sized.

The hats are "ungreased," and any bumps or protuberances on their surface are effaced by rubbing one portion of the tissue against another, or by means of friction with a dog-skin glove.

Straw-car'ri-er. 1. An endless apron in a thrashing-machine to lift the straw as it comes from the cylinder, and discharge it at the tail of the machine. The carrier being of open work, the grain and chaff are sifted out on the way. See THRASHING-MACHINE.

2. A straw-elevator at the end of the thrasher to lift the straw on to the rack.

Straw-cut'ter. *Cutting-boxes* or machines for reducing long feed, such as straw, hay, or corn-stalks, to chaff are very numerous and varied.

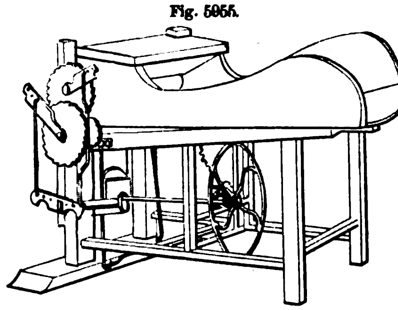
They may be classed under certain heads.

I. The guillotine-knife, operating in a straight line upon the straw which issues at a throat. *The knife reciprocates.*

II. The radial or curved knife, attached to a wheel revolving on an axis parallel to the direction of the feed, and thus cutting off the straw as it issues from the throat of the machine. *The knife revolves in the plane of its length.*

III. The cutting roller or pair of rollers with knives, between which the straw passes. *The knives are across the throat of the machine.*

Fig. 5955.

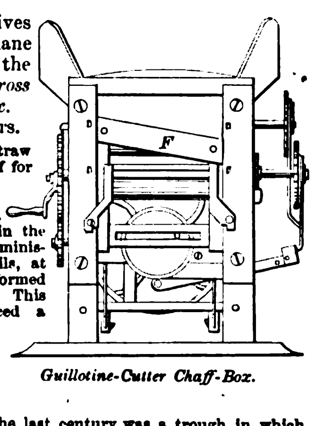


IV. Cutting knives revolving in the plane of the direction of the feed, and *cutting across the mouth of the box.*

V. Straw-grinders.

The Hebrews cut straw and grain in the sheaf for food.

Hohlfield, of Saxony, 1711-1771, invented a straw-chopper, while in the service of the Prussian minister, Count de Podenils, at Gusow. We are not informed as to its construction. This inventor also produced a thrashing-machine, an odometer, a pedometer, a loom for figured fabrics, a harpsichord, and several other ingenious machines.



Guillotine-Cutter Chaff-Box.

The chaff-cutter of the last century was a trough in which the straw or hay was pushed along by a fork, so as to be exposed at the end of the trough to a knife which was pivoted at one end, and oscillated by hand.

I. Of the guillotine knives, some make a simple straight cut, others an oblique cut, others a draw cut.

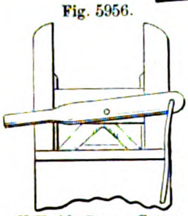
a. The straight cut is when the whole edge of the knife is brought into contact at once with the body of straw. This is so inferior in its results that it needs not to be illustrated.

b. The knife is presented obliquely so as to commence at one corner of the throat and terminate at the diagonally opposite corner.

This form is seen in the early patents of Hotchkiss, August 2, 1808, and January 18, 1817.

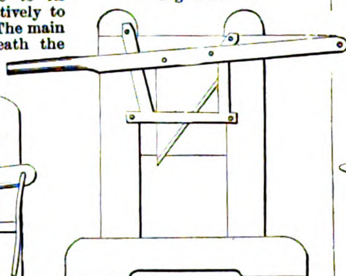
Fig. 5955 may be given as a sample. The knife *F* moves in vertical guides, the *draw* of the cut being due to its oblique position relatively to its line of motion. The main shaft is placed beneath the

Fig. 5956.



V-Knife Straw-Cutter.

Fig. 5957.



Angular-Knife Straw-Cutter.

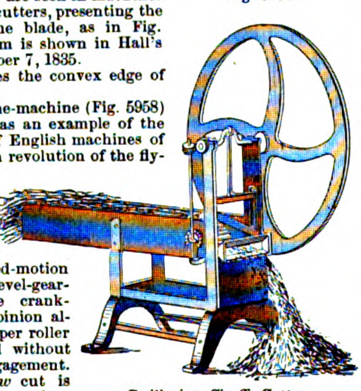
box and operates the knife-gate by a wrist-pin. A cam on the shaft also operates the lever which actuates the ratchet feed-wheels by means of connecting-rods.

Modifications are seen in machines with V-shaped cutters, presenting the concavity of the blade, as in Fig. 5956. This form is shown in Hall's patent, November 7, 1835.

Fig. 5957 uses the convex edge of the knife.

The guillotine-machine (Fig. 5958) may be taken as an example of the present state of English machines of its kind. Each revolution of the fly-wheel and crank gives an effective cut to the oblique guillotine-knife. The feed-motion is derived by bevel-gearing from the crank-shaft, a long pinion allowing the upper roller to rise or fall without risking a disengagement.

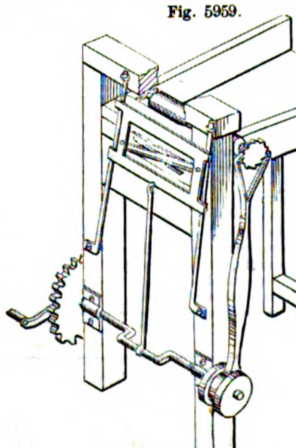
Fig. 5958.



Guillotine Chaff-Cutter.

c. The *draw* cut is when the knife receives a positive endwise motion in addition to its descending motion. The latter is the most efficient.

Fig. 5959.



Draw-Cut Straw-Cutter.

In Fig. 5959, the knife has cutting edges above and below, and is reciprocated in inclined guides, which give it a positive endwise motion.

Fig. 5960.

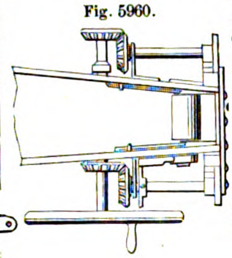
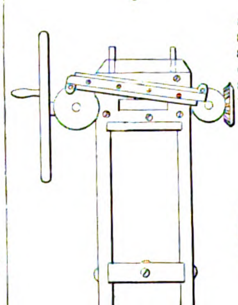


Fig. 5960 is a machine in which the knife is also double-edged. The ends of the knife are attached to separate co-acting cranks, which give a downward and lengthwise motion to the knife.

In Fig. 5961, one end of the knife is operated by a crank, while the other depends from a swinging arm.

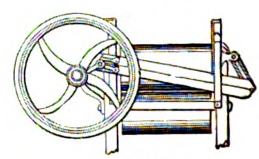
Class II. Knife cutting in a plane at right angles to the feed.

The knife is curved, so as to act diagonally across the body of straw, moving with the edge in advance. The feed is by a worm on the axis of the cutter-wheel, acting on wheels upon the axes of the feed-rollers. The feed is continuous, the straw advancing the length of the chaff between each cut.



Double-Edged Straw-Cutter.

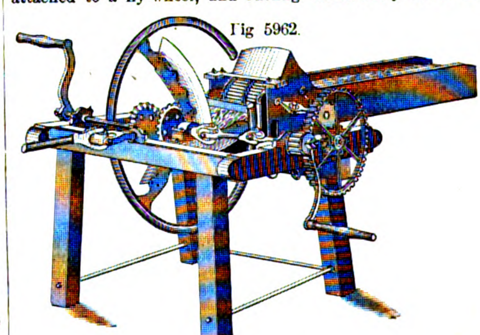
Fig. 5961.



Straw-Cutter.

Lester's machine, patented in England in 1800, had a knife attached to a fly-wheel, and cutting transversely across the throat. The earliest feed was an endless web of cloth passing over two rollers; but Heppenstall's improvement, patented in 1818, substituted a worm to turn two feeding-wheels to convey the straw to the knives attached to two arms of the fly-wheel.

Fig. 5962.



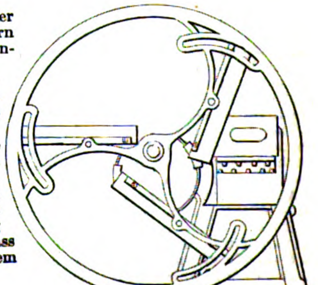
Corne's Chaff-Cutter.

Corne's straw-cutter (English) is a modern form of the same general design.

It has capacity for adjustment to cut chaff from ⅛ inch to 4 inches long.

Fig. 5963 has three knives, which are pivoted to the wheel-arms and governed by an eccentric, so as to have a rocking motion as they pass the throat, giving them a draw cut.

Fig. 5963.



Straw-Cutter.

Class III. has several varieties :

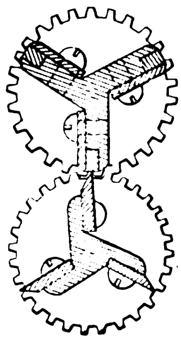
a. Radial knives mutually interlocking, as in the Sanford patent, October 12, 1843.

b. Knives cutting against a flat-faced roller, usually made of leather or raw-hide disks on a mandrel.

Fig. 5964 has spiral knives, with roller.

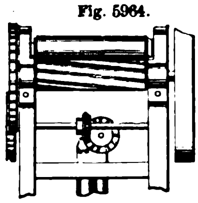
In Fig. 5965, the edges of the spiral knives cut against corresponding surfaces of comparatively soft metal which are clamped in the arms of the cylinder above.

Fig. 5965.



Straw-Cutter.

Fig. 5964.



Spiral-Knife Straw-Cutter.

c. In Fig. 5966, one roller has spiral knives and the other spiral abutment corrugations, whose intervals are entered by the knives.

The furze-cutter of England has interlocking spiral knives, like that just described. See Fig. 946, page 392.

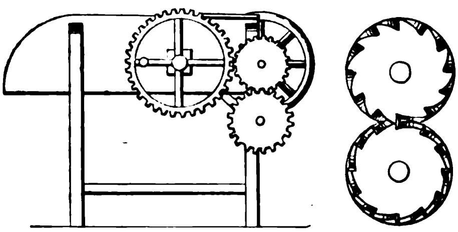
d. Rollers with spiral flanges mutually interlocking, as in the Macomber patent, November 5, 1850.

Fig. 5967 is an illustration of a machine in which the flanges make a shear-cut past each other.

IV. Cutting-knives upon a cylinder on a horizontal axis in front of the throat, and cutting toward the opening.

Salmon of Woburn, England, about 70 years since, introduced the oblique knife attached, cylinder fashion, between two

Fig. 5966.



Spiral-Knife Straw-Cutter.

wheels and cutting toward the throat of the straw-box; revolving in the same plane of motion as the straw is moved.

The feature is also seen in United States patents, Eastman, January 29, 1822; Denson, May 2, 1835.

In Fig. 5968, the cutters extend diagonally along the cylinder, being secured at their ends to the rims of the cylinder-heads. A sheet-iron band forms the periphery of the cylinder.

In Fig. 5969, the hay, after being cut, is crushed between rollers, and winnowed to expel the dust.

V. Feed-grinders.

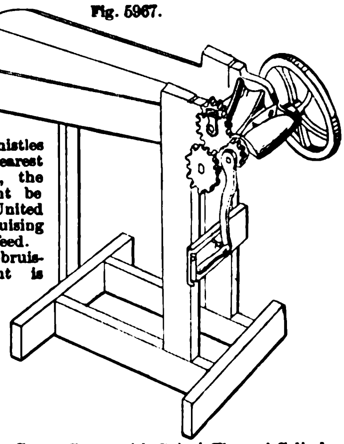
Fig. 5970 has a series of circular cutters *C* on a horizontal shaft. The knives work against an apron *J*, and the spaces between the knives are kept clear by the fingers *L*.

Fig. 5971 has a series of circular saws on two shafts. The teeth of the larger saws are designed to split or divide the stalks, and are aided by the smaller saws to crush the articles to be cut. Notched and forked plates pass between the saws, to clear them.

Supplementary to the subject of machines for cutting straw, hay, etc., into chaff for feed, may be mentioned a machine used in England for grinding the furze (*Ulex Europæus*, also called *gorse*, or *whin*). See Fig. 946. This is a thorny, evergreen, succulent plant, which covers square miles of country, making the landscape yellow with its beautiful yellow blossoms. It is cut with bill-hooks, and handled with leather mitts. It is relished by cattle when bruised so as to mash the spines with which it is so plentifully covered.

Although we have nothing like the furze to run through the machine, thistles being the nearest approximation, the machine might be useful in the United States for bruising sheaf oats for feed.

Fig. 5967.

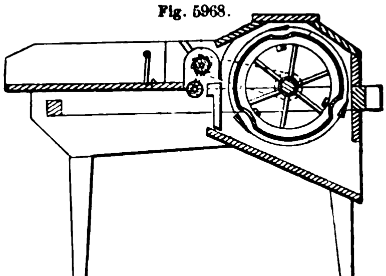


Straw-Cutter with Spiral Flanged Cylinders.

In the furze-bruiser, the plant is broken by hammers and then ground between rollers, which break and mash it. We should dispense with the hammers and be content with a mashing action which would break the kernel and scatter flour enough over the straw to make the whole mass palatable.

The peasants of Brittany use a more primitive mode of producing the same effect: a pair of pestles suspended from the

Fig. 5968.



Straw-Cutter.

ends of a bar, which is oscillated by the feet of a man standing thereon.

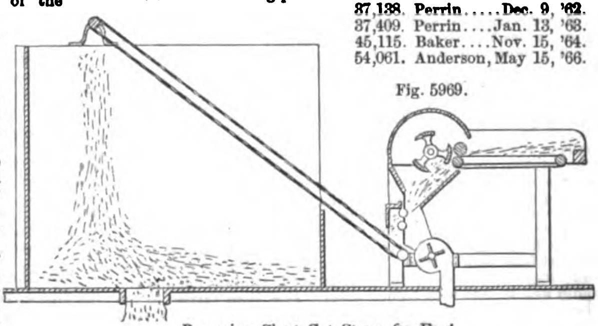
Straw-drain. (*Husbandry.*) A drain filled with straw.

Straw-fab'ric Loom. A loom for making goods the weft of which is of straw. Each piece of filling is laid in separately, and looms of this character are made to work with *straw*, *slats*, *splints*, *wands*, *willows*, *cane*, *rattan*, *palm-leaf*, *splints*, *whalebone*, and what not. See SLAT-WEAVING LOOM, page 2203.

See also following patents: —

37,138. Perrin.....Dec. 9, '62.
37,409. Perrin.....Jan. 13, '63.
45,115. Baker.....Nov. 15, '64.
54,061. Anderson, May 15, '66.

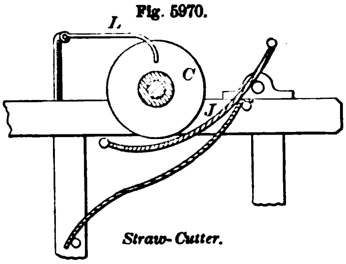
Fig. 5969.



Preparing Short-Cut Straw for Feed.

56,493. Free.....July 17, '66.
57,898. Hasecoster, Sep. 11, '66.
65,266. Perrin.....May 28, '67.
68,695. Brown.....Sep. 10, '67.
69,309. Brown.....Oct. 1, '67.
70,072. Brown.....Oct. 29, '67.
70,318. Brown.....Oct. 29, '67.
70,945. Angell.....Dec. 10, '67.

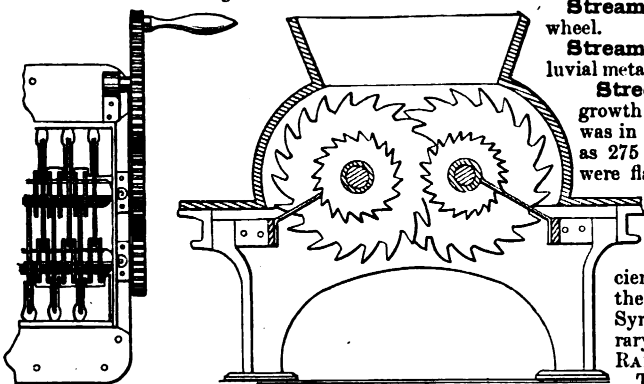
Fig. 5970.



Straw-Cutter.

71,852. Chandler, Dec. 10, '67.	127,318. Devol....May 28, '72.
75,500. Walkins, Mar. 10, '68.	133,332. Murphy, Nov. 26, '72.
79,923. Smith...July 14, '68.	135,427. Hastings, Feb. 4, '73.
100,477. Fitts....Aug. 16, '70.	153,417. Baldwin, July 28, '74.
111,343. Hastings, June 31, '71.	

Fig. 5971.



Cutting-Machine for Hay, Straw, and Vegetables.

Straw-hat Mak'ing. Tuscan straw is prepared by pulling the wheat while the ear is in a milky state. The wheat is sown very close, so that the straw is thin and short. The straw is spread out upon the ground for three or four days in fine hot weather to dry. It is then tied up in bundles and stacked, to complete the drying. After remaining in the mow for about a month, it is removed to a meadow and spread out, that the dew, sun, and air may bleach it. During this process it is frequently turned. The first bleaching being complete, the root and lower joint are pulled off, the straw is then steamed, and afterward fumigated with sulphur to complete the process. See STRAW-BRAID.

Straw-pa'per.

Straw is cut into small pieces by a chaff-cutting machine or grinder (see Fig. 4015), and then subjected to the action of a boiling solution of hydrate of soda or potash. It is then put into a vessel with a perforated false bottom, and a pipe communicates from this to a close iron vessel containing alkaline solution, which is kept boiling by steam heat. (See PULP-DIGESTER, pages 1821-1823.) The pressure of steam in this vessel drives the alkaline solution through the pipe, and it falls in streams upon the cut straw. From 30 to 40 gallons of the solution are used to each 100 pounds of straw. The liquor is caused to circulate through the straw for 8 or 10 hours, when the liquor is drawn off, and water is run through the straw until it runs off clear. The straw is then put into a bath of hypochlorite of alumina, in order that it may be bleached and its fibers disaggregated. There it remains 12 or 13 hours, being stirred from time to time. The straw is by this time reduced to *half-stuff* of good color, when the liquor is strained off, and the pulp well washed with boiling water. It is then carried to the beating-engine, and made into paper. It is customary to use a portion of rag-pulp where a good quality of paper is desired. See Figs. 4008-4112, and pages 1821-1823.

Stray-line. (*Nautical.*) A portion of the log-line, say 10 fathoms, between the log-chip and the first knot, and left unmarked in order to allow the latter to get out of the eddy in the ship's wake before turning the glass. When the *stray-mark* is reached, the glass is turned, and counting commences. See LOG.

Streak. 1. (*Shipwrighting.*) A course of planking on a vessel's side. See STRAKE.

2. The color of a mineral, when scratched to detect the appearance of ore.

Stream-an'chor. (*Nautical.*) An anchor of a grade between the *bower*, or large anchor, and the *kedge*. Used in warping; or mooring in a place but slightly exposed.

Stream-ca'ble. (*Nautical.*) One smaller than the cable of the *bowers*, and used in mooring or riding by the stream-anchor.

Stream'er. A pennon. See FLAG.

Stream-tin. (*Mining.*) Tin ore found in lumps in diluvial formations.

Stream-wheel. An *undershot* or *current* wheel.

Stream-work. (*Mining.*) Work on alluvial metalliferous deposits; of tin, for instance.

Street-car. The street-railway was a growth from the *tram-road* system which was in use in the English collieries as much as 275 years ago. The *tramways* at first were flat boards, balks, or paving-stones, so as to allow the wheels of the *trams* (wagons) to roll more easily, and prevent the road wearing into chuck-holes. This is a very ancient device, as old as the moving of the obelisks and ashlars of Egypt and Syria upon rollers running on a temporary track of timbers. See TRAMWAY; RAILWAY.

To this succeeded *rails* of wood, which are described, in a publication of 1676, as being shaped so that the "four rollers" of the wagon "fitted" to them. They were laid on transverse sleepers and secured by wooden pegs. It may be said with truth that these tram-roads were the precursors of our street-railways, as they united the cities with the suburbs.

Wooden rails with malleable iron caps were used in 1716.
Cast-iron rails in 1767.
L-shaped rails in 1776.
Rolled rails in 1820. See RAIL, pages 1857, 1858.

The railways originated in the collieries of the North of England, and the iron district of Shropshire.

They were at first used entirely for freight. When rails were invented it was a century and a half before steam-cars were made to run upon them. On the early railways of England horses were employed for 150 years. The Milton and Quincy, Mass., Railway, 1826; the Baltimore and Ohio, 1830; the Mohawk and Hudson, N. Y., 1830, were all worked by horses at the first. See RAILWAY, page 1861. The steam-car was at first made for common roads, as the steamboat was first made for canals. The early steam-carriages were those of

Cugnot (French).........1769	Evans (American)........1787
Hornblower (English)....1769	Medhurst (English)......1800
Symington (Scotch)......1770	Bompas (English)........1828
Murdoch (English).......1784	See STEAM-CARRIAGE.

The *locomotive*, considering the term as referring to a *steam-car on rails*, originated in Wales. The list of early inventors is about as follows: —

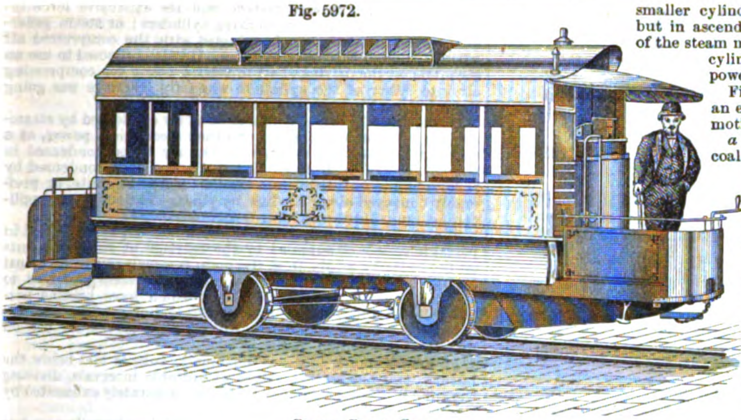
Trevethick (Wales).......1802	Stephenson (England)....1825
Blenkinsop (England)....1811	Stephenson (England)....1829
Blackett (England)......1812	Hackworth (England)....1829
Hedley (England)........1813	Braithewaite and Ericsson (England).............1829
Stephenson (England)....1815	

The three latter were contestants at the great trial on the Liverpool and Manchester Railway, in 1829. See LOCOMOTIVE, pages 1343-1347.

For other forms of steam-moved vehicles, see ROAD-ROLLER; STEAM-PLOW; PORTABLE ENGINE; TRACTION-ENGINE.

Beginning with horses, and then using stationary engines to raise or lower the wagons on grades, and to the *staiths* whence

Fig. 5972.

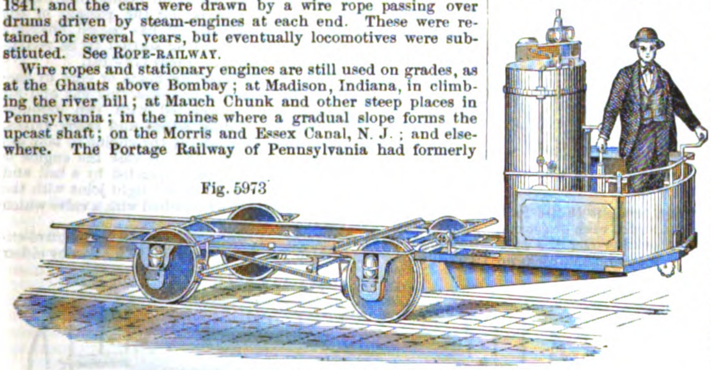


Steam Street-Car.

they discharged by chutes into the colliers, the contest for some years previous to 1829 had been between stationary and locomotive engines. Stephenson threw the weight of his influence in favor of the latter, and the trial on the Liverpool and Manchester Railway was to encourage invention on the latter plan. The London and Blackwall Railway of $6\frac{1}{2}$ miles was opened in 1841, and the cars were drawn by a wire rope passing over drums driven by steam-engines at each end. These were retained for several years, but eventually locomotives were substituted. See ROPE-RAILWAY.

Wire ropes and stationary engines are still used on grades, as at the Ghauts above Bombay; at Madison, Indiana, in climbing the river hill; at Mauch Chunk and other steep places in Pennsylvania; in the mines where a gradual slope forms the upcast shaft; on the Morris and Essex Canal, N. J.; and elsewhere. The Portage Railway of Pennsylvania had formerly

Fig. 5973



Truck and Machinery of the Baxter Steam-Car.

ten inclined planes overcoming an elevation of about 1,400 feet, going west. The western terminus of the railway is about 1,173 feet below the summit level. See INCLINED PLANE, pages 1174-1177.

Rope railways are also used in overcoming special elevations, such as the passenger elevators at Niagara, Cincinnati, and Pittsburgh; a vertical elevator for cars is used at Hoboken, N. J.

Street-railways for passenger cars were first established in the United States about 1850, and in England about ten years afterward. The Boston and Cambridge Railway, commenced in the fall of 1858, was the first in New England.

Street-cars are usually drawn by horses, but many attempts have been made to drive them by machinery. Steam-engines, known as *dummy* engines, have been used with success, but the fire and the noise of escaping steam are considered objectionable.

Fig. 5972 is a view of the Baxter steam-car; Fig 5973, the truck and machinery of the same.

The boiler is upright, and is placed on the front platform; a non-conducting partition prevents heat from entering the car.

The engine is below the platform. It is compound and double-acting. In ordinary use, the steam from the smaller cylinder exhausts into the larger; but in ascending grades, the full pressure of the steam may be made available in both cylinders, greatly increasing the power.

Fig. 5974 is the Knapp car; *B* an elevation, and *C* a plan of the motive apparatus.

a is the furnace, supplied with coal from the platform through the chute *b*; *c*, the boiler; *d d*, the cylinders. The exhaust steam is condensed by a blast of cold air from the fan-blower *f*; *g* is a smoke-pipe, terminating in a reservoir *h* containing milk of lime, to remove the carbonic acid from the smoke; this also acts as a spark and dust arrester, so that the gas, which finally issues from the pipe *i*, is invisible, and causes no inconvenience to the passengers or others.

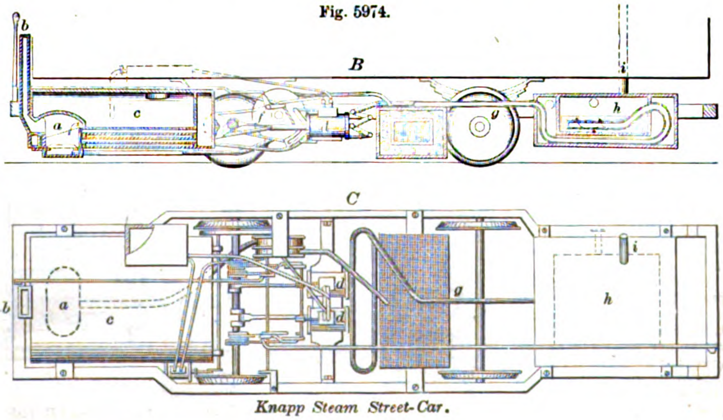
The car, Fig. 5975, has a circular cab *B*, which contains the dummy engine and boiler, and is supported on a circular platform *I* resting upon the fore truck *V*, and is provided with anti-friction rollers *h i*, upon which the front of the car body *A* rests; the shell of the cab also bears against vertical anti-friction rollers *m m*. A reach and center pin *U* connect the body and fore truck of the car, and the body is supported on a similar pivoted truck, provided with anti-friction rollers, enabling the two parts to turn independently of each other. The front and rear axles of the fore truck are coupled by connecting-rods *N*, and the rear axle *J*, which is cranked, is worked as a driver by a pair of oscillating engines. See also STEAM-CAR.

The following statement includes a number of applications of condensed air to the driving of street-cars: —

A British form of steam-locomotive, in which the engine carries no boiler, but a supply of steam sufficient for a trip, is termed the Fireless Locomotive.

Todd's combined dummy and car has a main lower frame 22 feet 6 inches long over the buffers, 7 feet wide over all, and 3 feet high from the rail to the top; and on this frame is placed the 14-feet body of an ordinary car. In the center of the frame are two receivers, each containing 30 cubic feet of water. Below the buffer-beams are screw-couplings and stop-valves with perforated pipes running right through the receivers. The wheels are 24 inches diameter, placed 4 feet 6 inches between centers. Cylinders, 9 inches diameter and 8 inches stroke, surrounded with large jackets open to the water of the receivers. At each end of the car, outside the dash-plate, is placed a brake-handle, and on either side of this a regulator and reversing handle, all arranged as shown. These latter handles fit into spring sockets,

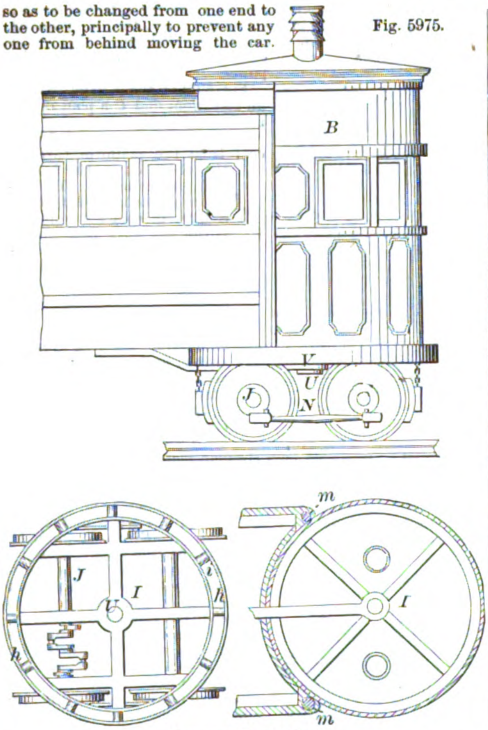
Fig. 5974.



Knapp Steam Street-Car.

so as to be changed from one end to the other, principally to prevent any one from behind moving the car.

Fig. 5975.



Dummy Street-Car.

There are four sand-boxes, with handles brought to the foot-boards. There are two exhaust-pipes, the end of each projecting slightly upward from the edges of the curtains over the foot-boards; and by a cock the waste steam is turned into whichever pipe happens for the time to be at the rear end of the car. All the working motion is quite protected from dirt by light boxes which have hinged doors at the sides. The engine is started on its journey with an initial pressure of 200 lbs. to the inch; and owing to the jacketing of the cylinders, the loss by radiation is said not to exceed 5 lbs. pressure per hour, allowing the engine to run 40 miles on level lines at one charging of the boiler.

The upper figure is a longitudinal section of the car, and the lower is an exterior elevation, also showing the stationary boiler from which the apparatus is charged.

Medhurst, English patent, August 2, 1800, proposed to propel carriages by means of compressed air carried in a reservoir, using a single-cylinder engine, or a double-cylinder engine with compound beam, according to the amount of power required.

Bompas, April 29, 1828, patented a method of propelling carriages or boats by means of air compressed by pumps in cylindrical iron vessels, with hemispherical ends placed in one or more rows underneath and behind the carriage. Fixed reservoirs to be located at appropriate stations, to replenish the air as the pressure becomes diminished in the cylinders; the compression to be from 30 to 150 pounds or upward. He preferred to use two cylinders, working expansively, if desired. The use of air or gas, condensed by being disengaged chemically from substances with which it is in combination in a confined space, is also mentioned.

Wright, April, 1828. Compressed air, contained in metallic cylinders beneath the car and charged from a stationary reservoir or by means of air-pumps, was admitted by appropriate pipes with valves to a third cylinder, where, by means of a furnace beneath, it was heated, and its expansive force increased before entering the working cylinders; or steam generated by the furnace might be mingled with the compressed air when it entered this third cylinder. He also proposed to use an eccentric on the driving-shaft to work a pump for compressing air into either of the cylinders when the carriage was going down hill, and to serve as a brake in descending.

Mann, June 1, 1829. Application of air condensed by steam-engines, wind or water mills, or other mechanical power, as a motor for vessels or carriages. The air to be condensed in portable reservoirs, to be carried on the carriages, condensed by steam-engines at the different stations along the route, or preferably conveyed along the line by pipes. Various other applications are pointed out.

Surrey, September 1, 1856. Compressed air, to be carried in portable vessels or supplied to the carriage at suitable points on the route by a tube from the main reservoir at the principal depot. In the former case, several small vessels preferred to one large one, as the air from those which have become partially depleted may be employed in descending grades, or where less power is required, and the full vessels reserved for use on up grades or for high speeds.

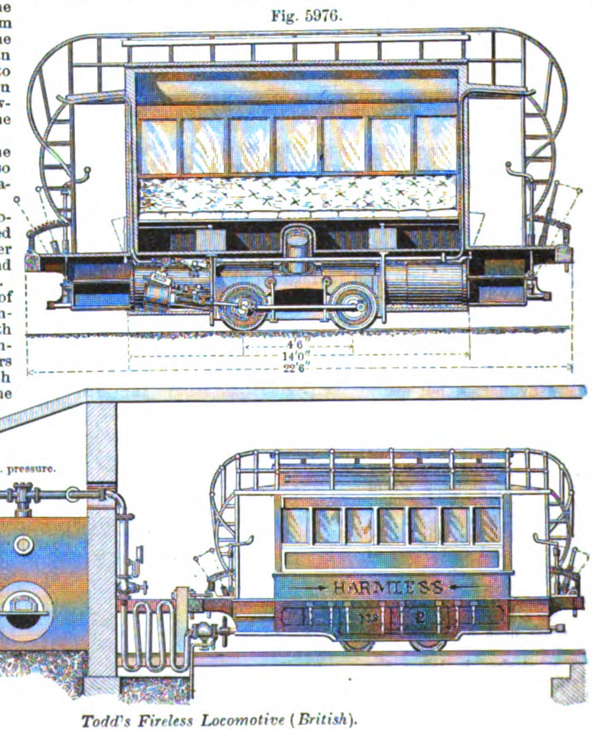
Pinkus, March 1, 1834. A pneumatic tube is laid below the railway, and has section valves at suitable intervals, dividing the tube into compartments, which are separately exhausted by engines at each of these stations.

The piston is attached to a frame or carriage traveling on two wheels, one in front, and the other behind, and having circumferential grooves fitting a continuous rib on the interior of the tubing. An arm projecting upwardly from the piston-carriage passes through a slit in the upper part of the tube, and is connected to the car, or the first of a series of cars on the railway. The slit is closed by a flexible valve arrangement, kept closed in front of the "dynamic traveler" by atmospheric pressure, but pushed aside as this advances, to admit air behind the piston. The section valves are opened to permit the passage of the traveler, and each may be closed after it has passed, enabling the work of exhaustion in the preceding section to be recommenced. See ATMOSPHERIC RAILWAY, pages 179-181.

Pinkus, August 26, 1839. Propelling boats or cars by gas-explosive engines. The engine has double-acting gas and air pumps, two piston-cylinders connected with two globular explosive chambers having igniting slides and safety-valves. Arrangements may be made for enabling the engine to take gas from the main without stopping. In this case the engine is provided with a flat pipe or tongue suspended by a ball and socket joint, and made so as to form an air-tight joint with the main or valve. The tongue is also furnished with a valve which shuts when it leaves the main or valve.

Count de Fontainemoreau, June 21, 1844. Locomotive-engines, either reciprocating or rotary, are put in motion by either

Fig. 5976.



Todd's Fireless Locomotive (British).

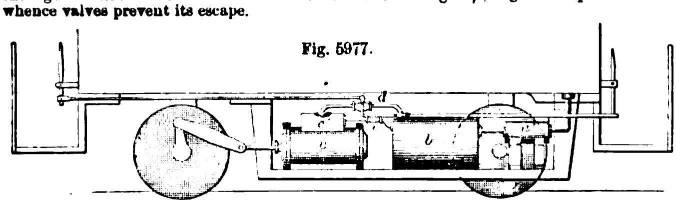
compressed or rarefied air derived from a tube along the roadway. Above the tube are fixed distributing-boxes, having a valve at bottom, and other valves at top, which are opened by a slide carried along with the locomotive and running in a groove at the top of the box, having a strip of sheet-iron on one side, and a leathern strip on the other; the valves automatically close after the slide passes over them.

Parsey, October 17, 1844. Employs a receiver and a regulating-chamber, where the density of the air is reduced, and from which it passes to the valve-box of the cylinder. After doing its work, it may be allowed to escape, or it may be forced back into the receiver by two air-pumps contained within it and communicating with the two ends of the working cylinder. See pages 603, 604, Vol. I.

Anderson, June 29, 1846. Using gun-cotton or yarn as means of propulsion. The locomotive has two cylinders, enlarged at their outer extremities, having pistons connected together by side-rods, and each furnished with a valve to allow escape of gas during the down stroke. The cotton or yarn is fed by rollers alternately in the narrow extremity of each cylinder through a small slit, and is exploded by wires from a galvanic battery.

Fell, October 7, 1847. Employs rarefied or compressed air. The latter is conveyed by a main or pipe placed centrally between the rails to reservoirs at equal distances along the line. These are located below the main, and have valved pipes passing through it, and flush with its upper surface. The main is partially embraced by a long slider attached to the engine, connected by a pipe with its air-chamber, and as the engine passes over each reservoir, levers connected with the valves of the pipes leading therefrom are struck by a bar attached to the engine opening the valves, and air passes from the reservoirs through the slider and tube into the air-chamber of the engine, whence valves prevent its escape.

Fig. 5977.



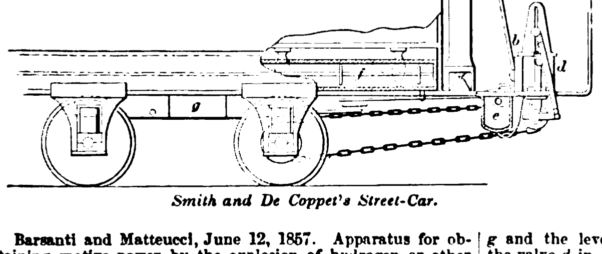
Smith's Pneumatic Engine for Street-Cars.

A different arrangement of valve is employed if rarefied air is used.

Van Rathen, November 2, 1847. High-pressure air from a reservoir is made to enter a set of expanding and warming tubes, by which its pressure is reduced from about 50 to 5 atmospheres, while retaining its heat and elasticity, and thence a moderator or chamber provided with a piston which is forced into the chamber by the action of a regulating spring or weight, and raised by the pressure of the air. From the moderator the air passes to the propelling machinery.

Johnson, June 26, 1856. Proposed to carry a small steam-engine and boiler for working two or more double-action air-pumps to compress the air into a receiver, whence it was to be delivered to the main actuating cylinders of the engine.

Fig. 5978.



Smith and De Coppet's Street-Car.

Barsanti and Matteucci, June 12, 1857. Apparatus for obtaining motive power by the explosion of hydrogen or other inflammable gas mixed with atmospheric air. In one method the vacuum produced beneath the piston by the explosion is alone availed of, two alternately acting cylinders being employed. In a second plan both the force of the explosion and the vacuum are utilized. Four cylinders are employed, one on each of two pairs of driving-wheels. The locomotive carries a reservoir of gas with regulating apparatus to give a uniform supply. The charge is exploded by a cylindrical circuit-breaker rubbing against a steel spring and rotated by band and pulley connection with the fly-wheel shaft.

Crever and Keeney, September, 1859, proposed the use of a stationary steam-engine at one of the termini, for compressing air into a large air-holder. A main connected with this reservoir leads along the track, and is provided at intervals with ascending branches having valves, which may be opened by contrivances under the control of the conductor, in order to replenish a compressed air-tank carried beneath the car.

Liquid carbonic-acid gas exerts a pressure of about 690 pounds per square inch at 42° Fah., 855 pounds at 60° Fah., and 1,200 pounds at 86° Fah. One pound of the liquid expands so as to form rather more than eight cubic feet of gas. It may be kept in tanks made of several thicknesses of sheet-steel rolled together in the form of a scroll and united by a solder of pure tin run in between the layers. (Mathews's patent.) Tanks made of a single thickness 1/16 inch of sheet-steel, lapped four inches at the edge, and soldered in this way, may be trusted to sustain a pressure of 300 pounds to the inch, the bursting pressure being 700 lbs. One of the thicker kind above mentioned, tested by hydraulic pressure at the Newport torpedo-station, withstood strains up to 3,132 lbs. per square inch before rupture.

Barbour, March 14, 1865. The car carries a supply of liquid carbonic-acid stored in a tank beneath. This is admitted in regulated quantities to the cylinder, where it expands, and after doing its work, the gas is exhausted into a reservoir over the car, having a capacity 450 times that of the tank in which it is contained in the liquid state. It is recondensed by appropriate machinery at the stations, and again used.

Smith, August 8, 1871. Compressed air, contained in a large tank on the body of the car, is admitted to a governor or regulator a', and thence passes to a small auxiliary tank b underneath; this is connected with the cylinder valve-chest c' by two pipes, one of which d is open and the other e closed while the car is in motion, but on stopping the car the latter is opened and the former closed, causing the compressed air in the cylinder c to be pumped back into the auxiliary tank, where it is stored up to assist in starting again. The illustration (Fig. 5977) shows the car-bed and lower works.

Smith and De Coppet, July 29, 1873 (Fig. 5978). Liquid ammonia, stored in a reservoir a, is withdrawn and injected by a pump b into a vaporizer c, heated by a lamp beneath. The gas is conducted to the engine d by a pipe, and is exhausted into a condenser e, where it is liquefied by a shower of spray falling through a perforated plate, the water being supplied by tanks f, one at each side of the car, and withdrawn therefrom by a pump. A third pump removes the ammonia from the condenser and forces it into a tank g beneath the car, where it is retained for farther use. Chains communicate motion from pulleys on the engine crank-shaft to pulleys on the driving-wheel shaft.

Bowen, September 2, 1873 (Fig. 5979). The car has under the seats tanks for compressed air, divided into compartments by partitions. The compartments communicate with each other by valves, which allow the air to pass from one to the other when they are charged at the end of the route, but prevent its passing in the opposite direction when the compartment first drawn on has a less pressure than that which remains intact. Each compartment has a separate pipe communicating with the working-tank d, and valves controlling these are successively opened as the pressure becomes reduced in the compartments first drawn upon.

Turnbull (Fig. 5980) employs a cut-off which automatically varies the bulk of air admitted to the working-cylinder in proportion to the degree of compression. $e\ e$ are air-holders; f, cylinder; l, slide-valve, working in chest p and operated from eccentric m by lever n and rod o secured to pivoted sleeve b, rendering the length of stroke adjustable; q is an air-chest, from which the chest p is supplied. The compressed air issues from the air-holders, which are connected by a pipe, through a valved pipe communicating with the dome t, and presses against the diaphragm f, having a stem u connected with the helical spring g and pivoted to the lever v. When, as at starting, the air in the tanks is highly compressed, the diaphragm f depresses the stem u in opposition to the spring g and the lever v, through the medium of $k\ l'\ m$, causes the valve d in chest q to cut off at short stroke; but as the pressure becomes reduced, the spring g, overcoming the resist-

ance of the diaphragm, raises the stem *u*, and allows the valve *d* to have a longer range, so as to admit a greater volume of air to the chest *p*. When the pressure in the tanks has become reduced to a certain amount, the valve *d* ceases to operate. *z* is a pipe conveying air from drum *t* to the chest *q*; *i*, connecting-rod, and *k*, crank to driving-axle *c*.

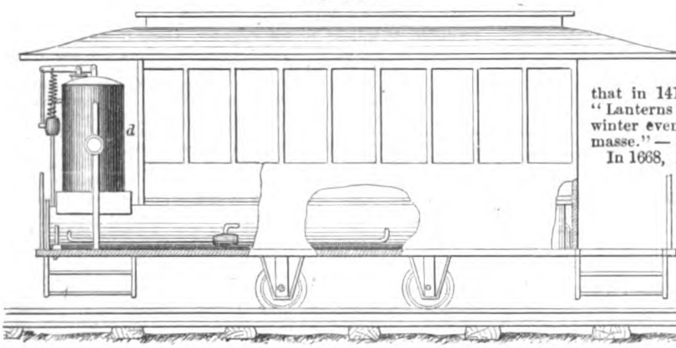
The Scott-Moncreiff system is used in Scotland.

A United States patent has been granted for a method of using the elastic force of rubber as a motor for street-cars and for other purposes. Two rubber bands, $2\frac{1}{2}$ inches in diameter and 56 feet long, are stretched to 10 times that length upon two drums, on which they are coiled. The unwinding of each coil is calculated to propel the car a distance of over two miles. When the first has been unwound, the second is brought into requisition, and while it is propelling the car, the first is to be again wound up by the devices used for stopping and controlling the car.

Still another mode of operating street-cars is by means of steel springs. This form is the subject of a French patent by M. Leveaux.

The winding-up of the spring barrels, which are carried under the car, is effected by engine power, placed at suitable intervals along the track, as may be convenient for the run. The stationary engine drives by belt the horizontal shaft, carried in bearings, inclosed in a metallic tube or casing, beneath the roadway, and extending across the track; close alongside which is a covered box, sunk in the roadway and inclosing a wheel, so shaped as to connect with the winding axle of the tramway car,

Fig. 5979.

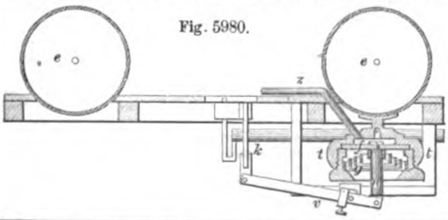


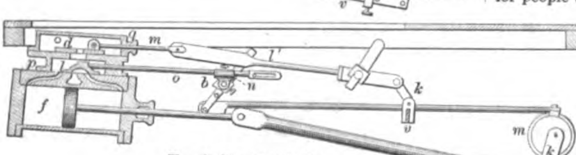
Bowen's Street-Car.

and thus give the requisite motion thereto. On the arrival of a car at any station, the spring barrels are wound up by the engine.

It has been computed that the actual tractive force, requisite to overcome the resistance of a street-car weighing gross 5 tons, is 60 pounds on the driving-wheels, corresponding to 720 pounds on the periphery of the spring barrel; 24 pounds and 288 pounds respectively correspond to a gross weight of 2 tons; and in like proportions for intermediate weights. So far as previous experience goes, a spring 6 pounds in weight, exerting a direct

Fig. 5980.





Turnbull's Street-Car.

pressure of 105 pounds, may be taken to represent the maximum in size and power of such steel springs. Steel manufacturers are now turning out springs 50 to 60 feet long, capable, when duly coiled, of exerting a pressure of 800 pounds to 900 pounds, without permanent set.

In a modification, in place of one spring, wound up at intervals along the road by means of stationary engines, a number of springs, each properly wound up, are taken on at the beginning of the route, and as fast as one expends its energy in moving the car, another is brought into play, and the trip is continued till all are exhausted, or the run is made.

Street-lamp. One publicly exposed on the street. The lighting of streets on occasions of rejoicings, processions, grand entries, and receptions has always been an accepted Oriental device for gracing such occasions. The feast of the dedication was such among the Jews. The Roman forum was lighted when night-games were celebrated. Caligula once lighted the whole city. Constantine lighted up the city of the Bosphorus on Easter eve.

The streets of Antioch and Edessa were lighted in the fourth and fifth centuries. The lights were lamps suspended by ropes.

The really comfortable lighting of some Eastern cities mentioned by Jerome, Libanius, Basilius, and others during the fourth century was far ahead of any attempts in that line in Greece or Rome, where people, venturing out after dark, were attended by lantern or torch bearers.

The public lighting of streets became large and regular service among the Saracens. In Cordova (Ar. *Korttubah*), under the Arabs, a person might walk after sunset for a distance of 10 miles in a straight line by the light of the public lamps and upon well-paved streets. *Al Makkari's* "History of the Mohammedan Dynasties in Spain." This was 500 years before any public lamp service in London or Paris.

The priority of lighting streets is contested between London and Paris. In London it appears that in 1417, Sir Henry Barton, Mayor, ordered "Lanterns with lights to be hanged out on the winter evenings, between Hallowtide and Candlemasse." — STOWE.

In 1668, householders were reminded that they should hang out lanterns duly at the accustomed time, and in 1690 this order was renewed, and these lights were required to be kept burning from dark till midnight every night between Michaelmas and Lady Day.

In 1716, farther ordinances for the better lighting of the city were made by the city authorities, but the duty still rested upon the people, and its execution was not a municipal act. The Common Council ordered that "all householders whose houses front any street, lane, or public passage shall, in every dark night, that is, every night between the second night after every full moon till the 7th night every new moon, set or hang out one or more lights, with sufficient cotton wicks, that shall continue to burn from 6 o'clock at night till 11 o'clock of the same night, under the penalty of one shilling." The rest of the night might take care of itself, and even these regulations were evaded and disregarded.

The streets were subsequently lighted by contract for 117 nights in the year. This proving unsatisfactory, an act of Parliament was passed in 1736, which authorized the corporation to establish glass lamps to be lighted from sunset to sunrise all the year round, and the number was increased to 5,000 within the bounds of the city proper; probably 15,000 within the group of municipalities known as London. In 1744, the lighting of the city was still farther regulated by act of Parliament, and at a somewhat later period Oxford Street alone was said to contain more lamps than all Paris.

Misson, the celebrated traveler, who visited England about 1680, states that in the streets of London, "instead of lanterns, they set up lamps which, by means of a very thick convex glass, throw out great rays of light which illuminate the path for people that go on foot tolerably well." These lamps were at every tenth house. They fell into disuse, and lanterns were substituted. These *bull's-eyes* were again introduced in London in 1799.

"Master Kemming" is noted as the enterprising establisher of public lamps in London. His oil lamps eventually gave way to Murdock's gas-lamps, 1798; and Winsor, 1803.

An order was issued in Paris, in the year 1524, that the inhabitants should keep lights burning, after nine in the evening, before the windows of all houses which fronted the streets; and in October, 1558, large vases filled with pitch, resin, and other combustibles were placed at the corners of the streets, or nearer together if necessary. These, in the next month of the same year, were superseded by lanterns.

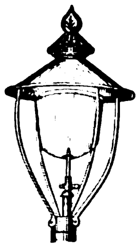
The lighting arrangements of the streets, however, still continued for many years on a very imperfect footing, and travelers still found it advisable to employ men bearing links or lanterns, when going abroad after nightfall.

In 1667 the lighting and police arrangements of Paris were improved; the project was that of the Abbé Laudati, and was legalized in 1662. In 1671 the lamps were ordered to be lighted from the 20th of October to the end of March, having previously been kept lighted only during the four winter months; at this time the lamps were kept burning on moonlight nights as well as others. Their number in 1771 was estimated at 6,232.

Amsterdam had street lanterns in 1669; The Hague, 1678; Copenhagen, 1681; Hamburg, 1675; Berlin, 1682; Vienna, 1704; Birmingham, England, 1783.

For lighting by gas, see GAS.

Fig. 5981.



Street-Lamp.

In the example, the glass is in a single piece, flaring at top, and having an opening at the bottom to receive the burner. The cover, to which it is attached, is conical in shape, is supported by four rods affixed to the top of the lamp-post, and is capped by a perforated hood.

James L. Ewin's street-lamp has a supply of naphtha or other oil sufficient to last for a week or longer, contained within a reservoir located in or beneath the pavement. Water under pressure from the street-main or a service-pipe is applied to the oil by a pipe, and the oil is conducted to the burner by another pipe, the flow being regulated by stop-cocks at the burner and in the water-pipe. The reservoir is furnished with a removable bucket inclosed by a hinged oil-tight lid, as means for discharging the water and refilling the reservoir with oil. A single padlock secures the lid and the water-supply cock. In this general form the oil-supply apparatus is used in connection with an ordinary gas-lamp post. In another form, an enlargement in the post constitutes the reservoir, and a simple cock provides for discharging the water. In some forms provision is made against the escape of the water or oil through the outlet of the other. The lamp-lighter simply turns on the oil at the burner, and the water-pressure keeps the flame supplied continuously until the flow is stopped or the oil is exhausted.

Fig. 5982.

Ewin's Street-Lamp for Coal-Oil.

Street-lo'co-mo'tive. 1. An engine (usually steam) for use on ordinary road or pavement. See ROAD-LOCOMOTIVE; TRACTION-ENGINE.

2. A small compact engine for use on board a street-car, as a substitute for horses. A dummy-engine (Fig. 5983). See STREET-CAR.

Street-rail'way. See STREET-CAR; STEAM-CARRIAGE.

Street-sprink'ler. A cask or water-box on wheels, with a rose at the rear to sprinkle water upon the street. Kinds and capacities are various. They are usually filled from the public hydrant or fire-plug, and have means by which the driver can control the issue of water.

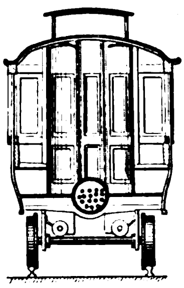
Street-sweep'ing Ma-chine'. A wagon provided with scrapers and brushes for gathering up street-dust and mud and depositing it in the wagon-bed.

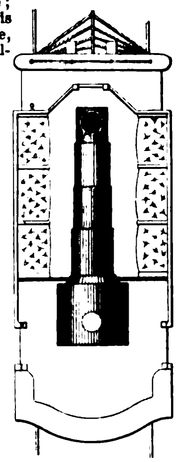
Boase's street-sweeping machine (England, 1831) had 5 rows of brushes spirally arranged on an axis which is rotated by bevel-gear from the main axle. It delivers the sweeping in a ridge at the off-side of the machine.

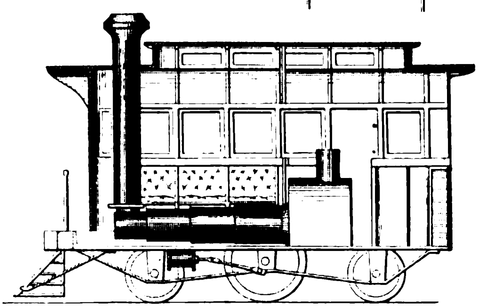
The street-sweeping machine adopted in the municipal service of Paris has a broom attached to the rear of a two-wheeled vehicle, by means of a framework, which is so hinged to the axle of the vehicle as to enable the conductor upon the box in front to raise it out of contact with the pavement, or to depress it for service at pleasure.

Upon one of the wheels of the vehicle is fixed a conical gear-wheel, which drives a pinion running on an axis inclined about 20 degrees to the axis of the vehicle; and this axis is connected with the axis of the broom by a chain working in a pair of rag-wheels. The axis of the broom itself is inclined so as to be parallel to the axis of the pinion just mentioned, and therefore oblique to the direction of movement. When the broom is applied to the pavement the rag-chain gives it a rotation opposite to that of the wheels of the vehicle; and the dust or mud of the street is swept on before it and turned aside, so as to form a continuous heap parallel with the axis of the road.

Fig. 5983.



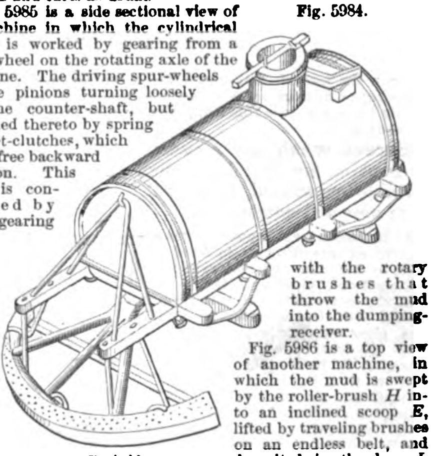




Dummy.

The broom is armed with stout splints, and is 2 feet in diameter. In length it is about 6 feet It leaves a track cleanly swept behind it of nearly this breadth. The dust is left in a ridge, or, as we should say, in wind-row, and is removed by shovels and carts as usual.

Fig. 5984.



Street-Sprinkler.

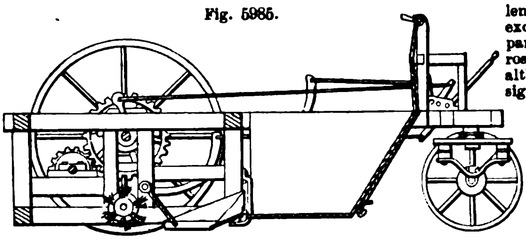
Fig. 5985 is a side sectional view of a machine in which the cylindrical brush is worked by gearing from a spur-wheel on the rotating axle of the machine. The driving spur-wheels engage pinions turning loosely on the counter-shaft, but clutched thereto by spring ratchet-clutches, which allow free backward rotation. This shaft is connected by chain gearing with the rotary brushes that throw the mud into the dumping-receiver.

Fig. 5986 is a top view of another machine, in which the mud is swept by the roller-brush *H* into an inclined scoop *E*, lifted by traveling brushes on an endless belt, and deposited in the box *I*. Erom thence it is dumped when the machine has been driven to the place of deposit.

Fig. 5987 is a machine for removing the dirt from close to the curbstone, and leaving it where an ordinary machine may reach it. The brooms and brushes are so connected by shafts and gearing with the ground-wheels as to revolve in a direction at right angles to the direction of motion of the machine.

Fig. 5988 shows, by a longitudinal section, a machine having

Fig. 5985.



Street-Sweeper.

an endless belt with brushes. The belt is moved by gear connection with the ground-wheels.

Fig. 5989 has a pair of oblique brushes to gather a wide swath of dirt into a position to be swept up by the succeeding cylindrical brush.

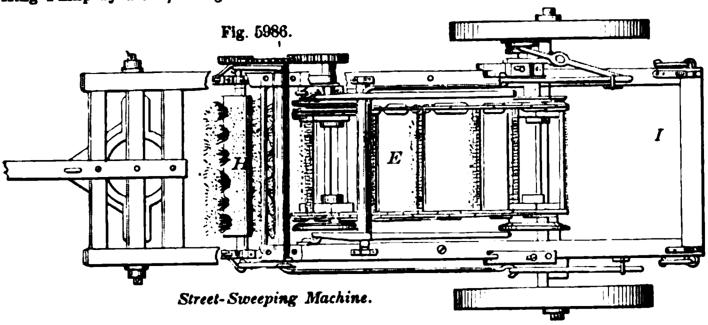
Ancient Rome had its cloacæ, and so had its beautiful colony Augsburg; but the cleaning of streets, except in exceptional cases, as in the splendid capital of the Spanish Caliphs, Cordova, was in a beastly state of inefficiency.

In Paris, in 1285, under Philip the Bold, an order was issued that each citizen should keep the street clean in front of his own house. In 1348 and 1388 stringent penalties were enacted against the remiss, and a dirt and garbage cart (*un tombereau*) was established. About the end of the fourteenth century the scavenger business became a regular trade. The government took charge of it in 1609, letting it out in contracts.

The work has changed somewhat in its character by the introduction of SEWERS (which see) and by other sanitary regulations and arrangements.

Without descending to the full particulars, we may state that every kind of filth was habitually thrown into the street until comparatively modern times. Swine were forbidden to run loose in Paris in 1131, in consequence of the death of the young King Philip by a fall, owing to one of these animals running

Fig. 5986.



Street-Sweeping Machine.

between the legs of his horse. By an ordinance of 1395 the throwing of filth into the streets was prohibited in Paris. It is only 120 years since this filthy practice was in full vogue in Edinburgh.

Street-wash'er. A name sometimes given to a hydrant or fire-plug from which the street may be sprinkled or washed, by a jet from hose and nozzle.

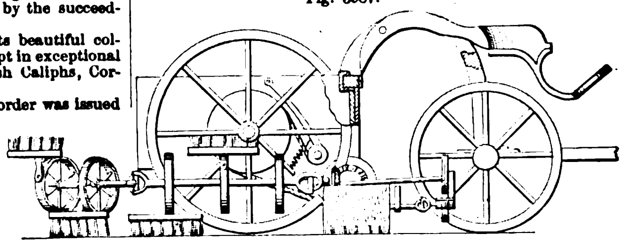
An invention for this purpose was introduced into Glasgow, in April, 1868, by Mr. Sim. On one side of the roadway, pipes were laid next the pavement, and connected with the water-main. The pipes were drilled with holes one tenth of an inch in diameter. On turning the water on from the main, it squirted across the street, completely and speedily watering, and, if required, washing the roadway.

"Engineering" describes a new process for "laying the dust" in streets, devised by a Mr. Cooper, who, amongst other contracts, undertook the watering for the parish of Marylebone, one of the largest in London, at a reduction of some fifty per cent on the other tenders. Mr. Cooper's system of watering is based upon the principle of utilizing the moisture always suspended in the atmosphere, by saturating the roads with a solution of deliquescent salts. Upwards of one million gallons of the solution have been distributed over various lengths of road with important and incidental advantages, exclusive of the enormous saving in water and labor. Apparently a sort of concrete is formed of the detritus of the road surface and the chemicals employed in the solution; for, although a road watered on this system may appear at first sight to be perfectly dry, upon closer inspection it will be seen that the dust is concreted together in masses too large to be blown about by the wind.

It is stated that the chemicals employed in the above solution have proved very destructive to the hoofs and feet of horses. *Quien sabe*

Strength of Ma-te'ri-als. The strength of materials is determined in three ways, — by their resistance to a *crushing* force, a *tensile* force, or by a *tortional* force. Of these tests, the former two possess the most general utility, as

Fig. 5987.



Street-Sweeping Machine.

compressive or tensile strains are those to which materials are most frequently subjected in structures of any kind.

The reader is referred to Barlow, "On the Strength of Materials." Consult, also, "Ordnance Manual," ed. 1861, and technical works on building, civil engineering, iron working and manufacture, etc. See TESTING-MACHINE.

Stretch'er. 1. (*Bricklaying.*) A brick whose length is laid in the direction of the length of the wall.

2. One of the extension-rods of an umbrella, attached at one end to the sleeve which slides on the handle, and at the other end to a rib of the frame.

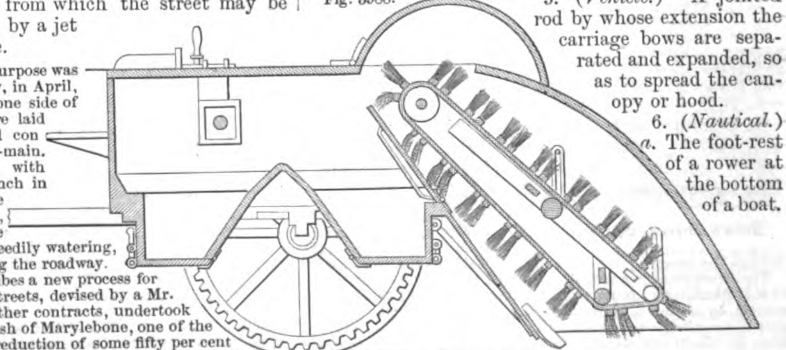
3. (*Carpentry.*) A tie-timber in a frame.

4. A round rail joining the legs of a chair. A *round.*

5. (*Vehicle.*) A jointed rod by whose extension the carriage bows are separated and expanded, so as to spread the canopy or hood.

6. (*Nautical.*) *a.* The foot-rest of a rower at the bottom of a boat.

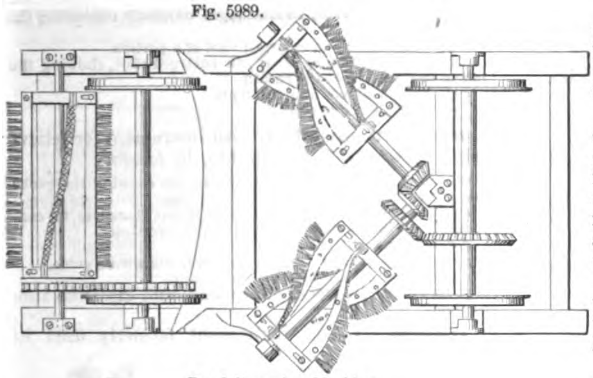
Fig. 5988.



Street-Sweeping Machine.

b. A cross-piece to keep the sides of a boat distended when slung to get on board or overboard.

Fig. 5989.



Road-Sweeping Machine.

7. A tool for expanding gloves.

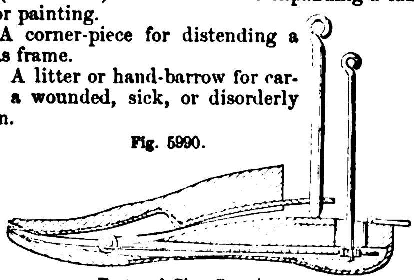
8. (*Shoemaking.*) An expanding last for distending shoes.

9. (*Fine Arts.*) *a.* A frame for expanding a canvas for painting.

b. A corner-piece for distending a canvas frame.

10. A litter or hand-barrow for carrying a wounded, sick, or disorderly person.

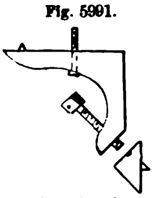
Fig. 5990.



Boot and Shoe Stretcher.

It is in great request at the front during an action, for carrying off the wounded to the rear, to a field hospital, or to ambulances for transportation farther to the rear. It is usually like a hand-barrow, with a bottom made of sacking, nailed to the frame. Some have legs, and some have none. Those with folding-legs pack more compactly for transportation.

Fig. 5991.



Stretcher for Painters' Canvas.

A number were patented during our late war. Fig. 5992 shows one which may be folded for transportation, is mounted on wheels and springs and on folding-legs, and its bed portions are adaptable to the necessities of varying cases.

Stretchers are also used for conveying dangerous persons to a place of safety; mad, drunk, or ferocious, to asylum, jail, police-station, or guard-house. See LITTER; BIER; HAND-BARROW.

Stretch'er-mule. (*Cotton-manufacture.*) A mule adapted to stretch and twist fine rovings of cotton, bringing them forward another stage in respect of attenuation and twisting. See MULE.

Stretch'ing-course. (*Masonry.*) A course of stones or bricks laid with their longest dimensions in the direction of the length of the wall. See BOND.

Stretch'ing-frame. (*Cotton-manufacture.*) *a.* A machine in which rovings are stretched in the process of converting them into yarn.

b. A long frame on which starched muslins are stretched and exposed in a warm room to dry. It is the substitute for the cylinder drying-machine, which is used upon heavier classes of goods.

To give the *patent finish*, the sides of the frame are moved backward and forward, so as to give a diagonal stretch in alternate directions to the cloth. This is continued until dry, and the effect is a soft and elastic finish, resembling clear-starching.

Stretch'ing-ir'on. (*Leather-working.*) A currier's tool, resembling a *slicker*, consisting of a flat piece of metal or stone fixed in a handle and used to scrape the surface of curried leather, to stretch it, reduce inequalities, and raise the *bloom*,— a certain powdery appearance which marks the surface of well-tanned leather.

Stretch'ing-ma-chine'. A machine for stretching textile fabrics so as to lay their warp and woof yarns in truly parallel positions.

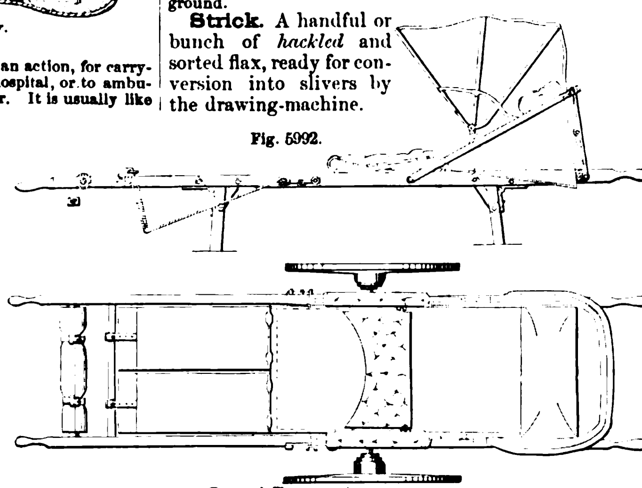
An ingenious and effective machine for this purpose, patented by Morand of Manchester, is described in Newton's "London Journal of Arts and Science" for December, 1835. See also TENTERING-MACHINE.

Striæ-de-tect'or. An instrument invented by Professor Töpler of Riga for detecting the streaks or striæ in glass-disks, caused by irregularities of density. These are sometimes of sufficient magnitude to be visible on simple inspection, but when not so, they render the glass unfit for optical purposes.

The instrument consists of a lamp before which is placed an opaque disk having apertures of various dimensions, enabling the observer to vary the size of the radiant at pleasure. The light is thrown on a large lens of short focus, and passes through the glass to be examined. Exactly at the focal point is placed an opaque disk of the exact size of the image there formed. If the lens to be tested is perfect, a complete eclipse will take place, but if irregularities exist they will cause the rays falling on them to deviate from the focal point, and will produce an image of their figure apparently more or less bright upon a dark ground.

Strick. A handful or bunch of *hackled* and sorted flax, ready for conversion into slivers by the drawing-machine.

Fig. 5992.



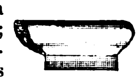
General Tompkins's Stretcher.

A cwt. (112 lbs.) of flax makes 300 to 400 *stricks.*

Strick'le. 1. (*Carpentry and Masonry.*) A pattern or templet.

2. (*Founding.*) *a.* A semicircular piece of wood used in smoothing molds of loam to form cores for curved and crooked pipes; also for spreading upon the cores a thickness of loam answering to the required thickness of the pipe. The core and its envelope form a model in the sand-flask, and are then removed; the outer thickness of loam is removed, exposing the core; this is placed in the mold, resting on

Fig. 5993.



Stretching-Iron.

prints; the mold is closed, clamped, and the metal poured.

b. A straight-edge of wood with which to remove superfluous sand from a flask after ramming up.

2. (*Cloth-shearing Machines.*) A straight-edge fed with emery and employed to grind the edges of a series of knives arranged spirally on a cylinder.

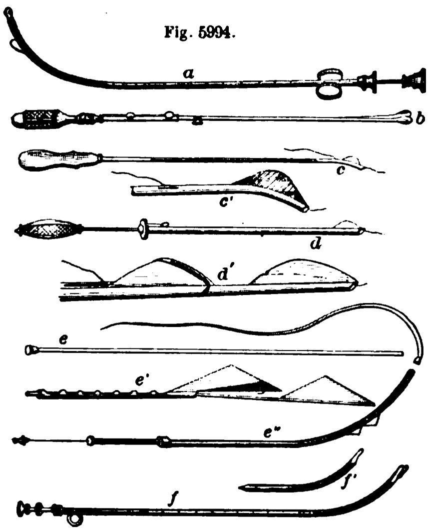
3. A straight-edge to strike grain to a level with the upper edge of the measure. A *strike.*

4. An instrument for whetting scythes. A *rifle.*

5. (*Flax.*) A *strike* or sword used in dressing flax.

Strict'ure-cut'ter. An instrument for dividing contractions of the urethra. A catheter concealing

Fig. 5994.

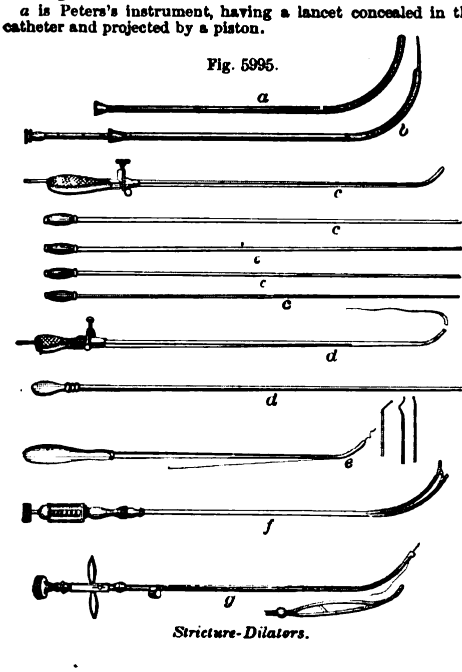


Tiemann's Stricture-Cutters.

a knife, which may be pushed out at the proper time, dividing the stricture without injuring any other part of the urethra.

a is Peters's instrument, having a lancet concealed in the catheter and projected by a piston.

Fig. 5995.



Stricture-Dilators.

b is Civialle's, having spoon-shaped terminals concealing the knife.

c is Gouley's. *c'*, an enlarged view of a portion.

d is another of Gouley's. *d'*, an enlarged view, showing the lancet projected from the sheath.

e e' e'' are Vollmier's instruments.

f f', Martin's instrument.

Strict'ure-di-lat'or. An instrument for relieving contractions in the urethra, by *tearing.*

a b are views of Miner's instrument, one showing the probe projected.

c c c c c are Holt's instruments, of different diameters, for consecutive use in expanding the walls of the urethra.

d d' is Bumstead's dilator.

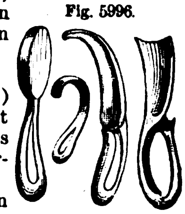
e shows dilators of varying forms, with whalebone guide.

f is an expansible bifurcated instrument.

g, Sir Henry Thompson's instrument, with expansible stem section.

Strig'il. 1. An instrument formerly used in baths for scraping off the sweat, but more specifically useful in exciting the action of the skin and tissues beneath.

Fig. 5996.



Strigils.

2. A flesh-brush.

Strike. 1. (*Brick-making.*) A small piece of wood about $1\frac{1}{2}$ in. × $\frac{1}{2}$ in., and 10 inches long, used to remove the superfluous clay from the mold.

2. A similar strip is used in measuring grain, and hence the term *struck* measure as distinguished from *heaped* measure. Customs vary in this respect, and the practice of selling by weight is superseding the old mode. See STRICKLE.

3. (*Founding.*) *a.* A hook in a foundry to hoist the metal.

b. A paddle or straight-edge. See STRICKLE.

4. (*Metal-working.*) A puddler's stirrer. A *rabble.*

5. (*Flax-working.*) A handful of flax that may be *struck* at once.

6. (*Sugar-making.*) The quantity of sirup, the contents of the last-pan, emptied at once into the coolers.

7. An iron pale or standard in a gate or fence.

8. (*Mining.*) *a.* The prolongation or extension of a stratum in a direction at right angles to the *dip.* The strike is also called the *line of bearing.* If a stratum *dip* to the N., the *strike* is E. and W.

Of the horizontal *drifts* of a mine, one set follows the strike of the vein and the other is at right angles to it. The former are for working the vein, the latter for removing the ore and draining the mine.

b. The intersection of a vein with the surface. The place where the vein *crops out.*

Strike-or-si'lent. (*Horology.*) A piece in a clock which sets the striking parts in or out of action. In the latter case, it pushes the warning piece clear of the pin in the hour-wheel, so that the latter, the prime agent in the striking, is allowed to revolve without setting in motion the train of parts which affect and regulate the striking.

In the *strike* position, the pin on the hour-wheel is effective in moving the warning-piece, so that the clock strikes the hour regulated by the *snail.*

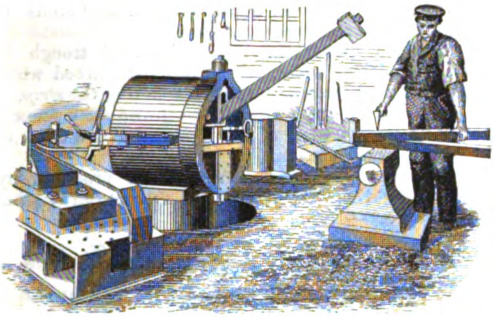
Strik'er. 1. (*Forging.*) A species of steam-hammer, striking in a manner similar to the trip-hammer, but operated directly from the engine, the cam-wheel being dispensed with. It may be adjusted to strike either vertically, or horizontally, or at any angle, and is designed as a substitute for the blacksmith's assistant, known as the *striker,* on heavy work.

Fig. 5997. Position for vertical blows.

Fig. 5998. *a* shows it in position for *upsetting*, delivering horizontal blows.

b. Position for blows at an angle of 45°, for bending angle-iron and T-stiffeners.

Fig. 5997.

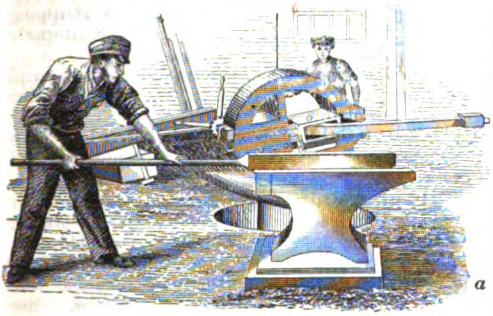


Striker.

The operator can regulate the force, direction, or rapidity of blows by actuating a foot-valve projecting through the floor, near the anvil. They can be arranged for working by compressed air or water-pressure, but are usually worked by steam.

2. A hardened mold or former upon which a softened steel block is struck, to receive a concave

Fig. 5998.



Davies's Striker.

impression from the *striker*. *Swages* are made in this way, the two portions receiving their grooves from a striker between them. See SWAGE.

3. A harpoon.

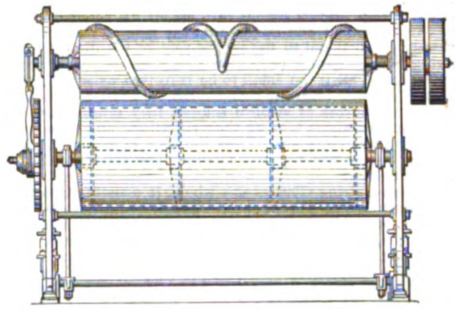
Strik'ing. 1. (*Architecture.*) The removal of a center upon which an arch has been built. It is done by striking the wedges on which the ribs rest. See CENTERING.

2. (*Joinery.*) Running a molding with a molding-plane.

Strik'ing-knife. When hides are taken from the last pit of tanning-liquor they are washed and dripped, being occasionally placed upon a long cylindrical horse and *struck* or smoothed with a triangular steel knife, which brings a bloom to the surface.

Strik'ing-ma-chine'. 1. (*Leather.*) One for

Fig. 5999.



Striking-Machine for Scraping Hides.

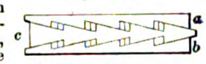
scraping hides. The hide, being laid upon the lower of two rollers, is gradually allowed to pass beneath the upper roller, which carries a sharp-edged spiral knife. The lower roller, being supported on springs, maintains a uniform but yielding pressure, and adapts itself to the varying thickness of the hide, the knife in the mean time scraping out the *bloom* on the hide.

2. (*Metal-working.*) A machine for stamping metals. See STRIKING-UP PRESS.

Strik'ing-plate. (*Carpentry.*) The device by which the wooden centering of an arch is lowered when the arch is completed.

The upper plate *a*, notched on the lower side, serves as a base for the framing of the center, and the lower plate *b*, notched on the upper side, rests on the pier or posts which support the whole. The two are separated by the compound wedge *c*, which is secured by keys. When these keys are driven out, the wedge *c* is free to slide backward, allowing the plate *a* and superposed framing to descend, leaving the voussoirs unsupported.

Fig. 6000.



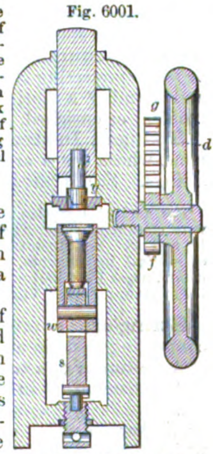
Striking Plates and Wedges.

Strik'ing-up Press. (*Sheet-metal Working.*) A press for *striking-up* or *raising* sheet-metal in making dishes, pots, pans, cups, etc. See also DROP-PRESS.

In that illustrated, the disk to be shaped is laid on the upper face of the hollow die *w*, the upward movement of which clamps it against the collar *y*, while the cameo-die a^2 descends and forms the object, which is afterward ejected from the matrix by a follower. The movements of both dies are derived from a rocking cam *s*, actuated from the fly-wheel *d* through gears *f g*.

See STAMPING-MACHINE.

Fig. 6001.



Striking-Machine for Metals.

Strik'ing-watch. One which indicates the time of day either automatically or in response to the pushing in of a knob. A REPEATER.

The watches of the time of Charles V. and Louis XI. had striking arrangements, and on two occasions mentioned in the chronicles of the times, thieves with the booty on their persons were detected by the striking of the watches.

String. 1. A cord of small diameter.

2. (*Music.*) The cord of fiber or metal whose vibrations produce the notes in instruments of the stringed class. See MUSICAL INSTRUMENTS.

"The following four laws govern the vibration of strings: The rate of vibration is inversely proportional to the length; it is inversely proportional to the diameter; it is directly propor-

tional to the square root of the stretching weight or tension; and it is inversely proportional to the square root of the density of the string. When strings of different diameters and densities are compared, the law is, that the rate of vibration is inversely proportional to the square root of the diameter of the string. The amount of motion communicated by a vibrating string to the air is too small to be perceived as sound, even at a small distance from the string. Hence, when strings are employed as sources of musical sounds, they must be associated with surfaces which take up their vibrations, and transfer them to the surrounding air. Thus the tone of a harp, a piano, a guitar, or a violin depends mainly upon the sound-board of the instrument.

"When a string vibrates as a whole, it usually divides at the same time into its aliquot parts. Smaller vibrations are superposed upon the larger, the tones corresponding to the smaller vibrations, which are known as overtones, mingling at the same time with the fundamental note of the string. It is the addition of such overtones in different proportions to fundamental tones of the same pitch, which enables the listener to distinguish the sound of a clarinet from that of a flute, and the sound of a violin from both. Could the pure fundamental tones of these instruments be detached, they would be undistinguishable from each other; but the different admixture of overtones in the different instruments renders their *timbres* diverse, and therefore distinguishable. When a stretched string is plucked aside, or agitated by a bow, all the overtones which require the point agitated for a node vanish from the clang of the string. The point struck by the hammer of a piano is from one seventh to one ninth of the length of the string from its end; by striking this point, the notes which require it as a node cannot be produced, a source of dissonance being thus avoided." — TYNDALL.

Pythagoras appears to have understood the relation of musical intervals, and is said to have stretched musical strings of equal lengths by weights having such proportion as to produce fourths, fifths, and octaves.

2. (*Mining.*) A small vein of ore, divaricating from the main vein and passing off into the rock. Still smaller veins are called threads.

3. (*Shipwrighting.*) The uppermost row of planks in a ship's ceiling, or that between the upper edge of the upper deck-ports and the gunwale.

4. A projecting course of bricks or stones in a wall. A *string-course.*

String-block. (*Music.*) A block in the wooden-frame piano-forte into which were driven the studs upon which the strings were looped.

It is now superseded by a *string-plate,* which has the same function, but has the advantage of metallic rigidity, as a consequence of which the strings remain longer in tune.

String-board. (*Carpentry.*) One of the slanting pieces of stairs into which the steps are notched.

String-course. (*Masonry.*) A course of brick or stone projecting slightly from the face of the wall and forming a horizontal line. It may be flat, molded, or enriched.

Stringed In'stru-ment. (*Music.*) An instrument whose tones are produced by the vibration of strings. See MUSICAL INSTRUMENTS.

The ancient Egyptian *harps* had 4, 6, 7, to 22 strings, and were elegantly made. Their *guitar* had 3 strings; *lyres*, 5, 7, 10, and 18. See MUSICAL INSTRUMENTS, pages 1499, 1500; list of musical instruments, page 1501; classification of instruments, pages 1500, 1501; table of compass of instruments, page 1498; HARP; PIANO; VIOLIN; etc.

String'er. 1. (*Carpentry.*) A horizontal timber connecting posts in a frame; as, —

A tie-timber of a truss bridge.

A horizontal tie in a floor framing.

2. (*Railway Engineering.*) A longitudinal balk or timber on which a railway rail is fastened, and which rests on transverse sleepers.

3. (*Shipwrighting.*) An inside strake of plank or of plates, secured to the ribs and supporting the ends of the beams. A *shelf-piece.*

String-piece. (*Carpentry.*) *a.* A horizontal connecting strip or plank of a frame.

b. The timber beneath a staircase which forms the soffit or ceiling.

c. A timber in a floor framing.

String-plate. (*Music.*) An iron bar in a piano-forte frame into which are inserted the studs to which the strings are secured.

Strip. 1. (*Mining.*) An inclined trough in which ores are separated by being disturbed while covered by a stream of water descending the *strip.*

2. (*Machinery.*) To tear the thread off a screw.

3. A narrow piece of board nailed over a crack or joint between planks.

Stripe. (*Weaving.*) A pattern produced by arranging the warp-threads in sets of alternating colors; or, —

In sets of varying fineness, of the same color; or,

By drawing bunches of warp-threads through the eyes of some of the heddles; or,

By passing several heddlesful through the same intervals of the reed.

A *weft* stripe crossing the warp stripe constitutes a *check* pattern.

Strip'per. 1. See FILE-STRIPPER.

2. (*Carding.*) A device for lifting the top flats from the carding-cylinder.

Strip'ping. 1. (*Carding.*) The operation of cleaning or removing the short fibers from between the teeth of the various cylinders and top flats.

Some machines are self-stripping; every other flat being moved in one motion of the stripping mechanism, the second motion taking the alternate flats.

2. (*File-making.*) The process of cross-filing and then draw-filing file blanks to prepare them for grinding or cutting.

3. Removing the *wings* of the tobacco leaf from the stems. The *wings* are piled and pressed, and form a *book.*

Strip'ping-knife. (*Husbandry.*) A tool for removing the blades of sorghum from the stalks, previous to grinding. See Fig. 1062, page 444.

Strob'o-scope. A toy depending for its effects upon the persistence of visual impressions, like the *thaumatrope* and *anorthoscope; zoetrope.* See PHENAKISTOSCOPE.

Strock'le. (*Glass-making.*) A shovel for frit, sand, etc. It has turned-up edges to increase its holding capacity.

Stroke. 1. The length of rectilinear motion of a piston, pump-rod, plunger, etc.

With a stationary engine, the motion of the piston-rod outward is the *front* stroke, the reverse is the *back* stroke. The *up* and *down* result from the position of the cylinder.

With a locomotive the *front* stroke is toward the *front* of the engine, and conversely.

The *stroke* of a valve is called its *travel* or *throw.*

The *throw* of a crank is the diameter of its circle of revolution; twice its radius.

The term *excursion* is applied in some cases; in others, the term *range.*

Strong-sand. (*Founding.*) That which contains a large quantity of clay, and is therefore tenacious.

Stron'ti-um. Equivalent, 44; symbol, Sr.; specific gravity, 2.54. This is a white, malleable metal, of but little importance in a mechanical point of view, but its salts are used in pyrotechnics to give a red glare.

Strop. 1. (*Rope-making.*) A rope with an eye at each end, used in twisting strands.

2. (*Nautical.*) A rope spliced into a circular wreath to seize around a block for hanging it.

3. Another name for strap, as *razor-strop.*

Stroud. (*Fabric.*) A coarse blanket-stuff, used in trading with the Indians.

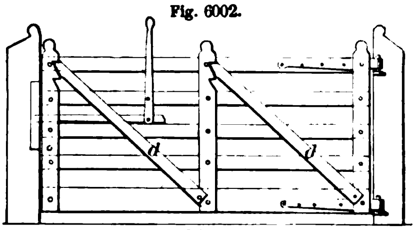
Strun'tain. (*Fabric.*) A coarse, narrow worsted braid.

Struse. (*Nautical.*) A river-craft of Russia for carrying produce and goods.

Strut. A bar in a frame having equal and opposite forces applied to its ends, acting inward and producing upon it a state of compression. A *tie* is a bar differently applied, its function being tensile. A bar applied to a strut to prevent lateral deviation is a *stay*. See TRUSS; ROOF; etc.

Specifically. *a.* A diagonal timber which acts as a post or brace to support a *principal rafter* or *purlin*. Its lower end is stepped into a *tie-beam*, or on a shoulder of a *king* or *queen post*. See KING-POST TRUSS.

Fig. 6002.



Gate with Diagonal Struts.

d d, in Fig. 6002, show struts to prevent the sagging of the gate.

b. Braces between joists. See STRUTTING.

Strut'ting. (*Carpentry.*) Diagonal braces between joists to prevent side deflection. See CHIMNEY.

When the pieces are crossed alternately, it is called *herring-bone strutting.*

Stub. 1. An old horseshoe nail. Iron formed therefrom. *Stub-iron.*

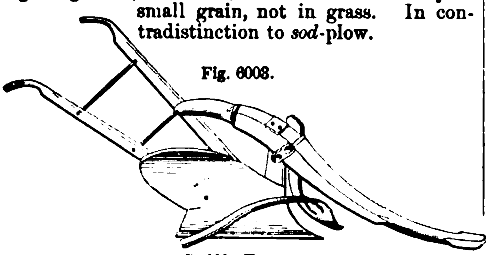
Stub-iron is used especially for gun-barrels of superior quality. The stubs are put into a tumbling-box to brighten them, removing all rust and dirt. They are then combined with from 12 to 50 per cent of steel in blocks of the same size as the *stubs*. The combined metals are puddled, hammered, heated, tilted, and rolled into ribbons, to be wound in coils around mandrels, heated to a welding heat, *jumped*, and finished by a hammer on the anvil. See GUN-BARREL; TWIST.

2. (*Locksmithing.*) A stationary stud in a lock which acts as a detent for the tumblers when their slots are in engagement therewith.

Stub-ax'le. A short axle attached on the end of a principal axle-tree. It is variously made and secured. Sometimes it is a sort of *jury* axle, made as a temporary expedient when the arm of an axle has broken off. It occurs frequently on horse hay-rakes and some other kinds of agricultural implements.

Stub'ble-plow. (*Husbandry.*) One for plowing *old* ground, so called; land which was lately in small grain, not in grass. In contradistinction to *sod*-plow.

Fig. 6003.



Stubble-Turner.

Stub'ble-rake. (*Husbandry.*) A rake for gleaning lately reaped fields of small grain; wheat, rye, oats, or barley.

Stub'ble-turn'er. An attachment to a plow to turn over stubble and trash before the principal plow reaches it. In the example, the stubble-turner is attached to the point of the coulter and curves over in front of the mold-board.

Stub-end. (*Machinery.*) The enlarged end of a connecting-rod, in which the boxes are confined by the strap.

Stub-mor'tise. (*Carpentry.*) A mortise which does not pass through the object in which it is made; not a *through* mortise.

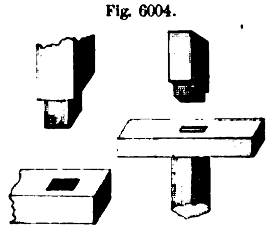
Stub-nail. A short thick nail.

Stub-short; Stub-shot. 1. The unsawed portion of a plank where it is split from the bolt or log. The saw-kerf reaches nearly to the end of the log, in *gig-back* saws; the plank is then split off the remainder of the distance: this remainder forms a short *stub*.

2. (*Turning.*) The portion by which an object to be turned is grasped or chucked. It projects beyond the ultimate surface of the object, and is cut off when the shaping is finished.

Stub-ten'on. (*Carpentry.*) A short tenon at the foot of an upright, such as the scantling or studding of a partition or a floor-bearer.

Fig. 6004.



Stub-Tenon.

Stub-twist. A gun-barrel made of a ribbon of combined iron and steel, the iron being derived from stubs (old horse-shoe nails.) See STUB.

Stuc'co. (*Plastering.*) *a.* Plaster for coating walls. It is usually made of pure lime slaked and settled, mixed with clean sand.

Stucco varies in quality and composition with the purpose for which it is intended. Gypsum and pounded marble sometimes enter into its composition, as well as gelatine or glue in solution.

One recipe gives 3 to 4 volumes of white sand, and 1 volume of fine stuff or lime putty.

b. The third coat of plastering when prepared for painting.

Troweled stucco is of the best description.
Bastard is a coarser kind.
Rough stucco is the coarsest kind prepared for painting.

Stück-fur'nace. (*Metallurgy.*)

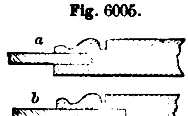
The stück furnace or Wolf's oven is a furnace for the reduction of iron, at one time common in Europe, now little employed. The interior of this furnace has the form of two cones united at their bases: it is usually from 10 to 16 feet high, 24 inches wide at bottom and top, and 5 feet at the center. There are generally two tuyeres, both on the same side. The opening called the breast is closed after the furnace is heated, after which charcoal and ore are thrown in, and the blast introduced. As soon as the ore passes the tuyere, iron is deposited at the bottom of the hearth; when this amounts to a ton, the blast is stopped, the breast-wall removed, and the metal lifted out in a solid mass, or *stuck*, *wulf*, as it is called by the Germans.

Stuck-on. (*Carpentry.*) A term indicating a molding worked on the edge of a frame; in contradistinction to one worked out of a detached strip.

a, *stuck-on.*
b, *laid-on.*

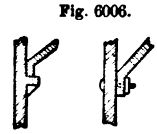
The operation of shaving down the arris is called *sticking*, *striking*, or *running* the molding.

Fig. 6005.



Stuck-On.

Fig. 6006.



Studs.

Stud. 1. (*Machinery.*) A boss or protuberance designed to hold an attached object in place.

2. (*Carpentry.*) An upright scantling.

3. (*Wear.*) A button with a shank and disk.

4. A nail with a large head.

5. (*Nautical.*) A cast-iron brace across the minor diameter of a cable link, to prevent collapse.

Stud'ding-sail. (*Nautical.*) An additional sail spread by the aid of light booms beyond the *leech* of a square sail; in order to extend the area horizontally, in light winds. They may be added on both leeches of a square sail.

The prolongation of the yard by which a *studding-sail* is extended is a *studding-sail boom*, which is supported by hoops on the yard called *quarter-irons* and *yard-arm irons*. See YARD.

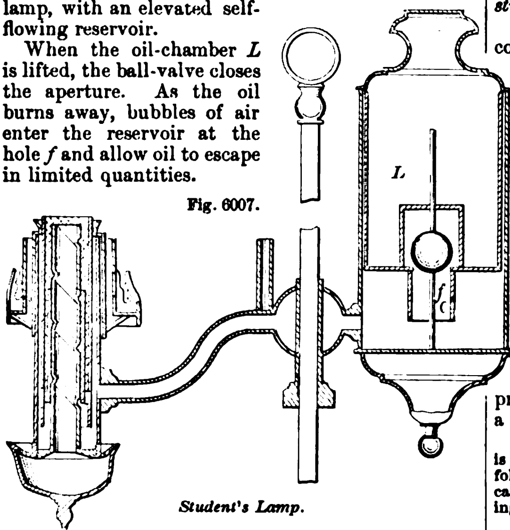
It is *rigged-out* by a *twofold purchase* called a *boom-jigger*.

Stud'ding-sail Yard. A spar rigged out from the end of a yard, to stretch a studding-sail.

Stu'dent's Lamp. A form of argand-burner lamp, with an elevated self-flowing reservoir.

When the oil-chamber *L* is lifted, the ball-valve closes the aperture. As the oil burns away, bubbles of air enter the reservoir at the hole *f* and allow oil to escape in limited quantities.

Fig. 6007.



Student's Lamp.

Stud-work. (*Building.*) Brickwork between studs. An old form of building once common in England and lately introduced into the United States by admirers of the ancient and picturesque.

Stuff. 1. (*Nautical.*) A melted mass of turpentine, tallow, etc., with which the masts, sides, and bottom of a ship are smeared.

2. (*Paper.*) Paper-stock, ground ready for use. When half ground it is known as *half-stuff*.

3. (*Fabric.*) An all-wool plain dress-goods for ladies.

4. (*Mining.*) Attle or rubbish.

5. (*Leather.*) A composition of fish-oil and tallow for filling the pores of leather. *Dubbing.*

Stuff-chest. (*Paper-making.*) The vat where the pulps from the engines are mixed and combined preparatory to molding by hand or machinery.

Stuff-en'gine. (*Paper-making.*) A pulp-grinder. See Figs. 4015 – 4020.

Stuff'er. A machine for packing or filling; as,

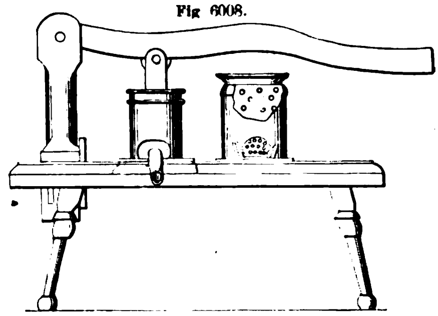
1. A machine for stuffing horse-collars.

2. A SAUSAGE-STUFFER (which see). In Fig. 6008, the sausage-reservoir is fixed to a block let into a recess of the table, so that it can be easily slipped out and the lard-vessel be substituted in its place.

3. A machine for saturating leather with *dubbing* in one part of the operation of leather-dressing.

Stuff'ing. 1. (*Leather.*) A mixture of fish-oil and tallow which is rubbed into leather after being

Fig. 6008.



Sausage-Stuffer and Lard-Press.

shaved by the currier's knife, and previous to the *boarding* or *graining*. The tool used is called a *stuffer*.

2. (*Fiber.*) Filling for cushions and mattresses, consisting of cotton, flocking, hair, wool, cork, sponge, hay, straw, tow, flax, moss, curled shreds of wood (*Excelsior*), etc.

Stuff'ing-box. (*Machinery.*) *a.* A box with an annular recess around a piston-rod, and provided with a follower and bolts, whereby the packing may be screwed down.

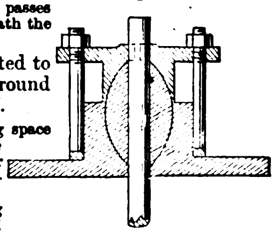
The invention of Sir Samuel Morland, an experimenter who lived in the interval between Newcomen and Watt, 1710 – 1761.

Two notable instances are: —

Around the piston-rod where it passes through the cylinder-cover; and

Around the screw-shaft of a steam-vessel where it passes through the stern beneath the water.

Fig. 6009.



Metallic Packing for Piston-Rods.

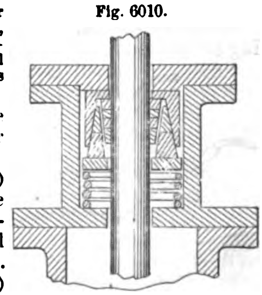
b. A sleeve adapted to press a collar of hemp around a piston-rod. A *gland*.

In Fig. 6009, the packing space is made elliptical, and the follower is perforated for casting in soft alloy as packing.

In Fig. 6010, a spring presses against the conical follower and drives the packing-rings against the piston.

The stuffing-boxes in a locomotive-engine are recesses for admitting some soft material, such as white spun-yarn, to render steam-tight any rod working through this stuffing or packing. The piston-rods, slide-valve rods, regulator-rods, and pump-plunger, all work through stuffing-boxes of this description.

Fig. 6010.



Piston-Rod Packing.

Stuff-shov'el. The paper-maker's shovel for handling materials.

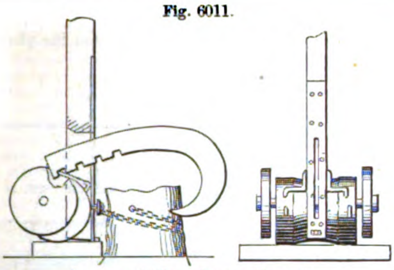
Stull. (*Mining.*) Timber placed in the back of a level and covered with boards or small poles to support rubbish.

Stump. 1. (*Locks.*) A projection, generally stationary, variously employed as a support for a dog, fence, or tumbler, as an obstruction to prevent the improper retraction of the bolt, or as a guide for any of the moving parts.

2. An artist's soft rubber, for blending or scumbling.

Stump-ex-tract'or. 1. (*Agriculture.*) A tool or machine for pulling the stumps of trees from the ground, in order to remove them from interference with cultivation.

Fig. 6011.



Lever and Claw Stump-Extractor.

There are many varieties, of which six may be mentioned as typical: —

1. The *lever and claw*. In the example of this, the lever is mounted on strong wheels, which act as a fulcrum for the lever. The claw is caught over the stump, in manner of a cant-hook, and the pulling over of the lever by a rope and team tips the stump over and lifts it free of the ground.

2. *Tackle*. This is mounted on a frame erected over the stump. The hitch is shortened or lengthened by means of the bar *c*. The team is hitched to the fall of the rope.

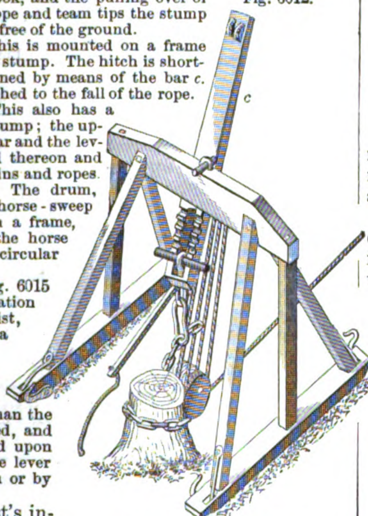
3. *Toggle*. This also has a frame over the stump; the upright hoisting-bar and the levers are arranged thereon and operated by chains and ropes.

4. *Windlass*. The drum, gearing, and horse-sweep are arranged on a frame, around which the horse walks in a circular path.

5. *Screw*. Fig. 6015 shows an application of a screw hoist, mounted on a wagon.

6. *Capstan*. The capstan is anchored to a firmer stump than the one to be pulled, and the chain wound upon the barrel as the lever revolves by team or by hand.

Fig. 6012.



Tackle Stump-Extractor.

2. A dentist's instrument for removing the stumps and roots of decayed teeth. They are of various forms.

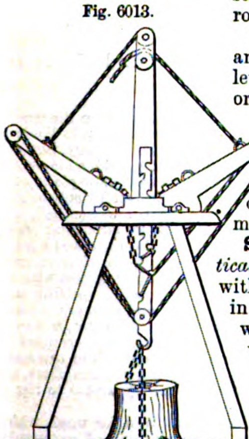
The *screw* is driven into the nerve cavity, and serves to withdraw the root.

Other tools are *gouges* and *elevators*, which act as levers to pry out the stump or root.

The *hook* is another form.

The *punch* operates, as its name indicates, by the blow of a mallet.

Fig. 6013.



Toggle Stump-Extractor.

Stump-mast. (*Nautical.*) A lower mast without tops. Common in those steam-vessels which never depend wholly upon sails.

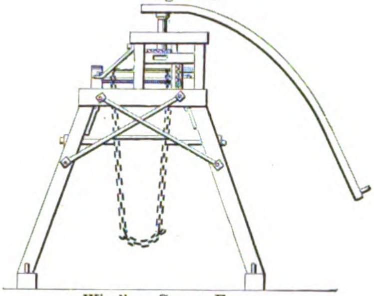
Stu'pa. (*Surgical.*) Tow used as a pledget, compress, or as a wad in fomentations.

Style. 1. (*Architecture.*) A name by which the more modern systems of architecture are known, in contradistinction to the Grecian and Roman *orders*.

2. A hard point for tracing, in manifold writing. See Pen.

3. The gnomon of a sun-dial.

Fig. 6014.



Windlass Stump-Extractor.

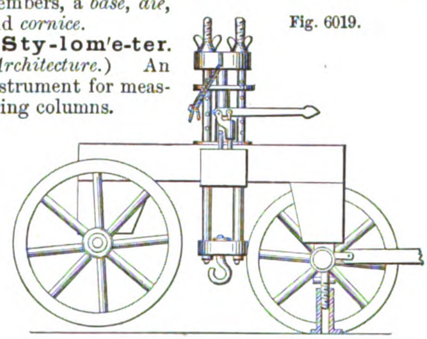
Sty'let; Sty'lus. 1. A *probe*.

2. A pencil or marker.

Sty'lo-bate. (*Architecture.*) A continuous basement beneath a row of columns or façades. It has 3 members, a *base*, *die*, and *cornice*.

Sty-lom'e-ter. (*Architecture.*) An instrument for measuring columns.

Fig. 6019.



Screw Stump-Extractor.

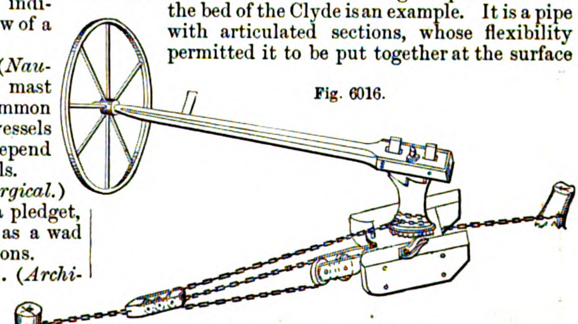
Stythe. (*Mining.*) Choke-damp, or carbonic-acid gas.

Sub. (*Well-boring.*) A short name for *substitute*. A short section of rod for connecting tools or bars of different sizes. See Well-boring Tools.

Sub-a'que-ous Hel'met. A diver's head-dress, supplied with air by pump from above. See Armor, Submarine, pages 155–157; Diving-bell, pages 713–715; Respirator, page 1923.

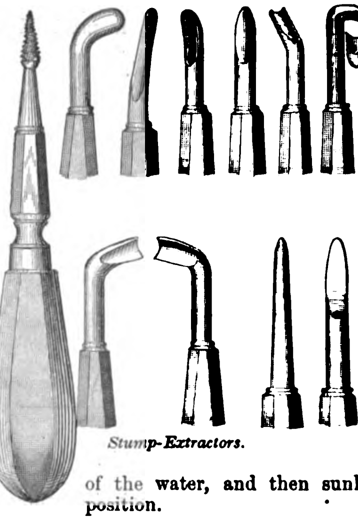
Sub-a'que-ous Tube. A pipe or tunnel (according to size) laid beneath the water as an aqueduct or viaduct. James Watt's submerged aqueduct across the bed of the Clyde is an example. It is a pipe with articulated sections, whose flexibility permitted it to be put together at the surface

Fig. 6016.



Capstan Stump-Extractor.

Fig. 6017.

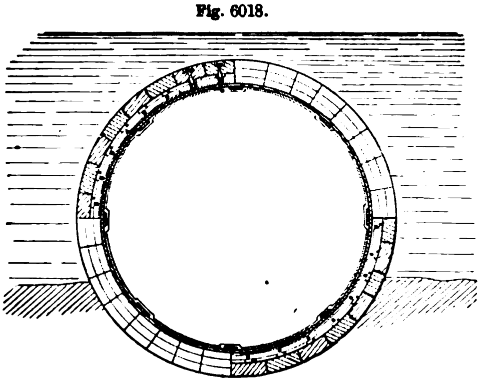


Stump-Extractors.

of the water, and then sunk into position.

Fig. 6018 shows a submerged tube whose outer casing of cement in form of blocks is attached by bolts, whose forked ends are riveted to rings of angle-iron surrounding the metallic part

Fig. 6018.



Subaqueous Tube.

of the tube. The blocks are connected together by tongues and grooves.

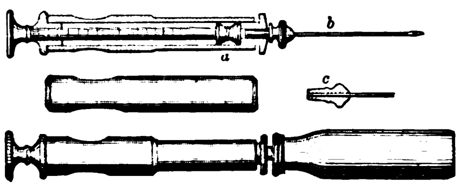
Sub-cal'i-ber Pro-jec'tile. (*Ordnance.*) A projectile for cannon or small-arms, of smaller diameter than the bore of the gun from which it is fired, but having a sabot large enough to fill the bore, allowing the usual windage; or with an expanding sabot, which is forced out so as to fill the bore when the gun is fired.

Sub'cu-ta'ne-ous Saw. A saw by which bony sections may be made without large incisions in the flesh. It may be compared to a probe, a portion of whose length, at and toward the end, is flattened and serrated, so that being driven in to the seat of its operations, it is reciprocated, so as to cut the bone without mangling the flesh to any serious extent.

Sub'cu-ta'ne-ous Syr'inge. (*Medical.*) An instrument for injecting medicinal solutions beneath the skin. It consists essentially of a tube with a piston for containing the preparation, and a perforated needle for piercing the skin, and through which the fluid is injected. Also called a *dermopathic syringe.*

Fig. 6019 is an improved form by Leiter of Vienna. In this, the lower end of the tube *a* is conically enlarged, for the more ready introduction of the lancet or needle *b* and the plug *c*, by

Fig. 6019.



Subcutaneous Syringe.

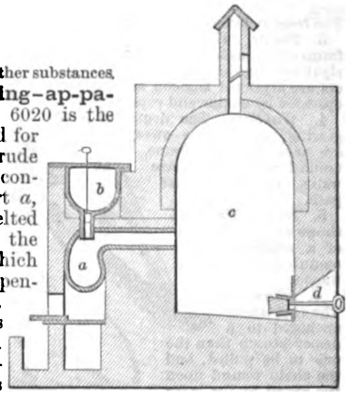
which it is secured in the tube. The piston-handle is graduated, that a definite amount of fluid may be drawn into the tube. See HYPODERMIC SYRINGE; ACUPUNCTURATOR.

Sub-li-ma'tion. A heating process by which solids are converted into vapor and again condensed, often in the crystalline form.

This process is adopted with

Mercury,
Zinc,
Arsenic,
Sulphur, and other substances.

Fig. 6020.



Sulphur-Sublimator.

Sub-lim'ing-ap-pa-ra'tus. Fig. 6020 is the apparatus used for purifying crude sulphur. This consists of a retort *a*, filled with melted sulphur from the reservoir *b*, which has a valved opening at bottom. The retort is heated by a furnace beneath, and as the sulphur is vaporized it passes over into the chamber *c*, where it condenses in the form of flowers of sulphur. After a few days' working, the walls of the chamber become sufficiently hot to fuse these as they condense, and the sulphur is then withdrawn from time to time through the plugged opening *d* and run into molds. See also ARSENIC-FURNACE, Fig. 373, page 162; CONDENSER, Fig. 1420, page 608.

Sub'ma-rine' Ap-pa-ra'tus. A device to enable persons to work under water.

The diving-bell is said to have been used among the Greeks in the time of Aristotle. It was first introduced into Western Europe near the beginning of the sixteenth century, but was not made practically available for use at considerable depths until Dr. Halley, in 1715, invented the method of displacing the water which entered the lower part of the bell by submerging casks containing air to a level a little below the bell, and discharging the air from them into it by admitting water at their bottoms by means of cocks. He also contrived a head-piece, open at the lower part, which enabled a diver to leave the bell and make explorations outside, being supplied with air through a flexible tube leading into the bell. Spalding subsequently divided the bell into an upper and a lower chamber, the former to be wholly or partially filled with water, and serving to regulate the buoyancy, while the latter was occupied by the divers. By admitting air from the barrels into the lower chamber and opening a cock connecting the two chambers, the upper could be filled with air, causing the apparatus to rise to the surface.

About 1788 Smeaton substituted cast-iron for wood, which had been previously used, made the machine of rectangular form, increased its capacity, and employed a forcing-pump for supplying it with air. See DIVING-BELL.

Submarine armor was successfully used by Klingert of Breslau, in 1798. His diving-dress consisted of a metallic cylinder with a hemispherical top for covering the head, a metallic cyl-

inder and a leathern jacket for protecting the trunk, and leathern sleeves and drawers covering the arms to the elbows and the legs to the knees. The head-piece had glazed apertures enabling the diver to see beneath the water, and pipes for breathing supplied by an air-reservoir which was sunk with him.

Tonkin's apparatus, used in Britain at the commencement of the present century, was a suit of complete metallic armor, covering the whole body except the arms, and surrounded by an exterior dress of leather. Air was supplied by an elastic tube from a compressed air-vessel at the surface.

An apparatus exhibited by the New York Submarine Company at the Paris Exposition of 1867 consists of a strong helmet of metal cushioned on the interior, and having a plate-glass window in front, and a water-proof dress entirely enveloping the person. This is weighted sufficiently to sink and enable the diver to stand firmly on the bottom. An air-reservoir is fastened upon his back, containing a supply of compressed air sufficient for several hours; this is conducted to the interior of the dress by a pipe provided with a cut-off valve under the diver's control. A cock on top of the helmet permits the discharge of the foul air from time to time. In order to prevent the dress collapsing against the person at considerable depths, is an inside protector, formed of a series of rings or ribs surrounding the person and lower extremities. See ARMOR, SUBMARINE. See also SUBMARINE BLASTING.

Secured beneath the diver's arms are a pair of water-tight sacks, which may be inflated from the reservoir at his back when he desires to rise to the surface. See also RESPIRATOR, Fig. 4272, page 1923.

Sub'ma-rine' Bat'ter-y. (*Vessel.*) A vessel capable of being submerged and maintained at a given depth below the surface of the water, and provided with means for penetrating the hull of an enemy's ship below the water line or of blowing her up, — usually a torpedo arrangement, which may be detached from the battery and attached to the bottom of the ship. The first practical development of the idea appears to be due to Bushnell during the War of the Revolution. Fulton afterward made various experiments on the subject.

Rockets of large size, guided by a tube projecting from the vessel, have been tried, but without very flattering prospects of success. See SUBMARINE BOAT; SUBMARINE GUN; TORPEDO.

Sub'ma-rine' Blast'ing. (*Hydraulic Engineering.*) A means for the removal of submerged rocks, shoals, sunken vessels, or other impediments to navigation.

The first effort in this direction was probably that of Colonel Pasley, about 1841, in blowing up the wreck of the "Royal George," sunk at Spithead, England, in 1782.

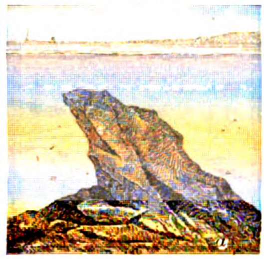
Fig. 6021 illustrates some of the operations for the removal of the submarine obstacles to navigation which formerly rendered that part of the East River known as Hellgate so dangerous to navigation in Long Island Sound. The principal of these were Pot Rock, on which the British frigate "Hussar" was wrecked at the close of the Revolutionary War, occasioning the loss of many lives and a large amount of treasure; Drake Rock; Holmes' Rock; the Frying Pan; and Way's Reef. These rocks were the cause of great injury to commerce, but though repeated surveys had been made and plans for their removal proposed, nothing was accomplished until the work was undertaken by Maillefert in 1851. Under an agreement with the New York Chamber of Commerce, this engineer undertook to remove Pot Rock, the Frying Pan, and Way's Reef for the sum of $ 15,000.

The first of these, shown in profile at *a*, was, at its highest part, but 8 feet below low-water level, and stretched across the strait, broadside to the current, for 130 feet, over which was an average depth of 10 feet water; the tide, setting through at the rate of 5 to 8 miles an hour, caused a fearful series of eddies and whirlpools among these rocks. At a short distance on either side, soundings of 50 to 75 feet are obtained. Owing to the strength and irregularities of the currents, boring was almost impossible, and the only time at which blasts could be effected was at slack water following flood or ebb tides.

M. Maillefert consequently applied his blasting charges, inclosed in water-proof cases, directly to the face of the rock, relying on the pressure of the body of water above to resist the expansion of the ignited powder sufficiently to cause it to shatter the stony stratum beneath.

The first blast was made August 19, 1851, and was perfectly successful, knocking off about 4 feet from the highest projecting pinnacle of Pot Rock. Operations were continued on this and other obstructions until March 26, 1852, when three men were killed by an explosion under the boat, owing to a misplacement of the battery connections. During this period 284 charges, containing in all 34,231 pounds of powder were exploded on Pot Rock, reducing its level to 18 feet below low-water mark; and 240 charges, containing nearly 27,926 pounds, on Way's Reef and the Frying Pan, by which they were considerably lowered. Shell Drake was increased in depth from 8 to 17 feet by the explosion of 6 charges of 125 pounds each upon it; and Bald-Headed Billy, a formidable isolated rock, dry at low water, was dislodged by a single blast, afterward drilled and split and the two parts grappled and removed. Two other small rocks were also destroyed. The total cost of these improvements was $ 13,000, a very small sum in view of the great improvements effected in the channel.

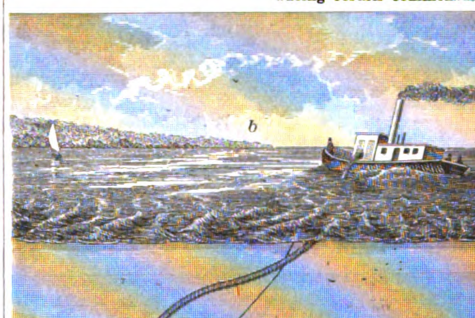
Fig. 6021.

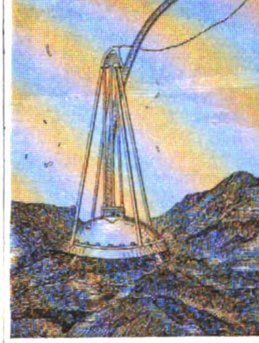


b. Mushroom-drill; a percussion drilling-apparatus, operated by steam from the tug employed as a tender.

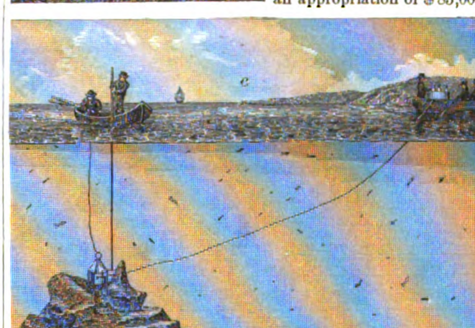
c shows the mode of applying a charge to the rock and firing it from an electro-magnetic battery at a distance.

In 1853, an appropriation of $ 20,000 was made by Congress for the improvement of the channel, which was expended without producing results commensurate with those previously attained. This, no doubt, was, in a large degree, owing to the fact that the shattering power of the charges when applied to a flat surface was far less than when employed in detaching projecting parts from a mass.



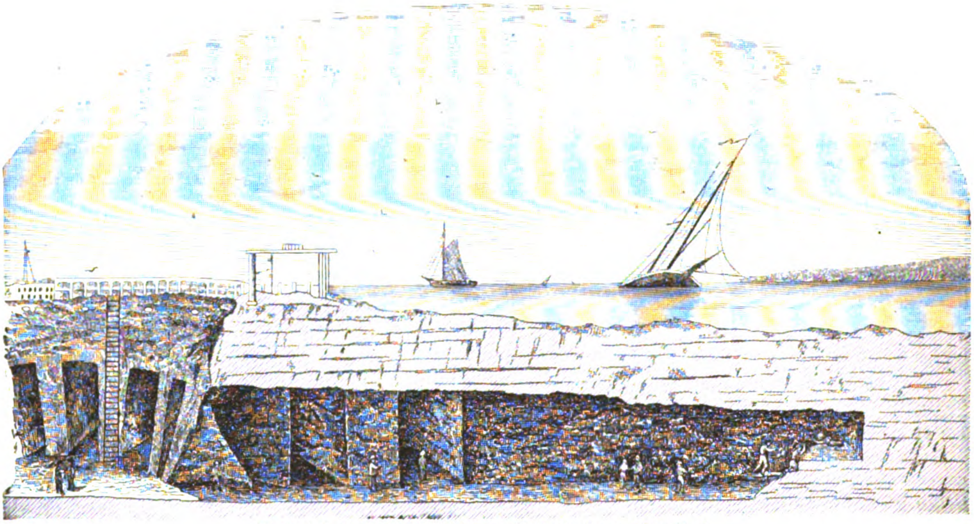


Little farther was done, notwithstanding the vast interests involved, until 1868. In the previous year, it was asserted, in a memorial to Congress, that the losses occasioned by the various obstructions in Hellgate amounted to from $1,500,000 to $2,000,000 a year. In 1868, an appropriation of $ 85,000 was made for their removal. Proposals for undertaking the work varied from $ 38,000 to $ 500,000, showing, notwithstanding the elaborate surveys previously made, that the bidders were entirely ignorant of what amount of work the requirements to be fulfilled might ultimately necessitate.



Submarine Blasting.

Fig. 6022.

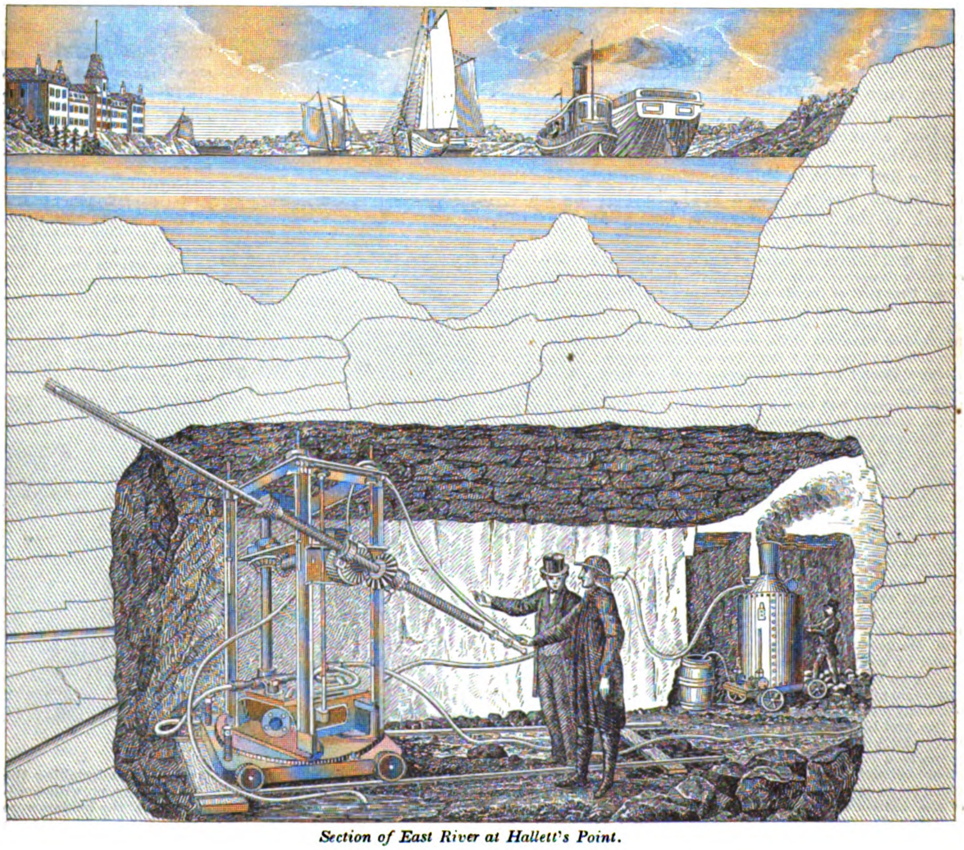


Vertical Section of Excavation at Hallett's Point, New York.

Mr. S. F. Shelburne of New York, being the lowest bidder, received the contract. He employed first a small diamond-drill, rotated by a turbine; but this proving ineffectual, a larger one, the "Mushroom," of similar construction, was substituted. Drills of this construction were, however, found inadequate to do the work in such an exposed locality; and finally a powerful striking-drill was employed with fair prospects of success, but was, however, unfortunately run down by vessels and destroyed before it was practicable to test its capabilities.

Plans had been suggested by the United States Engineer De-

Fig. 6023.



Section of East River at Hallett's Point.

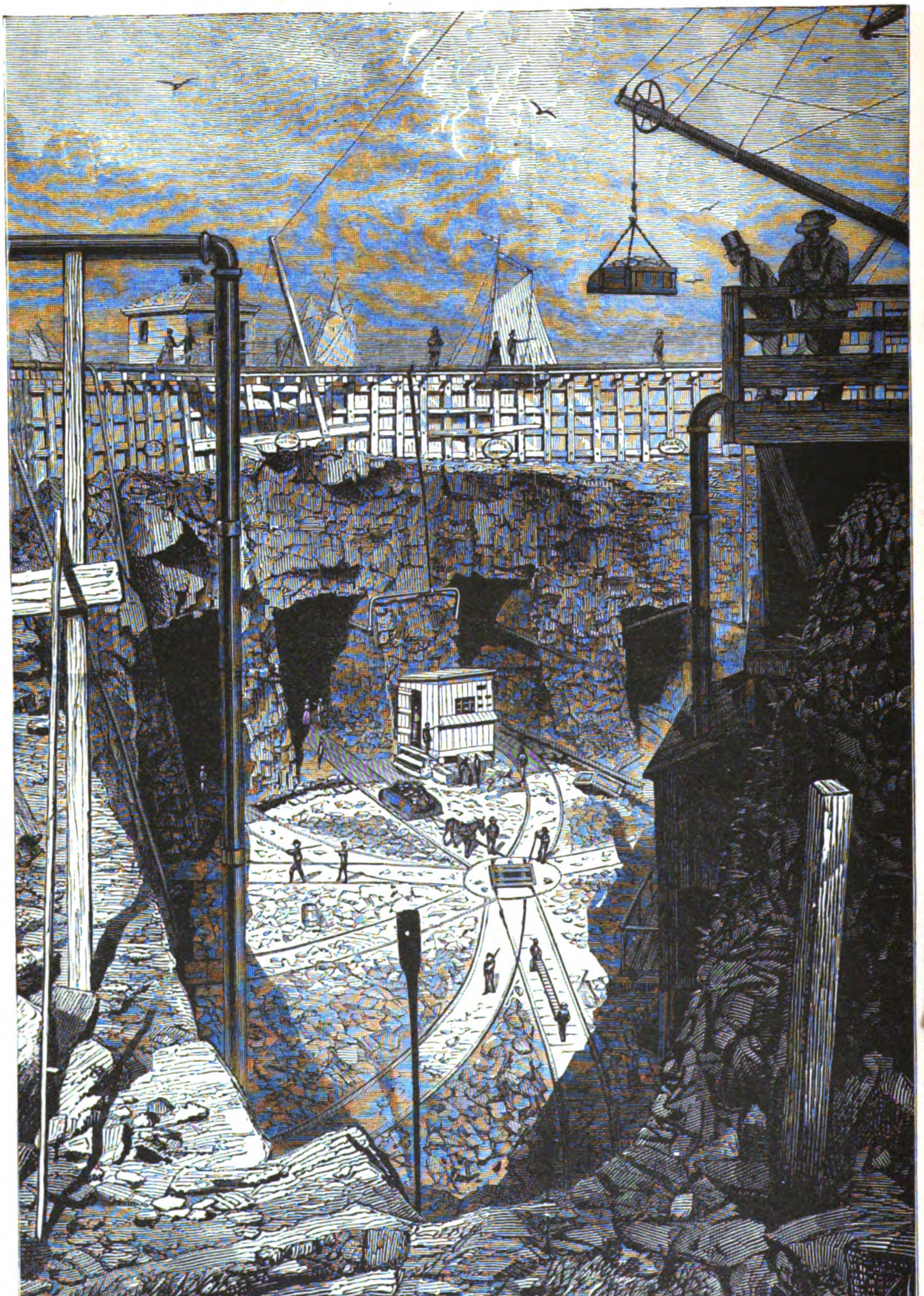


PLATE LXV. SUBMARINE EXCAVATIONS. See page 2437.

[illegible] outlay of from $2,000,000 [illegible] [illegible] at an [illegible] depth of 26 [illegible] the execution of these projects would [illegible] years.

[illegible] States Engineers, who had the gen[illegible] work, in 18[illegible], commenced operations [illegible] the ledge of rocks constituting Hallett's [illegible] stream, so as to throw the [illegible] For this purpose a coffer[illegible] heavy timbers bolted to the rock, and [illegible] was constructed, the water pumped [illegible] shafts, [illegible] extending [illegible] the intention [illegible] which [illegible] rock [illegible] afterward removed by grappling.

[illegible] longitudinal section of "Grant" [illegible] [illegible] of other tunnels are seen [illegible]

[illegible] of East River at Hallett's Point, and [illegible] showing also the steamboat [illegible]

[illegible] measure 2½ acres, and [illegible] length varying [illegible] from 12 to 16 feet. [illegible] and the water, and the [illegible] 26 feet deep at [illegible] heavy [illegible] rock and water [illegible] will be placed [illegible] and 10 pounds and [illegible] pipe filled with the [illegible]

Fig. 6[illegible]

Submarine Blast.

[illegible] during [illegible] vessels [illegible] the [illegible] breaking [illegible] greatly diminished. Previous to the explosion, the coffer-dam will be broken away and the water allowed to fill the entire excavation, so that it will serve as a tamping. Then, by means of [illegible] fuse, the [illegible] one in the [illegible] will be [illegible] which [illegible] the [illegible] up of [illegible] for [illegible] prehension [illegible] the result, it has been [illegible] [illegible] plosion of half the charges will be sufficient [illegible] cause it to fall to the sunken floor, [illegible] a greater depth, or necessitating [illegible] complete the work.

[illegible] blown off on the 4th of July, 187[illegible] [illegible] took for the purpose of record[illegible]

[illegible] Rock and other rock were been removed by dredging and blasting. Divers, equipped with submarine armor, descend to adjust the drills, insert the cartridges, etc.

The new operations at Flood Point will involve still greater cuttings than at Hallett's Point.

Fig. 6824 illustrates the effect of a submarine blast as viewed from the shore or a passing vessel; and Fig. 6825 shows a diver equipped in complete armor just about to make a descent.

Fig. 6826 shows the diver at work.

Plate LXV. shows a view of the Hallett's Point operations, looking down into the [illegible] the [illegible] of shafts appear above the coffer-dam, which holds back the water.

The Blossom rock, a dangerous [illegible] in the course which vessels are frequently [illegible]

[illegible] [illegible] later, [illegible] in 18[illegible] [illegible] A [illegible] [illegible] resulted [illegible] [illegible] it was [illegible] [illegible] quantity [illegible] [illegible] about 30 feet [illegible]

Fig. 6826

[illegible] to sink a vertical [illegible] preparatory to excavating [illegible] horizontal galleries, a crib of timber, forming a coffer-dam, [illegible] feet square, [illegible] with clay, was [illegible]

[illegible] Fig. 6827.

[illegible] cartridge [illegible] [illegible] April 23, 187[illegible] 800 yards distant from [illegible]

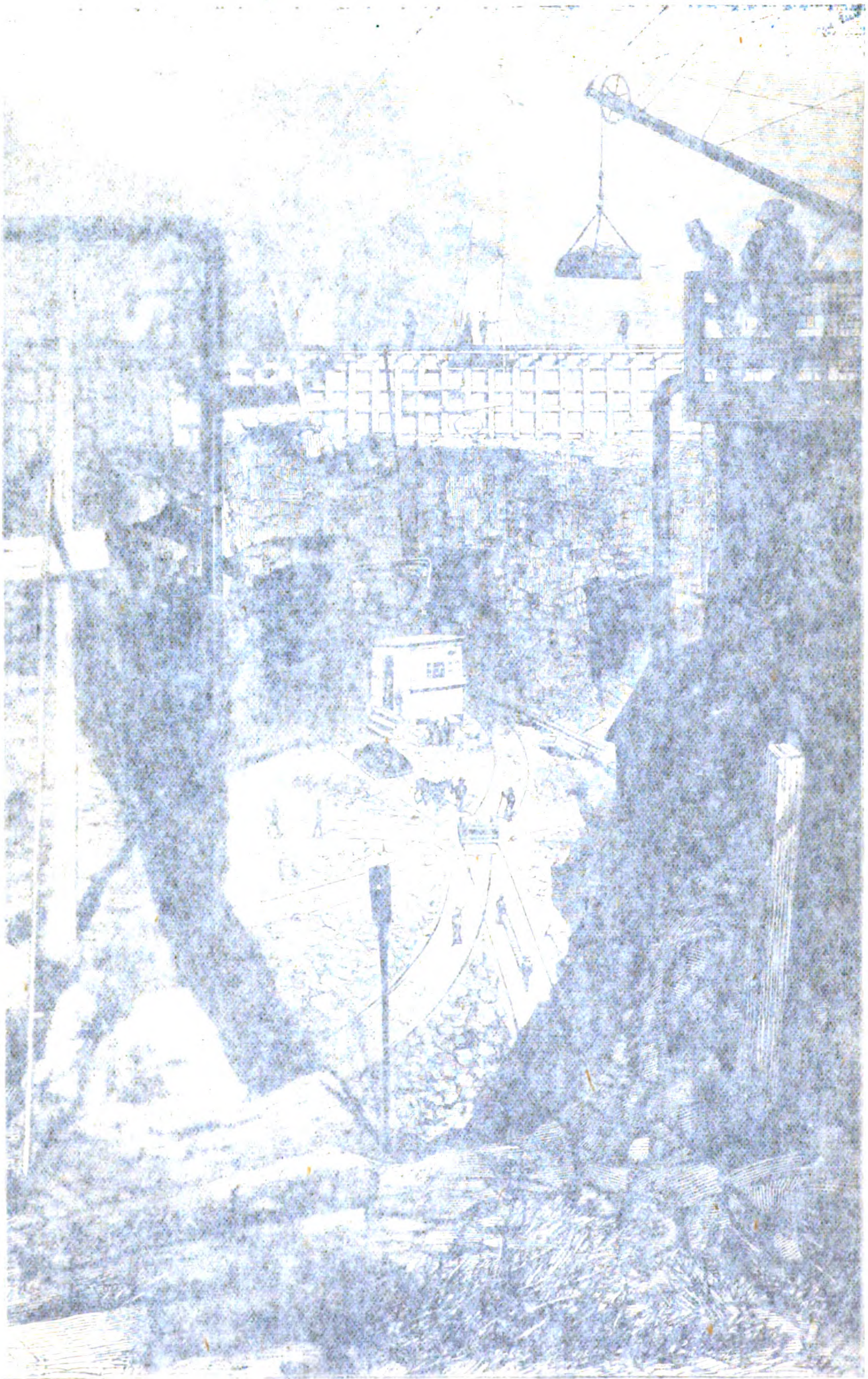


PLATE LXV

partment, involving an outlay of from $3,000,000 to $9,000,000, to entirely remove all the obstructions, and ensure a depth of 26 to 24 feet at low water. The execution of these projects would have occupied from 4 to 10 years.

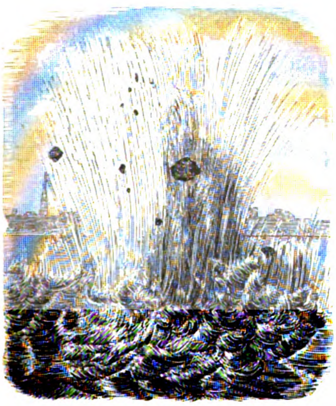
General Newton, United States Engineers, who had the general supervision of the work, in 1869, commenced operations by sinking a shaft beneath the ledge of rocks constituting Hallett's Point, which projects into the stream so as to throw the tidal current directly upon the Gridiron. For this purpose a coffer-dam 310 feet long, of heavy timbers bolted to the rock, and filled in with sand and clay, was constructed, the water pumped out, and a longitudinal shaft, having radial shafts extending from either side, excavated, the intention being to explode nitro-glycerine within the chambers, into which the displaced rock might fall and the fragments be afterward removed by grappling, if necessary.

Fig. 6021 shows a longitudinal section of "Grant" heading at Hellgate. The openings of other tunnels are seen to the left.

Fig. 6023 is a section of East River at Hallett's Point, and of one heading of the excavation, showing also the steam-drill. See also HEADING, Fig. 2463, page 1085.

The entire surface undermined measures 2½ acres, and the cuttings aggregate 7,542 feet in length, varying in hight from 8 to 22 feet, and in width from 12 to 13 feet. There is a roof 10 feet thick between the mine and the water, and the latter, at the outer edge of the excavation, is 26 feet deep at low tide. Between the headings and galleries heavy piers are left, which now sustain the immense weight of rock and water above. In each pier from ten to fifteen 2 and 3 inch holes are being drilled, and in the roof similar apertures are being made at intervals of 5 feet apart. All of these openings will be filled with nitro-glycerine, in charges of 8 and 10 pounds, and all will be connected together by gas-pipe filled with the same explosive. This will be done during the cold weather, when the danger of hauling the nitro-glycerine is greatly diminished.

Fig. 6024.



Effect of the Submarine Blast.

Previous to the explosion, the coffer-dam will be broken away and the water allowed to fill the entire excavation, so that it will serve as a tamping. Then, by means of an electric fuse, the nitro-glycerine in the gas-pipe will be fired, which will determine the blowing up of the whole affair. No fear is apprehended as to the result, since it has been determined that the explosion of half the charges will be sufficient to cave in the roof, and cause it to fall to the sunken floor, deepening the water at once to a proper depth, or necessitating but little dredging to complete the work.

The entire roof is to be blown off on the 4th of July, 1876; we cannot delay the issue of this book for the purpose of recording the success.

The Diamond reef and Coenties reef have been removed by drilling and blasting. Divers, equipped with submarine armor, descend to adjust the drills, insert the cartridges, etc.

Fig. 6025.

Diver Equipped for Descent.

The new operations at Flood Point will involve still greater cuttings than at Hallett's Point.

Fig. 6024 illustrates the effect of a submarine blast as viewed from the shore or a passing vessel; and Fig. 6025 shows a diver equipped in complete armor just about to make a descent.

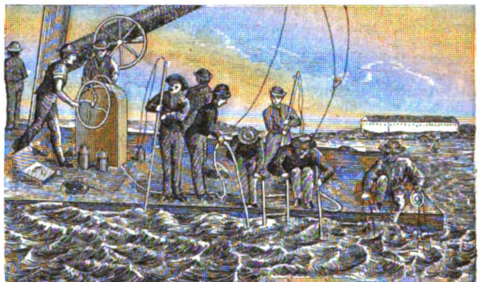
Fig. 6026 shows the diver at work.

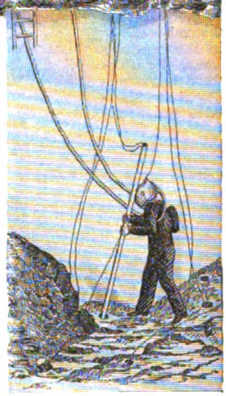
Plate LXV. shows a view of the Hallett's Point operations, looking down into the shaft. The sails of ships appear above the coffer-dam, which holds back the water.

The Blossom rock, a dangerous reef lying directly in the course which vessels are frequently compelled to take in entering or leaving San Francisco Harbor, was discovered by Captain Beechey, of H. M. S. "Blossom," in 1826. It is situated nearly midway between the islands of Alcatraz and Yerba Buena, and its top was but 5 feet below mean low water previous to the operations which resulted in its removal as an impediment to navigation in 1870. It was composed of a metamorphic sandstone of variable hardness, having a specific gravity of 2.64, and in some places containing small beds of gravel cemented together with a bluish substance resembling clay. Its greatest length was 195 feet, and its greatest width 105 feet at 24 feet below low water. The quantity of rock to be removed in order to obtain this depth was 5,000 cubic yards.

It was proposed to effect its removal by excavating longitudinal and transverse chambers in the interior of the rock to a depth of about 30 feet below low-water mark, leaving a thickness of about 6 feet between the excavation and the bottom of the bay, with pillars of stone left between these chambers, as at *A*, Fig. 6027.

Fig. 6026.





Diver at Work.

In order to sink a vertical shaft preparatory to excavating the horizontal galleries, a crib of timber, forming a coffer-dam having an interior open space 10 feet square, packed around with clay, was built and floated out to the reef, where it was sunk, and secured in position by driving steel-headed piles into the rock. On top of the crib a floor was laid, and a shed for lodging the workmen erected. The coffer-dam having been pumped dry and leakage stopped, a boiler-iron cylinder 6 feet in diameter was placed on it, and packing placed between it and the lining-walls. The sinking of the shaft was commenced December 7, 1869. At a depth of about 10 feet, the water again becoming inconvenient, a second iron cylinder of slightly less diameter was telescoped within the first; afterward a third cylinder of slightly less diameter than the second was similarly inserted.

When a depth of 30 feet was reached, drifts were run in the direction of the longer and shorter axes of the rock, and a swinging derrick constructed for hoisting the excavated matter by steam power and dumping it on the eastern slope of the rock.

The drifts were enlarged sufficiently to permit 16 men to work, who removed about 50 cubic yards of stone daily, and finally the chamber was increased to 140 feet in length, 60 in width, and 12 in hight, extreme dimensions. The crust of rock over the chambers was from 14 to 18 feet in thickness, or more than double that originally designed. This subsequently led to much labor in order to perform the conditions required.

The stone pillars were removed, with the exception of the four nearest the central shaft, and replaced by wooden props 8 to 10 inches square, each capped by a sill, between which and the surface of the rock wooden wedges were driven (*B*, Fig. 6027).

The arrangements were then made for blasting. For this purpose a nitrate of soda powder was used, being less expensive than ordinary gunpowder. Of this 43,000 pounds were used, placed in 38 ale-barrels and 7 old iron tanks, as shown at *C*, Fig. 6027. The charges were connected by tubes and wires.

An Abel cartridge was placed about midway of each iron tube and connected by two shorter wires with each of the battery circuit wires. The torpedoes were braced and fastened with timber, so that when water was admitted to the chamber, they would not rise to the surface. The charges were fired at 2 P. M., April 23, 1870, with a Beardslee battery, in a boat about 800 yards distant from the rock, raising a column of water 200

to 300 feet high, and 200 feet in diameter; around the base of this column was a simultaneous outburst of water probably about 70 feet high, which seemed to roll outwardly. The highest jet rose from the shaft.

An examination made shortly after the blast showed that there were but 14 feet water on the shoalest place over the rock. The fragments were removed into deeper water by a heavy iron drag, similar in appearance to an ordinary garden rake, and weighing $2\frac{1}{2}$ tons. This was suspended from a scow, which was towed back and forth over the rock by a steam-tug, which scraped the *débris* into deep water.

Sub′ma-rine′ Boat. A vessel constructed to navigate beneath the surface of the water.

Drebbel of Holland constructed for James I. a vessel which was manned by 12 rowers, and was tried on the Thames. The effete air was again rendered respirable by a liquor whose composition was kept secret by the inventor. The Marquis of Worcester, in his "Century of Inventions," refers to a contrivance of somewhat similar import.

Robert Fulton published his work on this subject in New York, 1810. His experiments were made at Brest in 1801. On July 3, in that year, he embarked with three companions on board his plunging-boat in the harbor of Brest, and descended in it to the depth of 25 feet, which was about as deep as the strength of his machine would bear. He remained below in darkness one hour. He afterward tried candles, but objected to them as destroying the vitality of the air. Bull's-eyes were then inserted in the top of the boat, and found satisfactory. His boat had one mast, a mainsail, and a jib, which moved her at the rate of 2 miles an hour on the surface, and were stowed in 2 minutes when preparing to dive. When submerged, the vessel was moved by the exertion of 2 men at the engine, while he governed the position of the boat by regulating the machine which kept her balanced and determined her depth below the surface.

The engine moved her about 500 yards in 7 minutes. On a subsequent occasion he took down reserves of compressed air, and descended for about 6 hours. His boat was called the "Nautilus." She did no effective service.

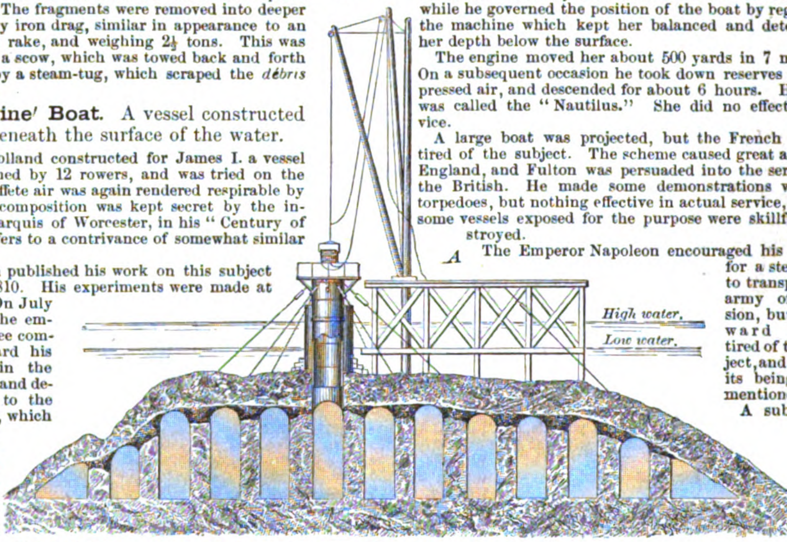
A large boat was projected, but the French became tired of the subject. The scheme caused great alarm in England, and Fulton was persuaded into the service of the British. He made some demonstrations with his torpedoes, but nothing effective in actual service, though some vessels exposed for the purpose were skillfully destroyed.

The Emperor Napoleon encouraged his project for a steamboat to transport the army of invasion, but afterward became tired of the subject, and forbade its being again mentioned.

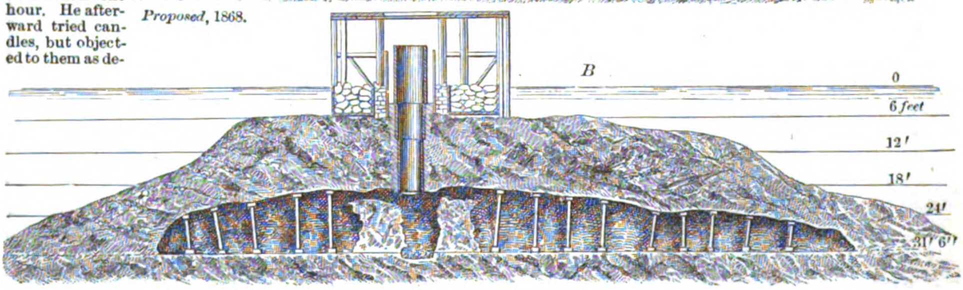
A submarine boat has been employed in the pearl-fishery by the Pacific Pearl Company. It is 36 feet long, 12 feet broad, and 13 feet deep, flat-bottomed, with two hatches in the bottom, through which the oysters are gathered. It is semi-spindle shaped on top, and has a turret for the entrance of the workmen; a compressed-air chamber; a working-chamber, into which the compressed air is admitted to expel the water when the bottom is reached; and a water or ballast chamber for sinking it. When it is desired to rise, the compressed air is let into this water-chamber, gradually expelling the water as the machine rises to the surface. The air in the chamber is compressed by a 30-horse-power engine to the density of 3 or 4 atmospheres.

M. Denayrouze, whose subaqueous helmet and respirator are shown at Fig. 4272, has invented a submarine boat to move beneath the surface at 8 or 10 knots an hour, and carry a crew of divers to remove torpedoes and carry on blasting operations against submarine obstruction of even the hulls of enemies' vessels. The defense against such boats would be similar ones, and the transfer of the scene of combat from the surface to the depths would add an item of terror to what was already quite sufficiently desperate.

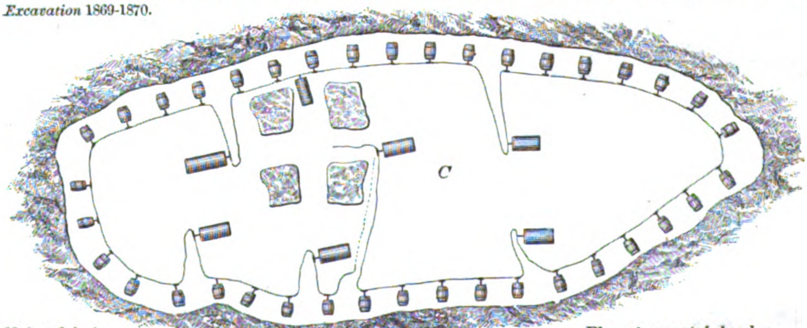
Fig. 6027.



Proposed, 1868.



Excavation 1869-1870.



Scale 32 *ft. to* 1 *inch.* *Plan of excavated chamber.*

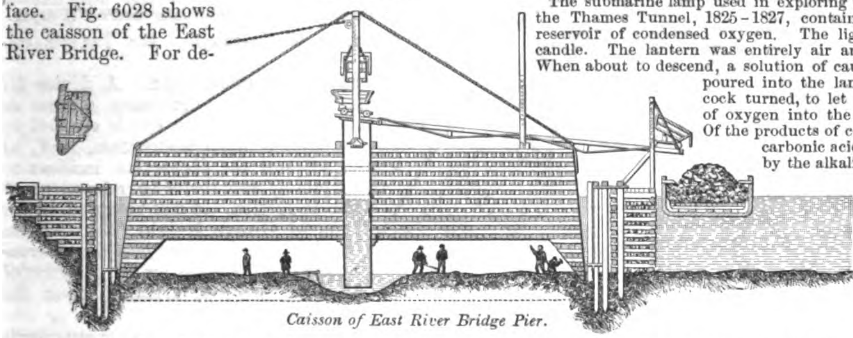
Submarine Excavation and Blasting of Blossom Rock, Harbor of San Francisco.

Sub′ma-rine′ Ca′ble. (*Telegraphy.*) A wire, or combination of wires, protected by flexible non-conducting water-proof material, designed to rest upon the bottom of a body of water and serve as a conductor for the currents transmitted by an electro-

magnetic telegraphic apparatus. See TELEGRAPH-CABLE.

Sub′ma-rine′ Ex′ca-va′tor. A device for removing earth or stone beneath the water surface. Fig. 6028 shows the caisson of the East River Bridge. For description, see the similar contrivance used in excavating for the piers of the St. Louis Bridge, page 49, and Plate II., opposite; also CAISSON, pages 420–422. See also DREDGING-MACHINE, pages 747–749; and other devices cited in the list under HYDRAULIC ENGINEERING, pages 1146–1148.

Fig. 6028.



Caisson of East River Bridge Pier.

Fig. 6029 shows an apparatus embodying a combination of conduits and mouth-pieces for excavating, dredging, and transmitting earthy and other loose matter, by means of forced currents of water, steam, or air, singly or combined. It is a form of dredge. The upper figures give details.

Sub′ma-rine′ Ex-plor′er. A diving-bell or lantern (see SUBMARINE LAMP; SUBMARINE TELESCOPE) used in examining sites beneath the surface of the water.

Storm's submarine explorer (Fig. 6030) consists of an interior and exterior shell of wrought-iron, connected by braces *N*. The interior shell is divided by a horizontal floor into two compartments, the lower of which serves as a working-chamber. These communicate by the man-hole *Q*. The lower part of the space between the two compartments constitutes a water-chamber to regulate the flotative power of the apparatus, and is divided by vertical partitions *C C′*, to prevent the water from surging from side to side when the machine is being moved. An iron ring *E* is permanently attached to the lower part, to act as a sinker; and other rings *E′*, which may be made in segments, can be added, if necessary. Light is admitted to the upper chamber through conical tubes *F*, having lenses at their inner extremities, and falls upon reflectors *V*, which diffuse it through the chamber. The upper chamber is lined with sheet-zinc *R′*, having numerous V-shaped perforations, and backed with felting, to absorb the carbonic-acid gas produced by respiration. Suitable valves are provided for admitting and exhausting air and water as required. *O* is a man-hole by which the upper chamber is entered.

Sub′ma-rine′ Gun. Submarine ordnance seems first to have been suggested by Saint Cyr in 1797, and consisted, as shown at *a*, Fig. 6031, of a mortar towed underneath a vessel by a span extending between two boats.

Fulton experimented with firing guns under water in New York Harbor in 1814, and was successful in penetrating a bulkhead representing the bottom of a first-class ship. His submarine battery of 100-pounder Colombiads is illustrated at *b*. The gun traveled on its carriage, the barrel of the piece slipping in a packed port-hole. The port was closed by a shutter, which was raised by a lanyard and dropped of its own accord when the gun recoiled.

Mr. Phillips of Indiana in 1855, and Woodbury of Boston in 1861–1864, worked at the problem. Woodbury's device is shown at Fig. 6032. An American submarine gun was shown at the French Exposition of 1867.

Fig. 6033 shows a submarine rifled projectile 5 feet long, 11 inches diameter, and with a bursting charge of 49 pounds. Total weight, 175 pounds.

Sub′ma-rine′ Lamp. A lamp adapted to burn beneath the surface of the water.

The submarine lamp used in exploring the breaches in the Thames Tunnel, 1825–1827, contained a spherical reservoir of condensed oxygen. The light was a wax-candle. The lantern was entirely air and water tight. When about to descend, a solution of caustic alkali was poured into the lamp, and a stop-cock turned, to let a small stream of oxygen into the light-chamber. Of the products of combustion, the carbonic acid was absorbed by the alkali, and the water condensed on the sides of the glass. The oxygen mixed with the nitrogen to form atmospheric air.

Oil-lamps, constantly supplied with air by means of a forcing-pump, and the electric light, have also been employed. The first was objectionable on account of the trouble it occasioned, and the latter by reason of its expense and the strong shadows cast by it.

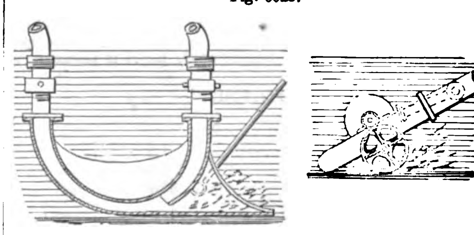
The lamp of MM. Leanté and Dénoyel is supplied with oxygen gas forced under a pressure of 10 atmospheres into a reservoir beneath, whence it is conveyed by a small tube to two annular receptacles, one inside and the other outside of the wick. Each is pierced with a number of small holes. Simple devices regulate the motion of the wick and control the supply of gas. The whole is protected by a thick glass cover, so as to be air and water tight.

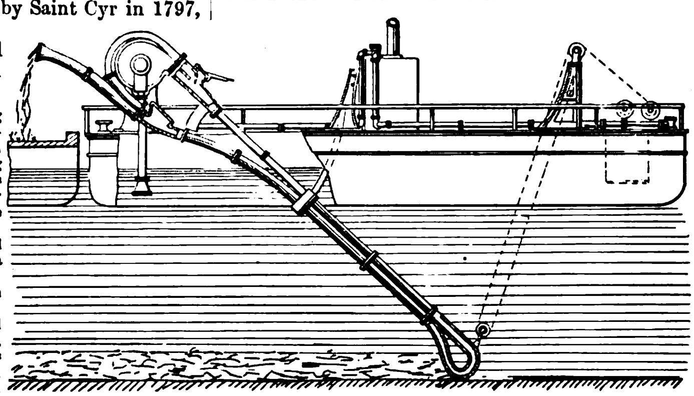
Van der Weyde's submarine lantern (Fig. 6034) has a cylindrical glass case, with the interior of which two channels communicate; one *C* connecting with a flexible pipe *D*, through which fresh air is injected, and the other *B* with the flexible pipe *E*, by which the products of combustion are carried off. *O* is the chamber, containing a hydrocarbon compound which readily vaporizes by heat, and *P* is the burner. The lantern is lowered by cords attached to the eyes *S S*. *T* is a ring by which the diver moves it from one place to another.

Sub′ma-rine′ Lan′tern. See SUBMARINE LAMP.

Sub′ma-rine′ Pho-tog′ra-phy. A photographic apparatus by Dr. Neumayer of Berlin, for ascertaining the temperature and direction of deep-sea currents.

Fig. 6029.

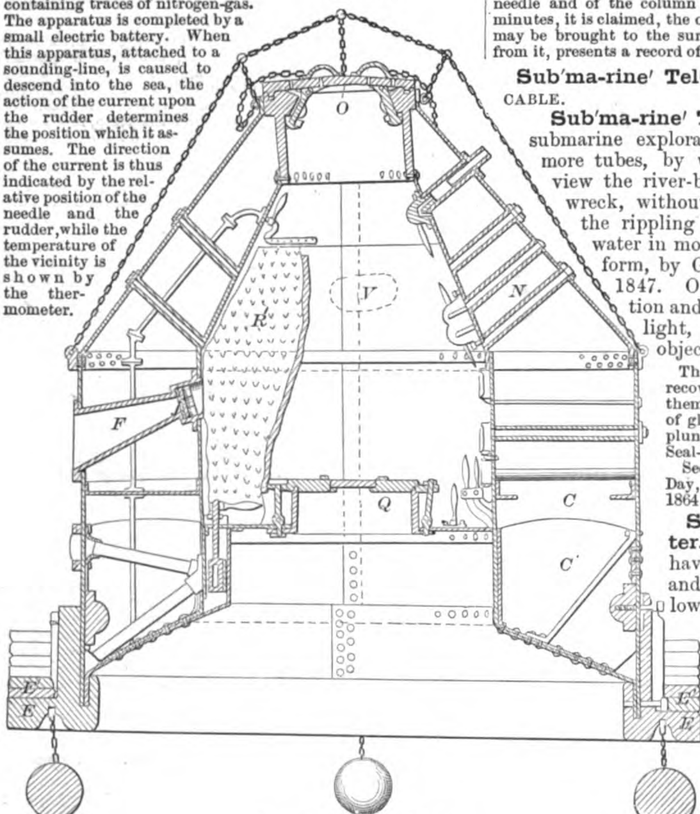




Robertson's Excavating-Machine.

It consists of a copper case hermetically closed, and furnished with an exterior appendage resembling a rudder. Within this case a thermometer and compass are inclosed, each in a glass vessel containing traces of nitrogen-gas. The apparatus is completed by a small electric battery. When this apparatus, attached to a sounding-line, is caused to descend into the sea, the action of the current upon the rudder determines the position which it assumes. The direction of the current is thus indicated by the relative position of the needle and the rudder, while the temperature of the vicinity is shown by the thermometer.

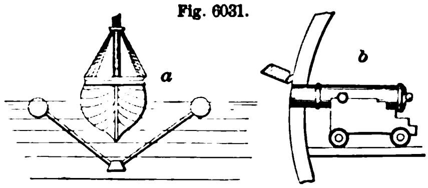
Fig. 6030.



Storm's Submarine Explorer.

But in order that these indications may be read at any desired spot in the ocean depths, it is necessary to fix them at the moment required. A leaf of photographic paper is placed in a

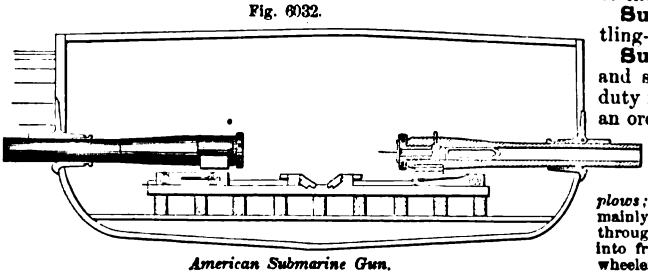
Fig. 6031.



Submarine Guns.

proper position next to the glass vessel containing the instruments. When it is desired to obtain the reading of the instruments, an electric current is sent through the nitrogen gas contained in these vessels. This produces a very intense violet light capable of acting chemically upon the photographic paper for a time sufficiently long to reproduce the shadows of the needle and of the column of mercury. At the end of three minutes, it is claimed, the operation is finished, the apparatus may be brought to the surface, and the paper, being removed from it, presents a record of the conditions observed in depth.

Fig. 6032.



American Submarine Gun.

Sub′ma-rine′ Tel′e-graph. See TELEGRAPH-CABLE.

Sub′ma-rine′ Tel′e-scope. A device for submarine explorations, consisting of one or more tubes, by which the eye is enabled to view the river-bed, an obstruction, rock, or wreck, without the distraction incident to the rippling and distorted refractions of water in motion. It was patented, in one form, by George Knight (England), in 1847. One tube was used for observation and the other for the direction of light, solar or artificial, upon the object.

The arrangement used by smugglers in recovering contraband articles sunk by them consisted of a cask having a plate of glass at the bottom. This end was plunged a few inches below the surface. Seal-hunters use the same contrivance.

See patents: Mather, April 16, 1845; Day, April 16, 1850; Mather, July 5, 1864.

Sub′ma-rine′ Ther-mom′e-ter. (*Nautical.*) A chamber having valves above and below, and inclosing a thermometer, is lowered to the required depth, the water flowing upward through the chamber as it descends. When the descent is checked, the valves close, and the chamber is hauled up, containing water from the depth reached.

A registering-thermometer is now used. See THERMOMETER.

Sub′ma-rine′ Valve. A port or valve in the side of a vessel, opening beneath the surface of the water, for the purpose of protruding a torpedo, the muzzle of a gun to be fired under water, or some other offensive weapon. See SUBMARINE GUN; TORPEDO.

In the example (Fig. 6035), the valve *D* is pivoted in a casing in the ship's side, being connected to the journal of the rock-shaft *F*, which may be operated from the engine-room or other convenient position. The movement of the valve is parallel to the side of the vessel, and covers or uncovers the exterior orifice of the blow-off pipe, a ventilator, or other opening. *i* is an index for showing the position of the valve.

Sub′ma-rine′ Ves′sel. See SUBMARINE BOAT; TORPEDO.

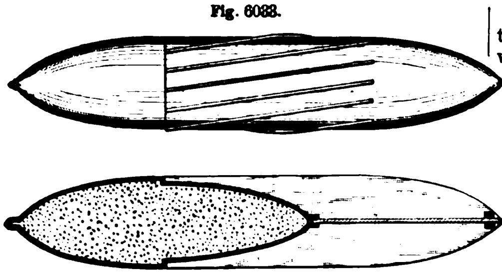
Sub-merged′ Pump. A well or cistern pump which is placed under water, the pump-rod and discharging-pipe reaching from the surface of the ground to the pump.

Sub-sid′ence-vat. A dyer's settling-vat.

Sub′soil-plow. One having a share and standard, but no mold-board. Its duty is to follow in the furrow made by an ordinary plow, and loosen the soil to an additional depth without bringing it to the surface.

In England they are called *trenching-plows;* and sometimes *horse-picks*, from their mainly consisting of a sharp share which is forced through the subsoil, lifting it and breaking it into fragments. It is drawn by 4 horses, the wheelers hitched to the clevis, and the leaders

Fig. 6033.

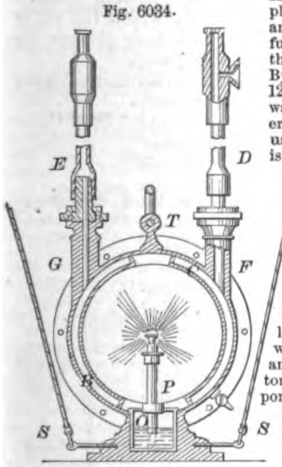


Submarine Projectile.

by a *soam*, or draft-chain, to the draft-rod of the plow, below the beam.

The first mention of subsoil-plows is in Worlidge's "Mysteries of Husbandry," 1677. He tells of an ingenious young man in Kent, England, who had two plows fastened on one stock, and the rear one plowing a furrow beneath the level of the sole of the preceding one. By this he stirred the land 12 or 14 inches deep. This was a regular subsoiling operation, though the now usual form of the implement is to stock the subsoil-plow separately and make it to follow in the wake of the ordinary plow.

Fig. 6034.



Van der Weyde's Submarine Lamp.

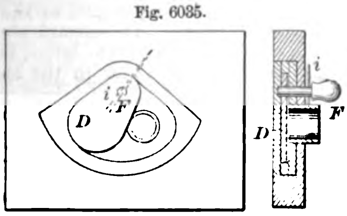
Smith of Deanston, Scotland, is credited with the invention and introduction of the modern implement. The illustration shows that it is destitute of mold-board and landside, having a share with wings adapted to raise and crumble the furrow bottom, comminuting it as a porous foundation for the mold which will be turned upon it by the ordinary plow in its next furrow.

It has a curved colter, which is designed to be self-cleaning. The draft is applied by a draft-rod, secured by a *bridle* to the beam.

It is drawn by four horses, two and two, and managed by one man. The usual mode is to make a 10×6 inch furrow with an ordinary plow, and follow with the subsoiler at an additional depth of from 5 to 7 inches.

Stracey's subsoil-plow (English) has several points in common with its predecessor, as may be readily seen by comparison. It is used with a wheel, is higher in the throat, and has the broad, flat, sharp standard, which experience has indicated is the best form of sheth for the angle-iron or winged share which cleaves the subsoil.

Fig. 6035.



Submarine Valve for Vessels.

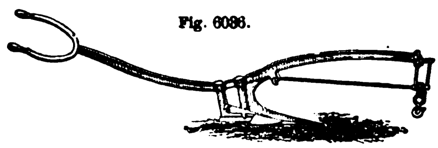
By a continued reduction of parts beneath the surface, the *subsoil-plow* becomes a *mole-plow*, in which a mere plug is attached to the *sheth* to force a way through the subsoil, leaving an arched drain, like a mole-track.

McMeekin's (Fig. 6038) has the standard *a* and brace *b* formed of a single bar of metal. The share has a flange which enters the loop thus formed, is bolted thereto, and is provided with a small landside and mold-board.

Fig. 6039 is an approved modern form of English subsoil-plow, adapted for subsoiling from 12 to 18 inches in depth. The plow-body is of wrought-iron. The small wheel serves as a furrow-marker.

Sub′sti-tute. **An optional bar or section, as the *substitute sinker-bar*, a shorter section to be used when a full-length section is not suitable.**

Fig. 6036.

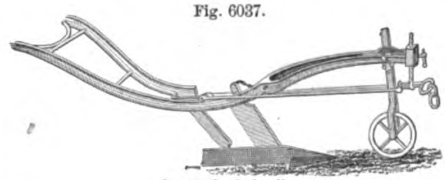


Smith's Subsoil-Plow.

Or a short section of sinker-rod having flanges to ream the hole and keep it straight. See WELL-BORING TOOLS.

Sub′ter-ra′ne-an Rail′way. A railway running its whole course beneath the level of the surface of the ground. The occasional dipping beneath the surface is a tunnel.

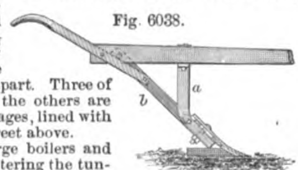
Fig. 6037.



Stracey's Subsoiler.

The subterranean railway in London, between Victoria Street, Holborn, and Paddington, was constructed 1860-1862. It is 3½ miles in length, having stations at an average distance of ⅝ of a mile apart. Three of these have glass roofs; the others are lighted by slanting passages, lined with white tiles, from the street above.

Fig. 6038.

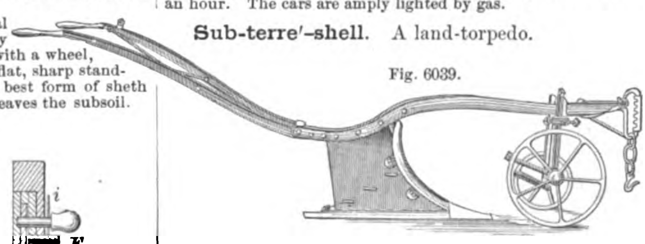


McMeekin's Subsoiler.

The engines have large boilers and cylinders, and before entering the tunnel steam is raised to 130 pounds. On entering the tunnel the exhaust is turned into a water-tank instead of up the chimney, so that the combustion of fuel is much reduced, and little smoke escapes; the steam-pressure is allowed to run down to 65 pounds, the cut-off being varied so as to maintain a uniform power sufficient to produce an average speed of 25 miles an hour. The cars are amply lighted by gas.

Sub-terre′-shell. A land-torpedo.

Fig. 6039.



English Subsoil-Plow.

Sub′way. An underground tunnel beneath the street surface in which the gas and water pipes and sewers are lodged, so that they can be examined, repaired, replaced, etc., without disturbing the pavement.

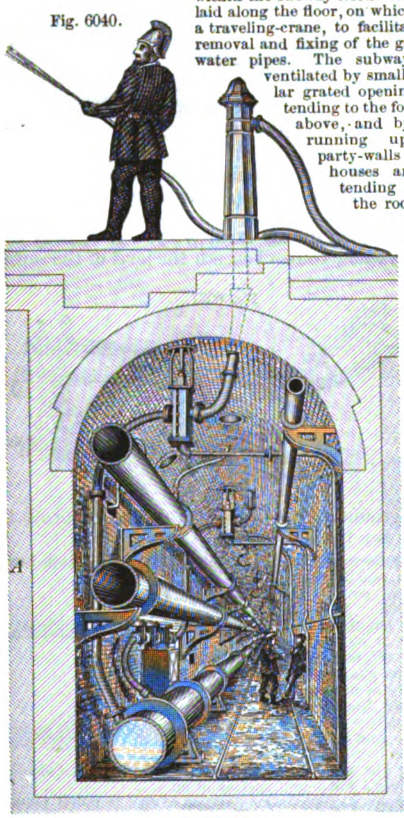
The plan was proposed by Williams in London in 1822, and has been adopted in Paris. See SEWER.

In Fig. 6040, *A* represents one of the subways on each side of the Holborn Viaduct, London. These are 7 feet wide and 11 feet 6 inches high, running between the great arches which carry the roadway and the house-vaults which support each footway. They are located immediately above the sewers, are floored with stone, and lined with brick. Along the wall nearest the fronts of the houses is a 14-inch water-main, and above this two 10-inch gas-mains supported on brackets. On the opposite side is a pipe containing the telegraph-wires.

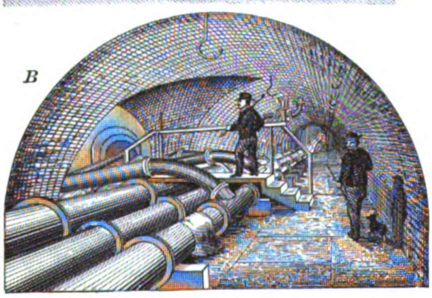
Junctions are arranged for carrying water and gas into each house along the route by pipes conducted through holes in the sides of the subways. Branch pipes are laid on to the street fire-plugs and hydrants, and gas is laid on to the street-lamps. All the usual valves, meters, and other apparatus are accessible within the subway itself. Rails are laid along the floor, on which runs a traveling-crane, to facilitate the removal and fixing of the gas and water pipes. The subways are ventilated by small circular grated openings extending to the footways above, and by flues running up the party-walls of the houses and extending above the roofs.

Fig. 6040.

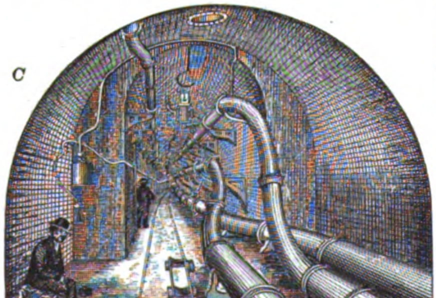
A



B



C



London Subway.

Where practicable, the entrance-doors are also constructed of open wire-work.

B, section of London subway; north side junction of Charterhouse Street.

C, section; south side at west end of viaduct.

Suc′cu-la. A plain axis or cylinder, provided with staves or handles for turning it, but having no drum.

Suck′er. 1. A pump-bucket; *embolus.*

2. The leathern flap-valve of a pump-bucket.

3. A round piece of leather having a central perforation for the attachment of a string; when rendered flexible by wetting, and applied to a smooth object, as a stone, the adhesion between the two surfaces due to atmospheric pressure enables the lifting of the stone.

Suck′er-rod. A rod connecting the brake of a pump with the bucket.

Suck′er-rod Swiv′el. A swiveled link at the top of a pump-rod. See WELL-BORING TOOLS.

Suck′ing-bot′tle. An infant's feeding-bottle.

Suck′ing-pump. A pump in which the water is raised within reach of the bucket or plunger by atmospheric pressure. A *suction-pump.*

Suck′ing-tube. Most of us are acquainted with the taste of sweet cider as sucked through a rye-straw. They are used in many parts of the world for other liquids than cider. Besides their use among us with *cobblers* and *juleps*, the Peruvian drinks his or her *mate* by means of a tube with fine holes to keep back the particles of leaf. The sucking-tube was used by the ancients as a domestic utensil, and also in the temples. The latter use has also descended to our times in the *sanguisuchello*, or blood-sucker, a golden tube by which the Pope sucks up the wine at high mass. A *chalumeau*, or tube of gold, and silver "pypes," for the same purpose, are also mentioned in old inventories of church property.

Fig. 6041.

Sanguisuchello.

Suc′tion-pipe. That pipe of a fire-engine, or other pump, which conducts water from a cistern to the cylinder of a pump.

Suc′tion-plate. (*Dental.*) A dental plate retained in position in the mouth by atmospheric pressure.

Suc′tion-pri′mer. A small force-pump worked by hand and used in charging a main-pump.

Suc′tion-pump. A pump in which the plunger or bucket is placed above the level of the water, the latter rising by atmospheric pressure, as the *sucker* (bucket) is raised. Between the upward strokes of the bucket, a *clack-valve*, below the latter, falls and prevents the reflux of the water in the ascension tube. See LIFT-PUMP.

Suc′tion-valve. 1. The valve below the plunger or bucket of a pump, and which is lifted by atmospheric pressure acting upon the water beneath it, as the plunger is raised.

2. (*Steam-engine.*) The valve through which the water is drawn from the hot-well into the feed-pump, by the rise of the plunger. See FEED-PUMP.

Sug′ar. A substance having a sweet taste, soluble in water, and capable of undergoing fermentation.

Three kinds are distinguished in chemistry: —

	Formula.
Saccharine, or cane-sugar	$C_{12} H_{11} O_{11}$
Glucose, or grape-sugar	$C_{12} H_{14} O_{14}$
Lactose, or milk-sugar	$C_{12} H_{12} O_{12}$

The first of these is derived principally from the sugar-cane (*Arundo saccharifera*), but is also obtained from beet-root, the sap of the sugar-maple, and various other plants. It is much sweeter and more readily crystallizable than either of the other kinds, and is that generally known to commerce.

The sugar-cane is a native of Asia. It is believed to have originated in China, and to have been used by the Celestials many centuries before it found its way to India and Arabia, from whence it was introduced into what is now the Christian world. In Sanscrit, sugar is *sarkara*. Our *candy* is also from the Sanscrit *kanda*. In Persian it is *schakar;* Hindostanee, *schukur;* Arabic, *sukkar*.

The references to it among ancient writers are few and indistinct. The first distinct notice of it is by Nearchus, who conducted the fleet of Alexander down the Indus. He speaks of the sugar-cane as growing in India, but does not refer to expression of the juice.

Sugar is mentioned by Dioscorides and Pliny, not from any commercial or domestic value that it possessed, but as a curious item of natural history and a presumed use as a medicine.

Galen also refers to it as a kind of honey secreted in reeds and brought from Arabia Felix and India.

It was known by the Greeks and Romans as an Oriental production, but was sometimes confounded by them with the *Tabaschir*, made from bamboo stems. (Sanscrit; *trak-kschira*, bark-mill.) Moses of Chorene, who lived in the middle of the fifth century, was the first who described circumstantially the preparation of sugar from the juice of the *Saccharum officinarum* in the province of Khorasan.

It is also mentioned by Paul Eginetta, a physician, A. D. 625.

The Arabs seem to have introduced it wherever they went, finally into Sicily and Spain. Through them it became known to the Crusaders, who liked the sweet honeyed reeds, and one of their chroniclers describes the mode of expressing and purifying the juice as practiced by the inhabitants of Acre and Tripoli.

The cane was cultivated in Cyprus, 1148, and a grant from William II. of Sicily, in 1166, includes a sugar-mill with "all its rights, members, and appurtenances." It does not, however, appear to have been generally known in Europe prior to the middle of the thirteenth century.

It is said that a Venetian merchant in 1250 visited Bengal and informed himself of the mode of culture and preparation. The art of refining sugar and making sugar loaves was also communicated by a Venetian about 1550. It is not known whether he independently originated the idea, or whether he received it from China, where it had been practiced for ages. Boiling and baking sugar was first practiced in Europe about 1420.

Bartholomew was the first Englishman who described the method of crystallizing and purifying sugar.

The plant was taken by the Portuguese to Madeira in 1420, and soon afterward, in 1506, to the Canaries, from whence it was taken to Brazil and to St. Domingo. Its culture thence gradually spread throughout the West Indies. Barbadoes was supplied from Brazil in 1641, and the culture was introduced into Louisiana by French refugees from St. Domingo toward the close of the last century.

For notice of beet-root sugar, see *infra*, also page 255.

Maple sugar was first made by the Indians, and La Salle refers to it as a kind of manna.

Sirup. The *sirup* of commerce is the residual product obtained in refining raw sugar. This is dissolved in water, filtered and decolorized, boiled, and formed into loaves.

The sirup which drains out of the loaves, called *greens*, is again purified, decolorized, and boiled down to crystallization. The crystals are separated in the centrifugal machine, and sold as a very light-colored *coffee-sugar*. The *greens* from this sugar yield, by purification, decolorization, and boiling, a light yellow sugar. The last *greens*, after three successive crystallizations of sugar, are purified and sold as *golden sirup*. This sirup still contains a considerable quantity of crystallizable sugar, which cannot be profitably extracted, together with uncrystallizable sugar, coloring matter, and the substances which give to sirup its peculiar agreeable flavor, but whose exact nature is not known.

Beet-Root Sugar. Oliver de Serres, 1605, suggested the use of beets for making sugar. Margraff first produced sugar from beets in 1747; Achard, in 1799. Bonaparte encouraged it, as his connections with the West Indies were very precarious, and were likely to become more so. 60,000 tons of beet-root sugar are now produced annually in France. Large quantities are also made in Northern and Central Europe, forming a large proportion of the amount consumed. The industry has been introduced into Illinois and California. It prospers in the latter.

Napoleon devoted 80,000 acres and 1,000,000 francs to encourage this industry,—one which has since grown to be of much importance in Europe. It is computed that beet-roots now supply nearly a fourth of all the sugar furnished to the markets of the world.

The amount of sugar contained in the beet varies from 8 to 13 per cent. As high as 40 tons of beets per acre have been raised in some parts of France. This would give, at 10 per cent, 4 tons of sugar to the acre; an average of one fourth as much is, however, considered satisfactory.

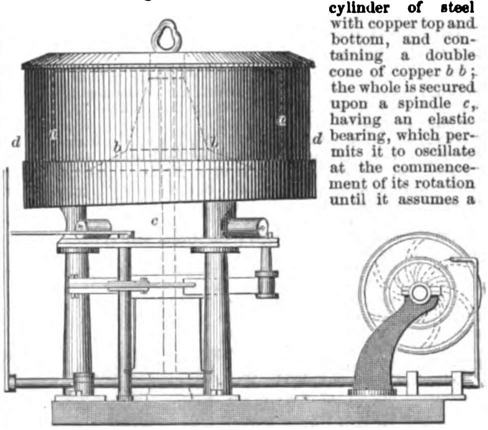
Beets for the manufacture of sugar are deprived of their tops, thoroughly washed by machinery, and then rasped into pulp or cut into thin shavings, according to the mode of manufacture practiced.

In the grating-machine the beets are fed into a hopper above and fall into two troughs beneath, where they are pushed forward, by means of two plungers operated by levers and links from a crank-shaft so as to have a quick return-motion, to a drum set with saws, which revolves at the rate of 600 to 800 revolutions per minute. The pulp is discharged into a chute.

In the slicing process a centrifugal root-cutter is employed. This consists of a stationary conical casing, within which are six grooved toothed knives. The beets fed from a hopper above are driven against the knives by two flyers on a rotary disk, and cut into slices of uniform thickness.

After the beets have been grated, the juice is expressed by a hydrostatic press, or by the centrifugal machine (Fig. 6042). The basket *a a* consists of a perforated cylinder of steel with copper top and bottom, and containing a double cone of copper *b b*; the whole is secured upon a spindle *c*, having an elastic bearing, which permits it to oscillate at the commencement of its rotation until it assumes a perpendicular position by the even distribution of the pulp in the basket.

Fig. 6042.

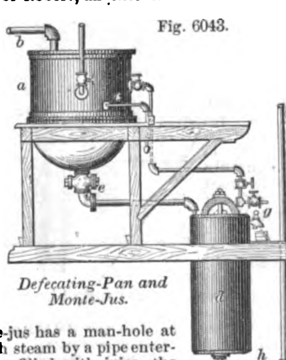


Centrifugal Machine.

The rotation of the basket by belting on the spindle assumes a great velocity, and the juice is expressed from the pulp, caught by the curb *d*, and flows to a conductor, by which it is conveyed to the defecating-pan.

The diffusion process of Robert, an extensive Austrian beet-root sugar manufacturer, is a mode of extracting the saccharine liquid from the pulp, and is described and illustrated, page 702, Fig. 1652.

Fig. 6043.



Defecating-Pan and Monte-Jus.

The defecating-pan *a* contains a steam-heated coil of copper pipe. The juice is admitted through the pipe *b*, while carbonic acid, entering through *c*, is distributed throughout the juice by a perforated pipe. The defecated juice and scums are drawn off into the *monte-jus d* through the cock *e*. The monte-jus has a man-hole at top, and is supplied with steam by a pipe entering above; as it becomes filled with juice, the air is driven out through the bibcock *g*, which also indicates when the monte-jus is full; when this takes place, the bibcock is closed and boiler-steam admitted, forcing the juice out through the pipe *h* into the receiving-tanks.

The filter-press is used for recovering the juice which runs off in the scums from the defecating-pan. Formerly the scums were put in bags and pressed in hydraulic presses. This required considerable manual labor and power, which is nearly all saved by the filter-press. This consists of a vat having cloth strainers, through which the juice is forced by steam-pressure. After this the sirup is passed through a *bone-black filter*, when it is ready for the evaporating-pans.

The sirup may be drawn off into another vacuum-pan for completion, or evaporated to the point of crystallization in the second evaporator, and then drawn off to crystallize, after which it is refined in the usual manner.

The refuse pulp from the manufacture of beet-sugar forms an excellent food for stock. Recent improvements are offered in

the treatment of the by-products of beet-root sugar-making. Hitherto they have been treated for the mineral salts they contain, and then abandoned. The residuary liquor is now concentrated, and by a process of dry distillation acetic acid, methyl, alcohol, and ammonia are obtained. The by-product is then treated for the mineral salts as before.

Glucose. Glucose, or *grape-sugar*, is a saccharine substance obtained from starch by boiling in water with one per cent of sulphuric acid. The liquid is drawn off, the acid neutralized by lime, precipitate allowed to subside, liquid decanted and evaporated.

Starch is also converted into a fermentable sugar resembling glucose, by the action of a diastase.

Ligneous fiber will also yield glucose by treatment with a stronger solution of acid than the above, the mixture being afterward diluted, boiled, neutralized by alkali, and decanted.

Glucose is also obtained from cane-sugar by boiling in diluted acid.

The term *glucose* has been made to comprise several distinct modifications of sugar, some of which are mentioned above, as well as the sugar of malt, cane sugar modified by acid; but, speaking in general terms, glucose is a non-crystallizable saccharine, which, like *dextrine*, turns the plane of polarization to the right hand, as the term *dextrine* indicates. Cane-sugar (*sucrose*), on the other hand, is crystallizable, and turns the plane of polarization to the left. See Miller's "Elements of Chemistry," Part III. pages 71, *et seq*.

Glucose is developed in the process of malting, and its infusion is the solution called *wort*, from which *beer* is made; or it makes the *wash* of the distiller.

Among the processes for the expedition or more perfect performance of the change of condition may be cited: —

Riley, March 5, 1850, converts corn meal into glucose under pressure in a boiling solution of sulphuric acid: water, 1,000 gallons; acid, 25 pounds.

Reitsch, February 3, 1852. The saccharine matter of wort evaporated to a viscid mass.

Hoffman, May 25, 1858. Meal treated with dilute sulphuric acid and steam under pressure of 350° Fah. Decant and evaporate.

Hawkes, February 3, 1863. Wort of malt boiled with decoction of hops; cane-sugar added; boiled to a thick sirup; add gelatine, and can.

Weiderfeld, April 28, 1863. Meal steeped in water impregnated with gases resulting from dry distillation of sulphuric acid; wood charcoal; crystallized soda.

Goessling, May 10, 1864. Corn soaked, bruised between rollers; soaked in repeated waters, to prevent fermentation. Knead, pass through sieve, wash; treat with caustic potash, then with acid and steam; neutralize with alkali; steam, fine, filter, and concentrate.

Thompson, June 7, 1864. Macerate grain in dilute acid.

Fleischman, July 12, 1864. Macerate grain in sulphurous-acid gas water. January 5, 1865. Add bicarbonate of soda to above, developing hyposulphurous acid.

Goessling, December 20, 1864. Attempts to crystallize a mixture of corn or starch sirup and cane-sugar.

Percy, February 28, 1865. Whey of milk and albumen boiled, and the resulting lactine treated with sulphuric acid or malt to produce glucose.

Hawks, June 27, 1865. Ground malt is macerated with corn meal and elutriated to remove saccharine, which is evaporated *in vacuo*.

Goessling, September 5, 1865. Soak corn in alkaline ley. Crush, strain, and add the starch to a boiling acid solution, defecate with charcoal, neutralize with alkali. Evaporate and crystallize (?).

Goessling, September 5, 1865. Two modifications of the last.

Watson, December 5, 1865. Kiln-dry meal, and macerate in water.

Seely, January 10, 1865. Saw-dust purified by alkali, macerated in boiling acid solution, and added to 5 times its quantity of starch, and 10 times the quantity of water. Concentrate.

Deissner, June 19, 1866. Corn boiled in water; malt, sugar, and flour added.

Hirsh, October 16, 1866. Corn soaked in dilute sulphuric-acid; heated to 170° Fah.; ground, sieved, washed; starch boiled in solution of sulphuric acid, sulphuric alumina, and charcoal. Neutralize, concentrate, evaporate, defecate with bone-black, filter, concentrate *in vacuo*.

Hoff, December 18, 1866. Soak barley in fennel water, and malt it; add various fragrant herbs. Ferment.

Pigeon, April 23, 1867. Starch and cellulose treated in acidulous water, boiled under pressure. Saccharine liquid neutralized with lime, filter, defecate with bone-black, concentrate to 20° B. Allow the lime to precipitate. Filter; neutralize with soda. Boil, crystallize (?). Mold.

Loew, June 25, 1868. Woody fiber digested in hydrochloric acid, and heat; acid distilled over. Glucose and paper-stock the results.

Wesselholft, October 6, 1868. Extract of malt for dietetic purposes.

Sim and Hutchinson, March 16, 1869. Meal treated with bisulphide of carbon to extract oil, rendering starch more easily saccharified.

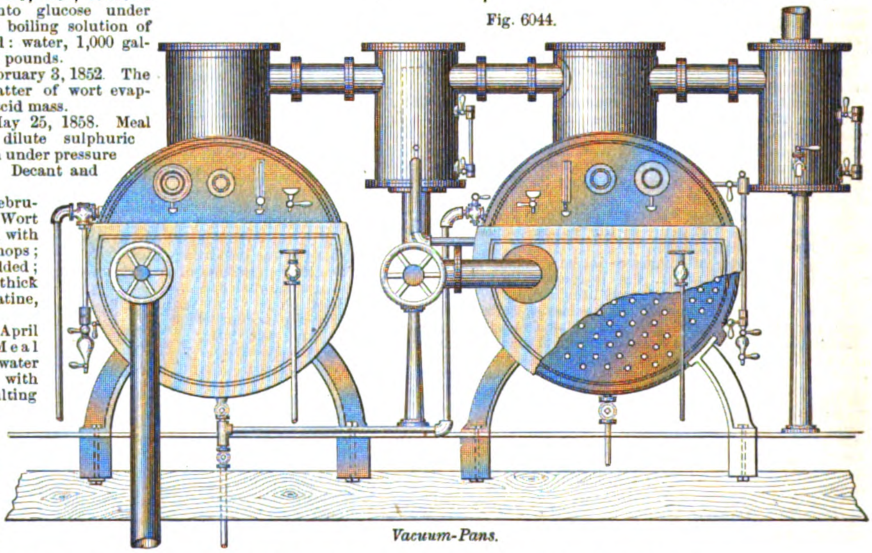
Delamarre, December 6, 1870. Sweet potatoes steamed, mashed, and mixed with malt, macerated, steamed, pulp precipitated, saccharine liquid decanted, concentrated.

Grosheintz, May 23, 1871. Hydrochloride or sulphuric acid saturated with an alkali to produce a salt which may remain in the saccharine matter.

Sug'ar-cane Mill. A mill for grinding sugar-cane. See Figs. 1059-1061, page 444. See also SUGAR-MILL.

Sug'ar-cane Plant'er. A machine for planting ratoons of cane in furrows made by the plow, to afford sprouts for the future plant.

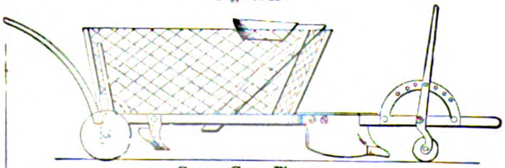
Fig. 6044.



Vacuum-Pans.

In Fig. 6045, the cane-slips are placed in the chute and delivered into the furrow made by the first plow; the two side-plows cover the cane, and the scraping-plates level the ground. The body is vertically adjustable by lever-arms carrying the wheels.

Fig. 6045.



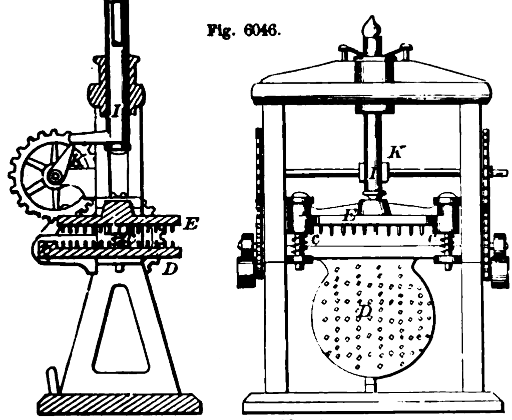
Sugar-Cane Planter.

Sug'ar-clar'i-fi'er. A filter for removing mechanical impurities or feculences from sirup. See

SUGAR-DRAINER; CENTRIFUGAL FILTER; etc. Or a DEFECATOR, see Fig. 1605, page 683; or other process by which immature, non-crystallizable, or fermenting matter is removed from sirup.

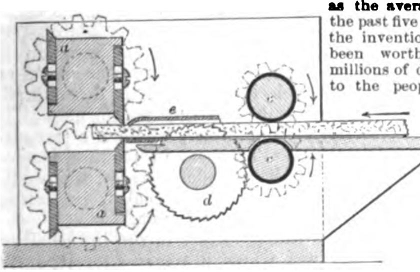
"In 1859, Richard H. Stewart patented a process of clarifying cane-juice for the manufacture of sugar, treating it with sulphurous gas. Sugar purified by this method was increased in value ½ cent per pound. The war hindered the introduction of the improvement, but since 1867 it would be difficult to find a planter who has not adopted it. In 1860, the sugar crop of Louisiana was 500,000 hogsheads. In 1867, it was only 5,000. In 1872, it had reached 80,000. If we take this figure as the average of the past five years, the invention has been worth two millions of dollars to the people of the United States during that period. Stewart received, from the fourteen years of his original patent, $44,350; or, in other words, he made from his patent in fourteen years not quite as much as the country made from it in six weeks. When the sugar production of Louisiana shall have reached its former extent, this improvement will add two millions and a half of dollars annually to the wealth produced by that State." — WHITNEY.

Fig. 6046.



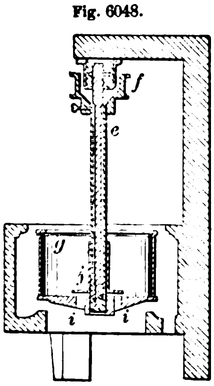
Sugar-Cutting Machine.

Fig. 6047.



Cube Sugar-Machine.

Fig. 6048.



Centrifugal Machine.

Sug'ar-cut'ting Ma-chine'. A machine for cutting up loaf or hard sugar into lumps.

In the example (Fig. 6046), the sugar in flat cakes is inserted between the hinged table *D* and the reciprocating-table *E*, both of which are studded with quadrangular pins. The table *E* is swung up and down by a cam-movement; the table *E* is struck by a hammer *I*, lifted by means of the wiper *K*, and is immediately after the impact thrown up by springs *c c*.

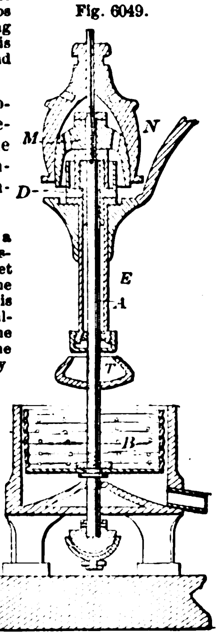
Fig. 6047 is a machine to cut loaf-sugar into cubes, operating upon slabs which are either molded in that form or sawn from the loaf.

The slab of sugar is laid upon the bench and pushed over the gang of parallel vertical saws *d* (only one of which shows in the elevation), which cut it into slips; passing onward, these slips are cut into cubes by the co-acting revolving cutters *a a*. The sugar is held by pressure-rollers *c c* and spring-clamps *e*.

Sug'ar-drain'er. An apparatus for separating the residual, non-crystallizable matter from sugar by centrifugal action. A centrifugal machine.

Weston's (Fig. 6048) has a spindle suspended from an elastic bearing or a ball-and-socket joint above. Surrounding the spindle and supported by it is a hollow shaft *e* having a pulley *f* at its upper part. The cylinder *g* is perforated at the periphery in the usual way and has openings *i i* at the bottom for discharging the sugar after the moisture is expelled. These openings are closed by a plate at the bottom of a sleeve *j*, which is lifted for the purpose of discharging. The expelled molasses flows into an annular trough in the base of the exterior casing, and access to the bottom of the cylinder is entirely unobstructed. The yielding bearing at the top of the spindle permits it to assume a truly vertical position when the cylinder is charged, and prevents any tendency to irregularity of motion when revolving.

Fig. 6049.



Sugar-Draining Machine.

In ordinary machines of this class the sugar is discharged at the top. In the English patents of Hardman, October 5, 1843, and Alliott, February 3, 1851, it was proposed to effect the discharge at the bottom. In the former, a circular plate below the cylinder was employed for closing the discharge-openings; this was lowered a certain distance for the purpose, still, however, remaining in the way. In the latter, the cylinder had to be turned, so as to bring an opening in its bottom directly over a funnel through which the discharge was effected. In both, the bearings of the shaft were under the cylinder, and obstructed the free delivery of the sugar.

Sug'ar-drain'ing Ma-chine'.

In Lafferty's centrifugal machine (Fig. 6049), the filter-box *B* is of corrugated metal, surrounded by woven wire. The shaft *A* is driven by a compound pulley composed of a drum *N*, which receives the belt, and an interior conical part *M* fitting within the former, and having perforations which cause a circulation of air around the shaft to cool it when in rapid motion. The oil from the cup *D* passing down the shaft flows down between it and the hollow exterior casing *E*, and is finally received in the drip cup *T*, which is so shaped as to prevent the oil being thrown out by centrifugal action. By lifting the barrel *N* it is disconnected from the cone *M*, and the rotation of the shaft is stopped. The appurtenances of the shaft are sustained by a hanger.

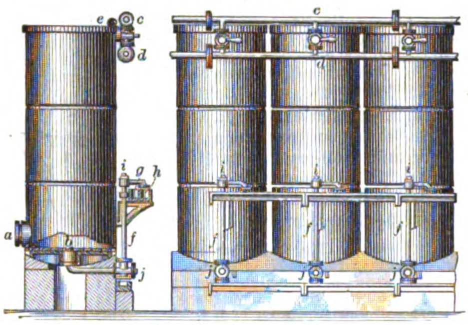
See also CENTRIFUGAL FILTER, Figs. 1213, 1214, page 514.

Sug'ar-e-vap'o-rat'or. A furnace and pan for condensing saccharine juices or solutions. See EVAPORATOR, pages 811 – 813.

Sug'ar-fil'ter. (*Sugar-making.*) The vessel employed for cleansing and decolorizing the defecated sirup by the aid of bone-black.

Those commonly employed are about 10 feet high by 4 feet in diameter, and open at the top; three are shown in the illustration. Near the bottom is a man-hole *a*, and below this an iron grating *b*, upon which a piece of filter-cloth is laid, and the vessel then filled with charcoal to within about a foot of the top. Sirup is then admitted through the pipe *c* until the charcoal has absorbed nearly all the coloring matter which it is capable of doing. The supply of sirup is then shut off, and cane-juice from the defecators is let on through the pipe *d* expelling the sirup; the power of the charcoal having been previously exhausted, its action upon the juice is simply mechanical. When this has continued to flow some time, it is shut off, and pure water is let in from the pipe *e*. This, in turn, drives out the cane-juice, and is allowed to flow until it no longer extracts

Fig. 6050.



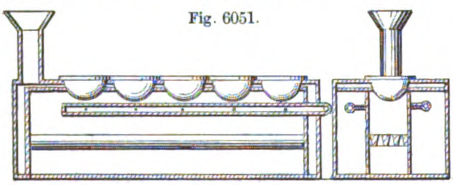
Sugar-Filtering Apparatus.

sufficient saccharine matter to pay for concentration. Several filters are employed, so that while one is filtering sirup, the second may be filtering cane-juice, and the third be cleansed by water.

The liquor and juice are drawn off by the pipe *f*, which discharges into the gutters *g h* through the swivel-joints *i*. The water is discharged through the cock *j* into the gutter below.

See also BAG-FILTER, Fig. 522; CENTRIFUGAL FILTER, Figs. 1213, 1214. See also BONE-BLACK, pages 327, 328.

Fig. 6051.



Sugar-Furnace.

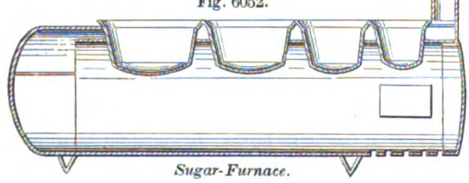
Sug′ar-fur′nace. One in which pans are set for boiling sugar-cane juice, the sap of the maple, or other saccharine solutions.

Fig. 6051 shows one in which air-jets to promote combustion are admitted below the pan.

In Fig. 6052, the kettles are set in a cylindrical metallic furnace, which may be made from a worn-out steam-boiler. The return caloric current passes through flues enveloping the upper part of the kettles.

See also EVAPORATOR, pages 811–813.

Fig. 6052.



Sugar-Furnace.

Sug′ar-gran′u-lat′or. Hersey's sugar-dryer is for granulating damp sugar.

The sugar is fed into one end through a spout, by a set of rolls placed above the machine, and by lifting shelves on the inside of the outer cylinder is carried up and dropped in a continuous shower upon the heating cylinder, and rolls off by the rotation of the machine, to be again carried up, working forward to the opposite end by the inclination of the apparatus, and is there delivered into the screen for separating into the different grades.

The steel plate heater-cylinder is put centrally within the iron conveyor-cylinder, which is 23 feet long and 6 feet in diameter, the heater-cylinder being 20 feet long and 36 inches in diameter, and makes five revolutions per minute. A striker passes off any sugar that may adhere to the cylinder when first entering the machine, and is operated by cams. The machine is rotated by means of outside gear on the conveyor-cylinder.

The current of air constantly passing through the machine carries off the moisture from the sugar through a pipe. The sugar is delivered cool from the end into which the cold air is passing, so that it does not cake, and can be immediately barreled, and will not cause the barrels to shrink.

Sug′ar-ket′tle. A kettle for boiling the sap of the sugar-maple (*Acer saccharium*), the sorghum, or the cane. A *sugar-pan*. See EVAPORATOR.

Sug′ar-ket′tle Bat′ter-y. A range of kettles in a sugar-furnace. See SUGAR-FURNACE.

Sug′ar-ma-chin′er-y. The old system of boiling in open pans is still in operation in cane-producing countries. The cane, on being passed through the rollers of the grinding-mill, is deprived of its juice, and the stalk or *bagasse* is carried on an endless belt to fall into a cart below, to be spread in the fields to dry, to form fuel for the furnaces. Meanwhile the juice runs through strainers, and is lifted by a force-pump to oblong troughs, which stand near the chimneys of the furnace. In these it is allowed to settle, and the scum rises in a few minutes to the surface, a gentle heat being applied. The juice is then drawn off into a train of copper kettles below, to be converted into sugar.

In the first of these kettles it is treated to a little milk of lime, which causes the scum to rise in a body to the surface, when it is removed by a skimmer. From this pan it is advanced to others, according to its advance toward crystallization, nearer and nearer to the mouth of the furnace, boiling furiously until it reaches at last the pan called the *teache-pan*, or *strike-pan*, over the mouth of the furnace. As the entire contents of one pan is discharged into the next, at the same time that a fresh supply of juice is introduced from those behind it, all are kept full, and the process of dipping is a very lively one, when the fires are well kept up. The feculences are principally skimmed off in the rear pan, in which the crude juice is introduced, but they are also skimmed off the boiling liquid in the other pans as they arise.

In the last pan the ultimate condensation is reached, and the sirup is subjected to the *teache* or touch test, by which its condition is determined. This is a delicate test, requiring judgment, but is preferred to the saccharometer, where the "sugar-master" is skillful. The test in making maple-sugar is different, as it is made in water, the condition of the *wax*, when rapidly cooled, indicating whether it is ready to take off or not.

From the *strike-pan* the sugar is run into shallow coolers (see COOLER), where it remains for about 24 hours, and is then transferred to cones or hogsheads to drain off the molasses. The hogsheads are set in a room called the *purgery*, resting on beams, and the molasses draining into a cistern beneath. (See PURGERY.) The cones are set into racks, and, after an interval of a couple of days, are removed to the *purgery*, the plug at the apex of the cone being removed as may be necessary to allow the non-crystallized portion to drain off. In about 20 days the loaf of sugar is found to be hard; white at the base, darker in the middle, and yellow, with molasses at the top, which, when dried, forms three grades in the Havana market. See EVAPORATOR.

The following are the processes: —

Grinding. The cane is first crushed by a powerful mill, driven by an engine of 60 horse-power, and having 3 rollers 8 feet in length and 3 feet in diameter. The cane is supplied by an endless belt moving in a channel-way of the same width as the rollers, and running almost level with the ground for 50 or 60 feet. 30 or 40 women are constantly employed in supplying this feeder with cane-stalks, which are smoothed by others. The stalks pass unceasingly between the rollers, the crushed cane falling upon another endless belt, which carries it out of the mill and drops it into light carts, which carry it to the fields to dry. This duty requires 7 carts. The cane is brought by trains of cars on a tramway from the field. See CANE-MILL.

Straining. The juice runs in a heavy stream from the mill, and passes through coarse strainers, which intercept dirt and pieces of cane. It is then pumped into cisterns in the boiling-house, from whence it is drawn in the defecators.

Defecating. These are copper kettles with steam-jackets, and

at the Yngenio San Martin there are 16 in a row. The juice being turned into one until it is nearly full, the stopcock is closed and that of the next opened. Steam is then admitted to the jacket around the first, a little slaked lime is added, and it is raised to the boiling-point. Being allowed to simmer a few minutes, a thick scum rises, and the consistence of the latter determines the time to draw off. The defecator discharges by a pipe beneath it, the clear juice running into a trough; as soon as it begins to run dirty with the broken scum, the stream is turned into another trough, leading it to a receptacle whence it is withdrawn to be purified again. A jet of cold water cleans the defecator, and it is again ready for duty. The same is true of each defecator, and when properly proportioned in size and number to the other machinery, they are worked in a regular succession, the first being again ready for duty as the last is charged, and the juice from the mill being kept constantly running. In the San Martin the circuit is completed in about an hour.

Filtering. The hot stream of defecated juice is poured into charcoal filters, 10 feet high, 23 of which stand in a row, dividing the defecators from the bulk of the machinery; and behind them is another rank of 20 filters, as many feet in hight, in which the juice is finally purified. The filters are charged with animal charcoal, and hold an amount valued at $ 2,000. A charge lasts about 7 days, and is then replaced by fresh bone-black, the sticky and lusterless coal from the filters being taken to the washing-machines, and thence to the furnaces to be reburnt. This is repeated until the coal becomes too fine for use, the loss being about 10 per cent at each use. See page 328.

It may be mentioned at this point that processes for defecating by the use of sulphurous gas have been used, and apparatus for this purpose patented. The object is to bring the juice in contact with the gas, which removes the tendency to fermentation, and thus prevents the disorganization of the sugar, by which it is turned to grape-sugar, increasing the yield of molasses and decreasing that of crystallizable sugar.

Condensing. After passing through the smaller filters, the juice is carried to the condensers, which perform the double duty of condensing the vapors rising in the vacuum-pan, and of evaporating the cane-juice which flows over them. These condensers constitute the distinguishing feature of the Degrand (Derosne) train, and are largely employed on some estates. A condenser is formed of horizontal pipes about 6 inches in diameter, arranged in a tall rack and formed by a convolution of the pipe, so that while the vapor from the vacuum-pan passes back and forth downwardly on the inside, the juice from the filters drips on to the upper fold of the pipe, and from thence to the next below, so as to keep the outside of the whole series wet, parting with a portion of its moisture, which rises in clouds of steam to the roof of the building.

Objections have arisen to the use of the Degrand condenser from the difficulty of keeping the pipes covered with an even film of juice, and the presence of clouds of steam which become condensed again in the building and interfere with other operations; the crystallization of the sugar, for instance. In some establishments the Degrand condenser is merely used to obtain the vacuum in the pan, water being dripped upon it instead of sirup. See CONDENSER, Fig. 1421.

Boiling. After passing the condensers, the sirup passes to the first vacuum-pans. In them the sirup is farther condensed, but not to the stage of granulation, it being subjected to a farther clarifying process before the final boiling. The vacuum-pan consists of a closed vessel with means for withdrawing the vapor as it is generated, and lowering the pressure of the atmosphere upon the sirup, so that the latter will boil at a lower temperature. This is favorable to the color of the sugar, as it is not subjected to a burning heat, and is also protected from the action of the atmosphere. It should have been mentioned that all the heating operations, in the defecators and in the vacuum-pans, are by means of steam under pressure. The vacuum-pans differ in some respects in their construction, though possessing the peculiar characteristic cited. They are spheroidal or nearly so, or cylindrical; are generally heated by jacket and internal coil, and are furnished with pipes and stopcocks, by which the sirup and steam are supplied to their respective places, the water of condensation removed, the condensed sirup discharged, etc. See VACUUM-PAN.

The usual form of Derosne's vacuum-train is what is called the double effect; that is, two pans stand side by side, one of which is boiled by the steam rising from the sirup in the other, the sirup also being drawn at intervals from the first to the second. In the San Martin they possess two trains of three pans each, the middle pan being slightly the largest and discharging its steam into both the others. In some places a treble effect has been tried, the vapor from the first pan boiling the sirup in the second, and that from the second boiling the contents of the third, but the plan does not seem to have been practically successful. The proof of the condition of the sugar is by *teache*, or touch, or by saccharometer, as in the case of the open-pan boiling, the sirup being withdrawn from the pan by a proof-stick for this purpose. See SACCHAROMETER.

Second Defecation. When the panful is brought to a density ranging from 26° to 28° B., where it is about half sugar, it is discharged into caldrons for farther defecation. The heat is kept up in the defecators by means of steam-coils, into which the steam is admitted at will. The liquor is brought to a froth, raising a scum, which is removed; the steam is turned off, and the action repeated each time it comes to a froth, the heat being damped and the scum removed.

Second Filtering. The sirup is now turned into the high filters, which are 20 feet high, and charged with bone-black; from them it issues a clear, bright, yellow liquid, ready for the final boiling, which is accomplished in the great vacuum-pan, called the *strike-pan*, where it is concentrated finally, being brought to the stage of crystallization.

Second Boiling. It is here boiled at a temperature of 180° Fah., but gradually, as the sirup thickens, the temperature is lowered, until, when the crystals have begun to form, the heat is not greater than 160° Fah. It is now thick with crystals of sugar floating in sirup, and the trial by *teache* is repeated frequently. The engineer peers anxiously through the glass windows at the boiling sirup, and finally makes preparations to discharge the contents of the pan into the heaters below. The sirup falls from the bottom of the strike-pan of a rich auburn color. The great vacuum-pan of the Yngenio San Martin is a magnificent piece of workmanship, costing $ 70,000, and capable of boiling in a day from 1,100 to 1,500 *panes* or cones of sugar, containing 100 pounds each of green sugar.

The heaters which receive the sirup from the vacuum-pan are kept hot by steam-jackets; their contents are stirred freely, to encourage granulation, and are then removed to the sugar-cones, which stand for a day in the high temperature of the boiling-house, and are then removed to the purgery, where they undergo the claying-process and are deprived of their molasses. The San Martin purgery is 150 × 400 feet, and affords room for 22,220 cones. One floor is pierced for the cones, and the floor below is used for a packing and drying house.

Drying. The lower room has double rows of cars, one above another, placed on tracks, and so arranged as to be run out into the sunshine with their loads of moist sugar to dry. The cones are broken into three pieces, according to quality, the base being whiter, the middle a second grade, and the tip being moistened and passed through the centrifugal machine to remove the molasses.

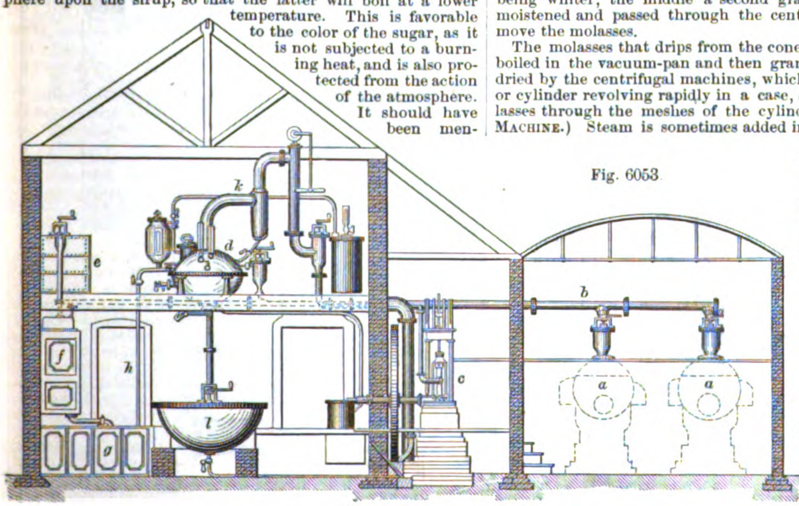
The molasses that drips from the cones in the purgery is reboiled in the vacuum-pan and then granulated in tanks. It is dried by the centrifugal machines, which consist of a wire cage or cylinder revolving rapidly in a case, and expelling the molasses through the meshes of the cylinder. (See CENTRIFUGAL MACHINE.) Steam is sometimes added in the centrifugal dryer to assist in expelling the molasses, thereby whitening the sugar.

The modes of packing do not need description.

Fig. 6053 shows a more modern plan.

a, steam-boilers.
b, steam-pipe.
c, engine.
d, vacuum-pan.
e, defecator.
f, bone-black filter.
g, cistern.
h, pipe leading to vacuum-pan.
k, air and steam exhaust-pipe from pan.
l, pan to receive condensed sirup from vacuum-pan.

Fig. 6053



Sugar-House.

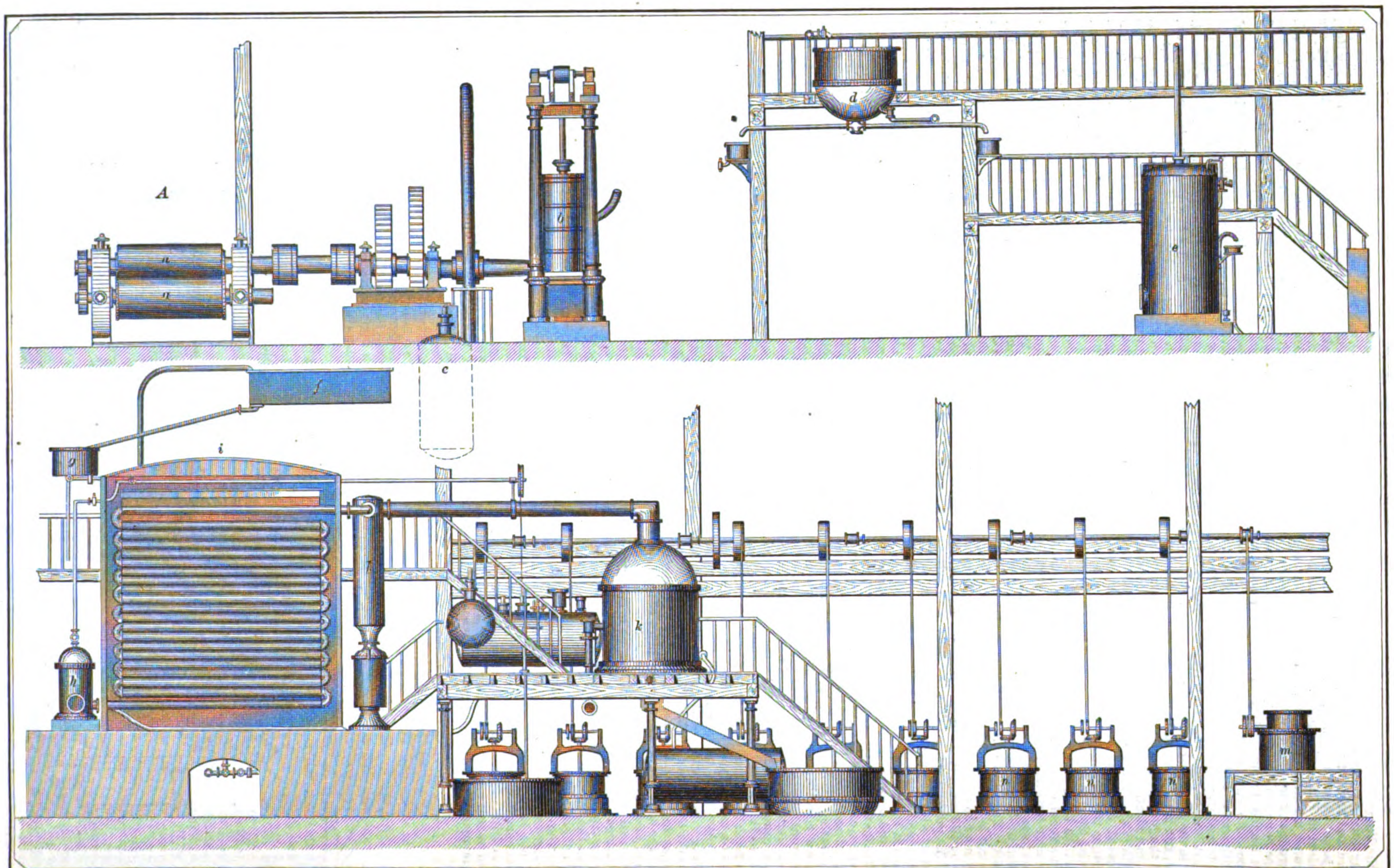
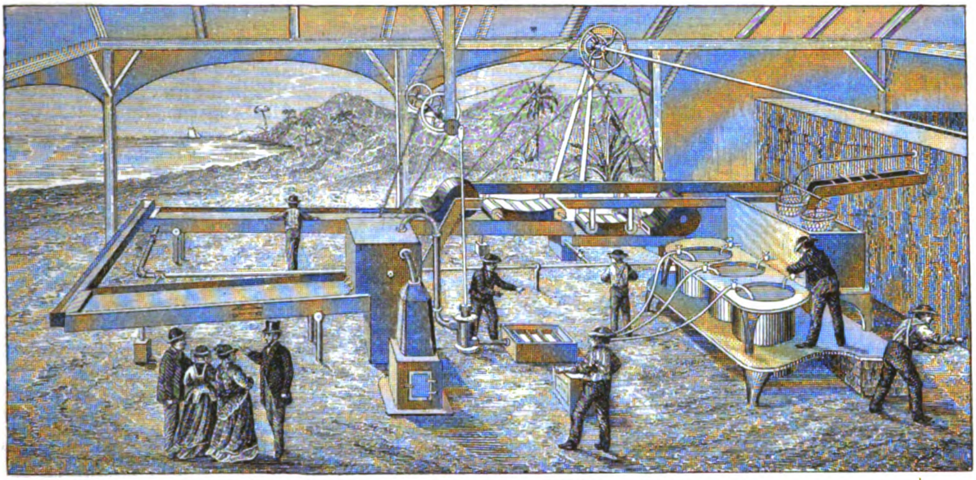


PLATE LXVI. VACUUM-PAN AND SUGAR MACHINERY OF A CUBAN PLANTATION.

See page 2450.

Fig. 6054.



Aschenbrenner's Sugar-Apparatus.

Plate LXVI. represents a complete system of sugar-machinery built by M. M. Cail & Co., of Paris, for a Cuban plantation. *A* is the grinding machinery; the rollers *a a* are driven by intermediate gearing from the engine *b*. The expressed cane-juice flows into a tank, whence it is conducted into the filter *c*. When this is sufficiently full, the supply is cut off, and steam admitted through a pipe, forcing the juice up into the purifiers *d*, six in number. These are heated by coils with steam under a pressure of 60 pounds to the inch, and are provided with proper supply and discharge pipes. About three per cent of lime is added to the juice, part being thrown in previous to its withdrawal from the tank.

After being purified by boiling, the juice is filtered through animal charcoal in cylinders *e*, to each of which a three-branched pipe leads for the admission of juice, sirup, and steam as required. Each filter has a perforated false bottom, from whence the juice flows into a tank *e*, and is lifted by steam pressure into a vessel *f*; it thence flows into the vessel *g*, which regulates the supply to the evaporating-condensers *h*, in which a vacuum is maintained, and thence passes through the tubular steam-heated condensers *i*, after which it is pumped into the vacuum-vessel *k*, in which the processes of evaporation and condensation are completed. Separators *l* receive any water or juice that may pass out with the vapor.

The juice, now concentrated to sirup, is clarified by blood in the usual way, and again filtered and concentrated and placed in molds, where it drains and crystallizes. In order to remove any remaining molasses and thoroughly dry the crude sugar formed by this last process, the loaves are ground in crushing-machines *m*, and the pulverized sugar is then placed in the centrifugal machines *n*, driven at the rate of more than 1,200 revolutions per minute, by which the remaining moisture is expelled.

The above machinery is capable of treating 100 tons of cane daily, producing 8 tons of sugar, and cost $ 160,000.

It is claimed that in the ordinary processes of manufacture, less than one half of the saccharine matter in the juice of the cane is extracted as crystallizable sugar.

The apparatus of Dr. Aschenbrenner, shown in Fig. 6054, is designed to produce the sugar in crystalline form, no molasses being formed, unless it is so desired.

The juice from the crushing is delivered through the trough seen to the right; in this are placed two filters of different degrees of fineness, which separate mechanical impurities; the juice then passes through a flannel strainer, of which several are provided, so that one may be removed, washed, and replaced by another, as required, and is then received in a tank, from which it is drawn off into three open kettles having double bottoms and heated by steam, in which it is purified by lime and magnesia, the sediment being drawn off at the bottom. The purified juice then passes through siphons to another filter, which separates any remaining impurities held in suspension. From the filter the juice is pumped into a case, where it is agitated by a paddle-wheel and subjected to the action of sulphurous fumes from a furnace, by which it is bleached, and thence flows into a steam-heated metallic trough, from whence it is conducted to a second and third similar trough successively; at the lower end of the third trough it is subjected to the action of a fan, which cools it and promotes the evaporation of the vapor. It has now become so thick as to require the use of a scraper, which consists of an endless band moving around pulleys and carrying a series of blades; this conveys the sugar to another incline, where it is acted on by a second fan. It is now entirely crystallized, and is removed by hand into a receiver. When desired to produce molasses, a small proportion may be obtained by making the incline of the troughs steeper and dispensing with the use of the fans.

Other plans of treating the cane have been suggested, and in some cases adopted. The following may be mentioned: —

De Manöel and Brafen, of Martinique, obtained U. S. patent, February 22, 1848, for a process of drying and pulverizing sugar-cane, and then washing the saccharine matters therefrom to be manufactured into sugar by evaporation in the ordinary way. The cane is chopped into small pieces by a cane-cutter, is dried in a kiln and ground in a mill. The meal is then placed in tubs, which are tightly closed, and water passed in succession through them till the sugar is all extracted. The filter and boiling-pan conclude the operation. See also DIFFUSION-PROCESS, Fig. 1652.

See under the following heads: —

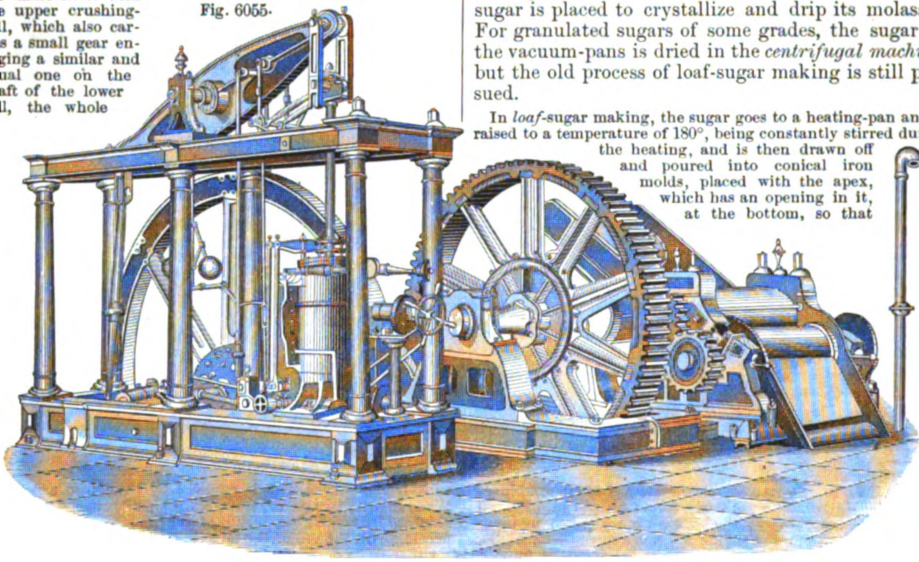
Sug'ar-mill. A mill for expressing the juice from sugar-canes. It has usually three rollers; two in the same horizontal plane, and the third over and between these. The canes are fed in between the upper and first horizontal rollers, where they receive their first squeeze, the juice running down into a trough at the base of the mill; they then travel onward, receiving a second squeeze between the top roller and the second horizontal roller, which extracts the remaining juice. The residual woody fiber, termed bagasse, when dried, is used as fuel for the furnace-boiler. Fig. 6055 illustrates an approved form of sugar-mill, with the beam-engine for driving it.

In the mill (Fig. 6056), the crushing-rolls are operated directly from the fly-wheel shaft of the steam-engine through three pairs of interposed gear-wheels and pinions; the last gear-wheel is on the same shaft with the upper crushing-roll, which also carries a small gear engaging a similar and equal one on the shaft of the lower roll, the whole forming a very compact and simple arrangement. See also CANE-MILL.

Sug'ar-mold. A conical iron mold in which sugar is placed to crystallize and drip its molasses. For granulated sugars of some grades, the sugar for the vacuum-pans is dried in the *centrifugal machine*, but the old process of loaf-sugar making is still pursued.

In *loaf*-sugar making, the sugar goes to a heating-pan and is raised to a temperature of 180°, being constantly stirred during the heating, and is then drawn off and poured into conical iron molds, placed with the apex, which has an opening in it, at the bottom, so that

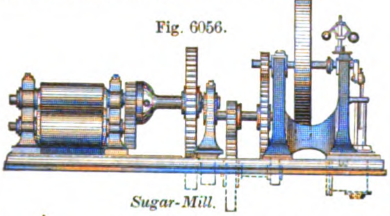
Fig. 6055.



Sugar-Mill

whatever liquor has remained may drain off through the opening. After several hours, the *loaves* left in the molds are *liquored* by pouring in at the top a clear solution of pure sugar, which removes the remaining coloring-matter. The

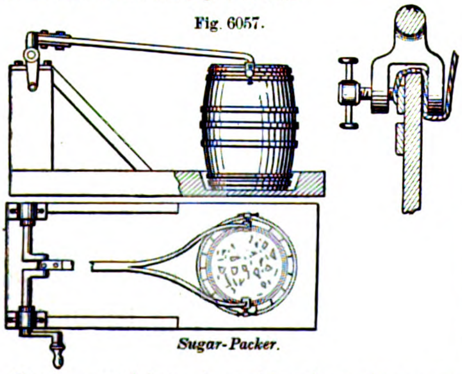
Fig. 6056.



Sugar-Mill.

liquoring-process is sometimes repeated several times, until the loaves become perfectly blanched. Then they are left two or three days in a drying-room heated by steam, are trimmed, if necessary, in a lathe, and are finally papered for market. The trimmings, the draining from the molds, etc., are saved for the manufacture of inferior grades of sugar. The old method of employing molds takes a longer time and is more expensive than the centrifugal process, and is gradually being superseded by the latter as the taste for loaf-sugars declines.

Fig. 6057.



Sugar-Packer.

Sug'ar-pack'er. A machine for packing sugar in barrels.

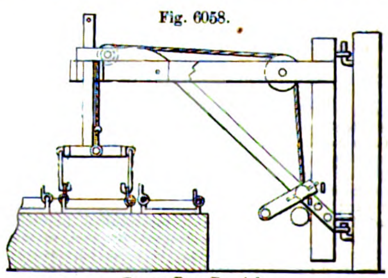
In the example, the barrel to contain the sugar rests in a cavity in the platform, and by means of a forked bar with a screw clamp on each fork end, the upper rim of the barrel, with the filling bag, is tightly clamped, while the single opposite end of the forked bar is fitted to a crank, from which it receives and imparts to the barrel a reciprocating motion.

Sug'ar-pan. See EVAPORATOR; SUGAR-FURNACE; SUGAR-MACHINERY; VACUUM-PAN.

Sug'ar-pan Lift'er. A crane rigged in a sugar-house to lift flat pans from the furnace. It is only seen in a certain arrangement of devices, where flat pans travel along the walls of the furnace as the boiling proceeds, being lifted at the rear end as the boiling is completed, and the pan set aside that the contents may granulate.

The hoisting-cord is attached to a frame from whose four corners depend hooks for engagement with the rings at the corners

Fig. 6058.



Sugar-Pan Derrick.

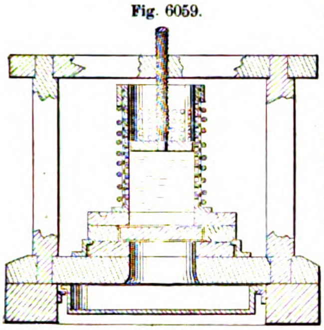
of the pan. From the center of the frame arises a sliding upright which passes through the derrick to steady the frame.

Sug'ar-press. A machine for expediting the drainage of the molasses from the sugar.

The box has perforated sides, so that the molasses expressed from the crude sugar may escape and be collected outside. After the pressure has been carried to a sufficient extent, a wedge in the platform, upon which the press-box stands, directly beneath the box, is withdrawn, and the dry sugar falls through the opening into a box below.

Sug′ar-re-fin′ing. The process of purification or discolorization of raw or brown sugar.

Fig. 6059.



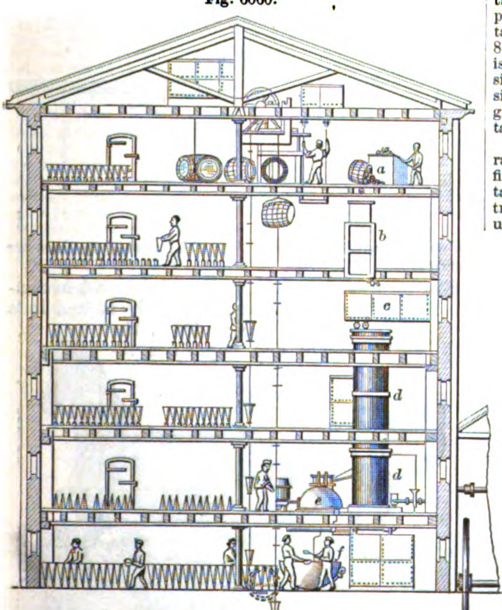
Sugar-Press.

The sugar is, —

1. *Dissolved* in water, a little blood and lime-water being added.
2. *Filtered* in bags, to remove feculences.
3. *Filtered* through animal charcoal, to remove color.
4. *Boiled* in a vacuum-pan, to concentrate it.
5. Crystallized in molds.

Fig. 6060 is a transverse section of a sugar-refinery. The packages are hoisted to the top floor of the building, emptied, and transferred to the dissolving-pan *a*, where the sugar is mixed with water and agitated by a mechanical stirrer. A temperature of about 165° Fah. is maintained in the pan by means of a steam-coil, and the solution, having been brought to the specific gravity of about 1.25, or 29° Beaumé, is transferred to bag-filters within cases *b* (see BAG-FILTER). The sirup passing through these is drawn off into a vat *c* on the floor below, and thence conducted to the bone-black filters *d*; the decolorated liquid, after passing the filters, is drawn into vacuum-pans *e* and evaporated at a heat of 170° to 180° Fah. at the beginning of the process, reduced to about 145° when crystallization is sufficiently advanced. While yet sufficiently fluid, it is let down through a valve in the bottom of the pan to the heater *f*, where its temperature is raised to 180°, and stirred until crystallization is complete. The moist crystalline mass is then drawn off into ladles and transferred to conical molds, for making loaf-sugar. After standing several hours to drain and solidify, the molds and their contained loaves are conveyed to an apartment above, kept at a temperature of about 100°, where they are still farther drained, and a clear saturated solution of sugar poured upon them which percolates through and whitens them; this is repeated several times. When the proper color is produced, they are transferred to a stove heated to 130° or 140°, where they are kept two or three days, till they are baked thoroughly dry.

Fig. 6060.



Transverse Section of a Sugar-Refinery.

The drainage from the molds is again concentrated by boiling, to form a lower grade of sugar; the uncrystallizable portion remaining after this operation constitutes treacle or sirup.

For producing granulated sugar, the processes, previous to boiling, are conducted as before. Large vacuum-pans, having extra heating-coils are employed, and the boiling is continued until crystals begin to appear, when more liquor is added, and the concentration continued. This process is repeated several times, to cause the formation of large crystals. When sufficiently concentrated, one half the liquor is removed to the heater, the remainder being left to assist in the formation of crystals in the next charge. After being thoroughly crystallized in the heater, the moist mass is transferred to the centrifugal machine, the rapid rotation of which soon expels the moisture. In order to cleanse the crystals, a small quantity of liquor is sprinkled upon them while in the machine. The percentage of sugar obtained in this and at each subsequent crystallization is considerably less than that obtained in making loaf-sugar, though the total product does not vary materially. The drainage is diluted, filtered through animal charcoal, boiled, and again passed through the centrifugal machines, forming a second quality of sugar having smaller crystals. A third, and sometimes a fourth quality of sugar is produced by similarly treating the resulting drainings.

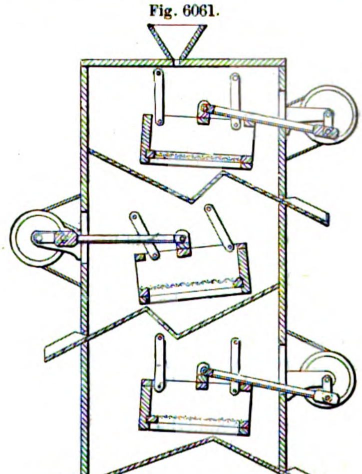
M. Van Goethem, a Belgian sugar-refiner, has a machine in which fifty sugar-loaves are ranged radially in a kind of horizontal wheel, and then the whole is made to revolve with the speed of 800 revolutions in a minute The proper liquid is applied by a beautiful contrivance; and in about twenty minutes the fifty loaves of sugar are found to be not only freed from molasses, but rendered almost completely dry. Many days would be required to effect this by the old method.

Boivin and Loiseau's process is founded upon the use of the sucrate of the hydrocarbonate of lime, for the purification of raw sugar instead of blood, bone-black, etc. For the preparation of this compound, milk of lime is made from the waste sweet liquors of the refinery, and enough sirup added to give the mixture 20° Baumé. This is well agitated, and run through a cooler until the temperature sinks to 68° Fah. From the agitators the liquid flows into vats, where it is partially saturated with carbonic acid: the gas is passed through until the desired precipitate of sugar, lime, and carbonate of lime settles as a gelatinous mass. After the purifying agent has been thus prepared, it is applied in the following manner: —

The raw sugar is dissolved in a cylindrical pan, similar to a vacuum-pan, under diminished pressure. Revolving buckets carry it into receivers over the boilers, and from these it is permitted to flow into the boilers, where it comes in contact with the sucro-carbonate of lime previously introduced, in a quantity proportional to the percentage of raw sugar. They generally take about 650 gallons of the gelatinous sucro-carbonate to 8,000 pounds of sugar. Water is added if necessary; the whole is boiled, and in this way the solution and clarification are simultaneously accomplished. One advantage is that when sirup is boiled in presence of lime, ammonia is evolved, all glucose is decomposed, and anything likely to produce fermentation is destroyed.

The sirup from the boilers is filtered, the excess of lime separated by carbonic acid, and it is farther concentrated and finished in the usual manner. The slimy residues and precipitates are squeezed out in filter-presses until they contain no trace of sugar, and can be thrown away. The wash-water is used in the preparation of new material.

Fig. 6061.

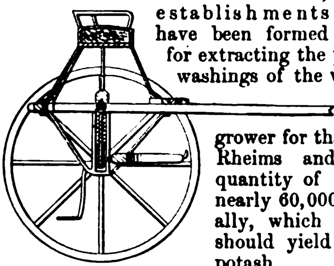


Sugar-Sifter.

Sug'ar-sift'er. A machine for sorting grades of crushed or ground sugar according to fineness of grain. The reciprocating sieves are arranged in a frame, one below the other. One end of each sieve is left open, to allow the sugar to fall on the discharge-spouts, which are arranged alternately on opposite sides of the frame. The sugar passes alternately through the sieves and conducting-troughs and is discharged below.

Su'int. The natural grease of wool. It consists of insoluble saponaceous matter together with a soluble salt containing from 15 to 33 per cent of potash. In the great wool-growing districts of France, establishments have been formed for extracting the potash from the washings of the wool, which are purchased from the wool-grower for that purpose. At Rheims and Elbœuf, the quantity of wool washed is nearly 60,000,000 lbs. annually, which it is estimated should yield 3,000,000 lbs. potash.

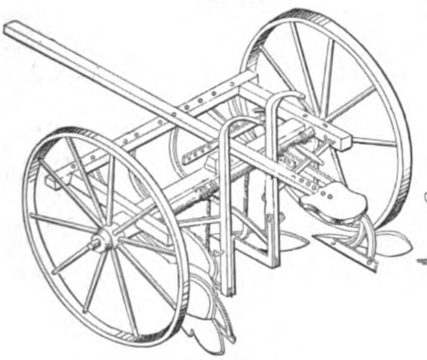
Fig. 6062.



Sulky.

Sul'ky. A light two-wheeled vehicle, having a seat for a single occupant, used as a pleasure-carriage and for trials of speed between trotting-horses.

Fig. 6063.



Sulky-Cultivator.

In the example, the usual elliptical spring is associated with a spiral spring near each wheel. Braced guide-rods from the frame embrace the axle.

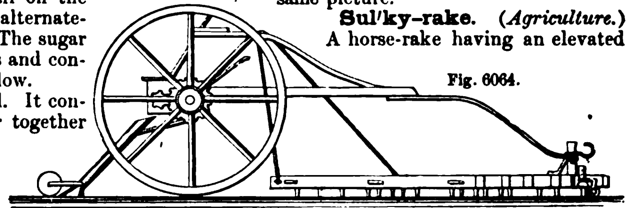
Sul'ky-cul'ti-va'tor. One having a seat for the rider, who manages the plows, moving them to the right or left as the plants in the rows may require.

Sul'ky-har'row. One having a wheeled carriage and seat for the rider. The fore part of the harrow rests upon an adjustable caster, and is connected to the front end of a flexible bar attached to the sulky-hounds. The draft-hook is at this point.

Sul'ky-plow. One having a seat for the plower. In the example, a portion of the seat is just apparent beyond the pulley *G*, on which the plow-supporting chain winds. The Bayeux tapestry, which represents the invasion of England by William I., and the death of Harold at Hastings, shows a plow having a pair of wheels, on which a man rides and drives a horse. A square harrow and a man sowing from a basket are in the same picture.

Sul'ky-rake. (*Agriculture.*) A horse-rake having an elevated seat for the driver. Levers easily accessible to the hand or foot are provided for lifting the rake when it has accumulated sufficient hay to form a windrow, and for holding it clear of the ground altogether when required. The former operation is sometimes performed by means of automatic devices. See HORSE HAY-RAKE.

Fig. 6064.



Sulky-Harrow.

Sul'lage. 1. (*Founding.*) The scoria which rises to the surface of the molten metal in the *ladle*, and which is held back when pouring to prevent porous and rough casting.

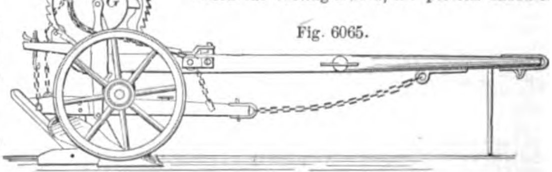
2. (*Hydraulic Engineering.*) Silt and mud deposited by water.

Sul'lage-piece. (*Founding.*) A *dead-head*, or *feeding-head.* A piece of metal on a casting which occupies the ingate at which the metal entered the mold.

When it is desired that a heavy casting (such as a gun of several tons) should be especially solid, it is always poured on end, and, in addition to the length required, a continuation of the mold upward is made. In this piece the sullage rises, hence its name.

When the casting is cold, the portion added is cut off, and, with it, the impurities which floated up there are removed.

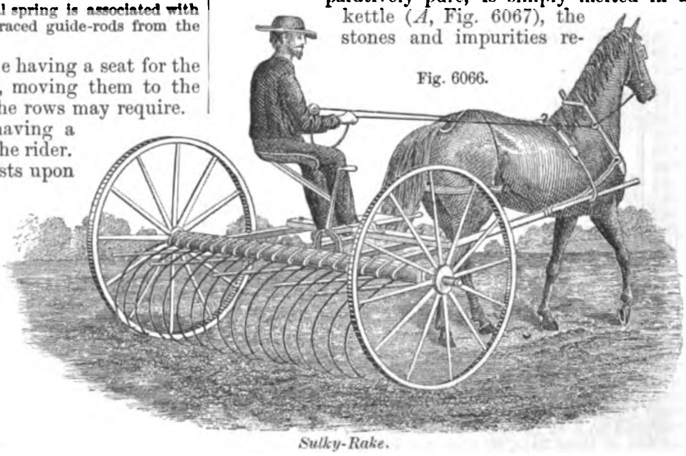
Fig. 6065.



Sulky-Plow.

Sul'phur-fur'nace. Native sulphur, when comparatively pure, is simply melted in a kettle (*A*, Fig. 6067), the stones and impurities re-

Fig. 6066.

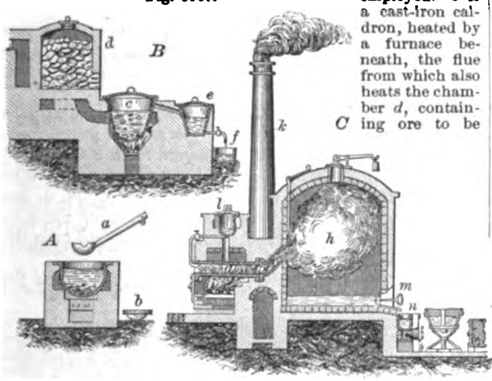


Sulky-Rake.

moved by a *ladle a*, and the mass cast in a mold *b* previously moistened with water, to prevent adhesion.

The stones and gangue containing the sulphur are sometimes roasted in a tall furnace, the fluid sulphur being drawn off at the bottom: distillation is, however, preferable. For this the apparatus *B* is employed. *c* is a cast-iron caldron, heated by a furnace beneath, the flue from which also heats the chamber *d*, containing ore to be

Fig. 6067.



Sulphur-Furnace.

transferred to the caldron. The distillate is condensed in the vessel *e*, and in the fluid state is drawn off into *f*.

***C* represents Michel's apparatus as improved by Lamy for refining crude sulphur. It comprises two cast-iron cylinders, one shown at *g*, used as retorts, and a condensing-room *h*. The retorts are heated by a furnace *i*, the smoke of which is carried off by the chimney *k*. The crude sulphur is placed in the vessel *l*, where it is melted and partially refined, passing into the retort *g*, where it is sublimed, condensing in the chamber *h*, whence it is withdrawn through the tap-hole *m*, fitted with a conical plug, being received in the vessel *n* and then cast into rolls.**

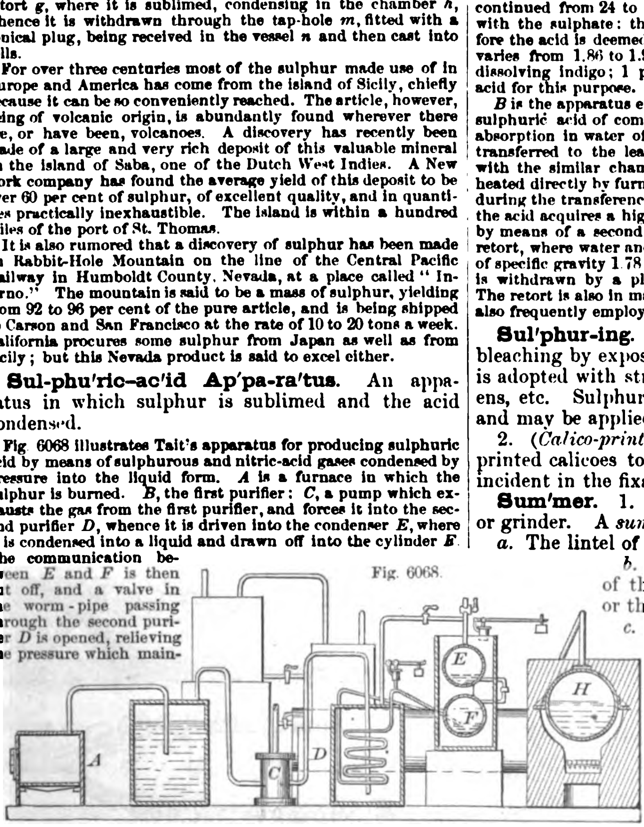
For over three centuries most of the sulphur made use of in Europe and America has come from the island of Sicily, chiefly because it can be so conveniently reached. The article, however, being of volcanic origin, is abundantly found wherever there are, or have been, volcanoes. A discovery has recently been made of a large and very rich deposit of this valuable mineral on the island of Saba, one of the Dutch West Indies. A New York company has found the average yield of this deposit to be over 60 per cent of sulphur, of excellent quality, and in quantities practically inexhaustible. The island is within a hundred miles of the port of St. Thomas.

It is also rumored that a discovery of sulphur has been made on Rabbit-Hole Mountain on the line of the Central Pacific Railway in Humboldt County, Nevada, at a place called "Inferno." The mountain is said to be a mass of sulphur, yielding from 92 to 96 per cent of the pure article, and is being shipped to Carson and San Francisco at the rate of 10 to 20 tons a week. California procures some sulphur from Japan as well as from Sicily; but this Nevada product is said to excel either.

Sul-phu'ric-ac'id Ap'pa-ra'tus. An apparatus in which sulphur is sublimed and the acid condensed.

Fig. 6068 illustrates Tait's apparatus for producing sulphuric acid by means of sulphurous and nitric-acid gases condensed by pressure into the liquid form. *A* is a furnace in which the sulphur is burned. *B*, the first purifier; *C*, a pump which exhausts the gas from the first purifier, and forces it into the second purifier *D*, whence it is driven into the condenser *E*, where it is condensed into a liquid and drawn off into the cylinder *F*. The communication between *E* and *F* is then cut off, and a valve in the worm-pipe passing through the second purifier *D* is opened, relieving the pressure which maintains the sulphurous acid in liquid form, and permitting it to assume the gaseous condition. It flows through this pipe into a receiver, where the nitric-acid gas, oxygen, and steam from the boiler *H* are admitted, and is then submitted to a pressure sufficient to liquefy both it and the nitric acid. The reactions between the oxygen and the nitric and sulphurous acids result in the production of sulphuric acid.

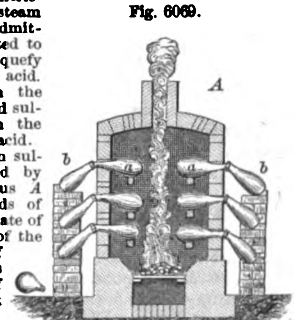
Fig. 6068.

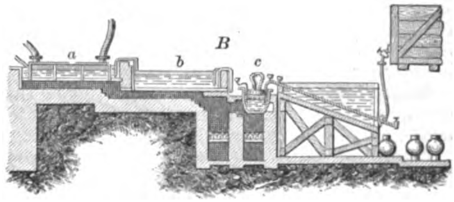


Sulphuric-Acid Apparatus.

Fuming or Nordhausen sulphuric acid is prepared by means of the apparatus *A* (Fig. 6069). 2¼ pounds of vitriol stone (dried sulphate of iron) are placed in each of the flasks *a a*, etc., made of fire-clay, whose necks pass through the walls of the furnace; on the first application of heat only sulphurous acid and weak

Fig. 6069.





Sulphuric-Acid Apparatus.

hydrated sulphuric acid pass over, which are usually allowed to escape. When white vapors of anhydrous sulphuric acid appear, the necks of the flasks are luted to the receivers *b b*, each of which contains 30 grammes water, and the distillation continued from 24 to 36 hours, when the flasks are again filled with the sulphate: this operation is repeated four times, before the acid is deemed sufficiently strong. Its specific gravity varies from 1.86 to 1.92. This variety is principally used for dissolving indigo; 1 part being mixed with 2 of the common acid for this purpose.

***B* is the apparatus employed for concentrating the ordinary sulphuric acid of commerce. The weak acid, prepared by the absorption in water of the gas evolved by calcining pyrites, is transferred to the leaden chamber *a*, connected by a siphon with the similar chamber *b*; the latter and the retort *c* are heated directly by furnaces, and the former by a flue therefrom; during the transference from the first to the second chamber the acid acquires a higher degree of concentration, and is then, by means of a second siphon, conveyed from thence into the retort, where water and weak acid are driven off, strong acid, of specific gravity 1.78 to 1.8 remaining in the retort, whence it is withdrawn by a platinum siphon of peculiar construction. The retort is also in many cases made of platinum, but glass is also frequently employed.**

Sul'phur-ing. 1. (*Bleaching.*) A process of bleaching by exposure to the fumes of sulphur. It is adopted with straw-braid, straw hats, silks, woolens, etc. Sulphurous acid is the bleaching agent, and may be applied by means of a watery solution.

2. (*Calico-printing.*) The process of exposing printed calicoes to sulphurous-acid fumes. It is an incident in the fixation of *steam-colors.*

Sum'mer. 1. (*Carpentry.*) A horizontal beam or grinder. A *summer-tree.*

a. The lintel of a doorway.

b. A floor timber receiving the ends of the joists and supporting the floor or the ceiling, as the case may be.

c. A beam resting on pillars, as in the case of a shop front, and supporting the superincumbent wall with which its front face is flush. Called a *breast-summer.*

2. (*Masonry.*) The first stone or beam laid over a column or beam. A *lintel.*

Sum'mer-tree. A *breast-summer* or *summer.* A horizontal beam brought even with the face

(breast) of a wall, to support a wall above a gap or opening, as a store front, for instance.

Sum'mit. The highest elevation of a railway or canal.

Sum'mit-lev'el. A comparatively level place of a railway, with inclined planes on either side of the mountain. The level *pond* of a canal with lockage at either end, for descent.

Sump. 1. (*Mining.*) *a.* A pit or well in the floor of a mine at the bottom of an engine-shaft, to collect the water, which is pumped from thence.

b. A catch-water drain.

c. The part of a judd of coal first brought down.

2. (*Metallurgy.*) A pit of stone at a furnace to collect the metal at its first fusion.

3. (*Salt.*) A pond of water for salt-works.

Sump-fuse. A thick kind of fuse used for blasting under water. The fuse composition is inclosed in a hempen cord, which is twisted, overlaid with another cord, and varnished. The end is placed in the water-proof cartridge and tied; the end of the fuse is then dipped in pitch, and the protected fuse is ready for duty.

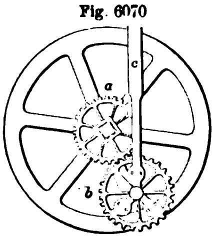
Sump'ing. (*Mining.*) A small square shaft, generally made in the air-headings, when crossing faults, etc., or to try the thickness of the seam.

Sump'ing-shot. (*Mining.*) A charge of powder for bringing down the sump, or for blowing the stone to pieces in a sinking pit.

Sum'pit. The arrow of the *sumpitan*, or blow-tube of Borneo. See ARROW; AIR-GUN, page 48.

Sump-plank. (*Mining.*) Strong balks of timber bolted together, forming a temporary bottom or scaffolding for the shaft.

Fig. 6070



Sun-and-Planet Motion.

Sump-shaft. (*Mining.*) The engine-shaft.

Sun-and-Plan'et Mo'-tion. Invented by James Watt as a substitute for the crank. Watt had applied the crank to the use of his "fire-engine," as he called it, — what was eventually termed a steam-engine. A spying fellow saw the value of the application, and, rushing to London, obtained a patent. See CRANK.

The central gear *a* is called the *sun-gear*, and the outer one *b* the planet-gear. In the form shown in the illustration, the revolution of the planet-wheel rotates the sun-wheel, together with its shaft and the fly-wheel. For this purpose the planet-wheel *b* is fast to the pitman *c*, and its axis is caused to revolve around the wheel without the rotation of the planet-wheel on its own axis. See PLANET-WHEEL and EPICYCLOIDAL WHEEL.

Sun-burn'er. A large reflecting cluster of burners placed beneath an opening in the ceiling, for lighting and ventilating a public building.

Sun-case. (*Pyrotechny.*) A strong paper case filled with a composition which does not burn so fast as rocket-composition. They are driven similarly to rockets, but solid, and are attached, at short intervals apart, to wooden frames, usually circular, to produce what are called stationary and revolving *suns* and other similar effects in pyrotechny, giving out a steady and brilliant stream of light while burning.

Sun-di'al. A time-measurer, in which a gnomon casts a shadow upon a graduated plate.

Said by Pliny to have been invented by Anaximander of Miletus, 550 or 562 B. C. The dial of Ahaz, referred to by Hezekiah, was near two centuries precedent to that of the Grecian. It probably originated with the Chaldees or with the race of Asiatic descent known to us as Egyptians, who were the dwellers in the valley of the Nile at the period of Abraham, and long previous. See DIAL.

Sunk Coak. (*Carpentry.*) A mortise or recess in the scarfed face of a timber, and designed to receive the counterpart *coak* or tenon of the other timber. See SCARF.

Sunk'en Bat'ter-y. (*Fortification.*) In a sunken battery all the earth from the parapet is taken from the interior space, which is lowered from 2 feet to 3½ feet, according to the hight of the gun-carriages to be used. This kind of battery can be constructed in less time than an elevated battery, the mass of earth in the parapet being smaller, but its command over the surrounding country is of course less.

Sunk'en Ves'sels, Rais'ing. Apparatus for lifting foundered vessels.

Sowesbutt's apparatus for raising sunken vessels consists of a number of cases, made just sufficiently heavy to sink when filled with water; each contains a metallic receiver filled with compressed air. They are lowered from the wrecking vessel and attached along the sides of the ship by divers; when the arrangements are complete, valves in the receivers are opened, either by the divers or by self-acting mechanism, and the compressed air thus liberated expels the water from the pontons, which buoy up the vessel. See also Figs 1617, 4148.

Sunk Fence. A ditch with a retaining-wall on one side.

No portion projects above the general level of the ground, and it is not visible at any great distance. For this reason it is also known as a *ha-ha* fence. It is used upon the edge of a garden bordering upon a park, so as to give an apparently greater extent to the home grounds.

Sunk Mo'tions. (*Gearing.*) The driving-gear of a rolling-mill, etc., which is below the level of the floor. The iron floor which covers it is called the *standing*. The sunk motions of the Corliss engine-shafting, Machinery Hall, Centennial grounds, weigh 200 tons.

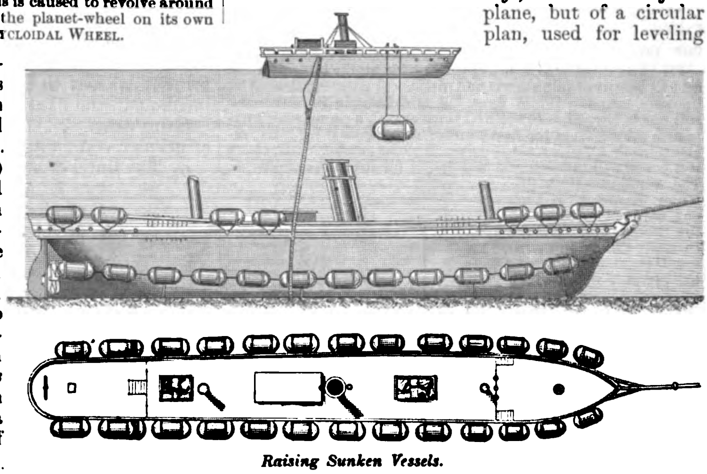
Sunk-pan'el Ceil'ing. One divided off into recessed compartments, with roses in the middle and bolection moldings around them.

Sunn. An East Indian fiber, used in place of hemp.

Sun-pic'ture. A name applicable to all kinds of pictures produced by the action of light upon sensitized surfaces. A *photograph*, or *heliograph*.

Sun-plane. (*Coopering.*) A tool like a jack-plane, but of a circular plan, used for leveling

Fig. 6071.



Raising Sunken Vessels.

down the ends of the staves of a cask or barrel. The groove for the head is then made by the *croze*, and the chamfer of the *chime* is made by the *howel*.

Fig. 6072.

Sunk Fence.

Sun-shade. 1. A parasol.

2. An awning or canopy.

Su-per-fine′ File. A dead-smooth file.

Su-pe′ri-or. (*Printing.*) A character which stands above the general line of the lower-case letters; commonly employed for notes and references.

Fig. 6073.

Sun-Plane.

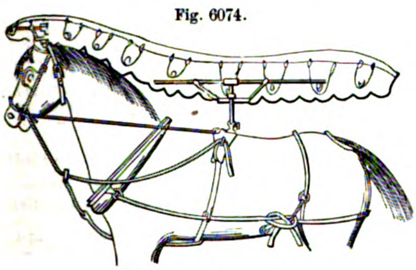
Superior letters............B^a C^b D^m

Superior figures...........A^4 H^{10} L^2

Su-pe′ri-or Slope. (*Fortification.*) A slope extending from the *crest* of the parapet to the summit of the *exterior slope*, with which it forms an obtuse angle. See PARAPET.

Su-per-roy′al. (*Paper.*) A size of drawing and writing paper measuring $27\frac{1}{2} \times 19\frac{1}{4}$ inches, and weighing according to quality and thickness.

Fig. 6074.



Sun-Shade for Horses.

Sup′ple-ment′a-ry En′gine. An auxiliary steam-engine, for feeding the boiler when the main engine is at rest; for working the pumps, cargo-winch, etc.

Sup-ply′-roll′er. (*Printing.*) An intermediate working-roller.

Sup-port′. A term of very general import. A stand, frame, or bed for an engine, machine, apparatus, implement, tool.

(*Chemistry.*) A stand for a blow-pipe lamp, crucible, retort. (See Fig. 4279.) A rack for test-tubes.

Sup-port′er. 1. (*Surgical.*) These are of various kinds, as indicated by their names. Most of them are considered under the following heads:—

Abdominal supporter.	**Pessary.**
Body-supporter.	**Pile-supporter.**
Catamenial supporter.	**Shoulder-brace.**
Fracture-supporter.	**Spinal supporter.**
Hernia-supporter.	**Testes-supporter.**
Menstrual supporter.	**Uterine supporter.**
Obstetric supporter.	**Vaginal supporter.**

2. (*Shipbuilding.*) A knee-piece of timber bolted firmly beneath the cathead, to reinforce it when sustaining the weight of the anchor.

b. A piece bolted to the hounds of a mast for supporting the trestle-tree. See BIBB.

Sup-pos′i-to-ry. (*Surgical.*) *a.* A plug to hold back hemorrhoidal protrusions.

b. A medicinal ball introduced *per ano.*

Sur′base. 1. (*Architecture.*) A cornice or series of moldings at the top of a pedestal, podium, etc.

2. (*Joinery.*) A board running round a room on a level with the top of the chair-backs.

Sur′based Arch. (*Architecture.*) An arch whose rise is less than half the span.

Sur′cin-gle. (*Saddlery.*) A belt or girth to be passed around a saddle, pad, or blanket, to fasten it to the horse's back.

Sur′face-chuck. (*Lathe.*) A face-plate chuck to which a flat object is dogged for turning.

The backs of stereotype-plates may be thus turned off.

The magnetic chuck will grasp iron disks without clasp or dog.

Sur′face-con-dens′er. 1. (*Steam-engine.*) A chamber or congeries of pipes in which steam from the cylinder is condensed. Invented by Napier.

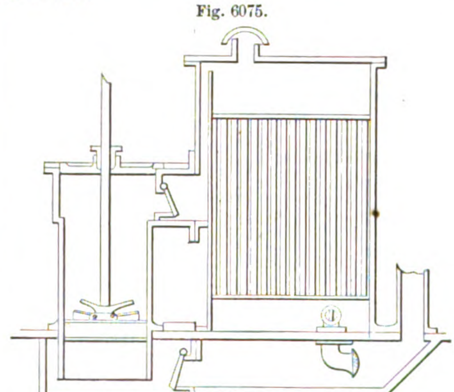
It generally consists of a large number of brass tubes about $\frac{1}{2}$ inch in diameter, united at their ends by means of a pair of flat, steam-tight vessels, or of two sets of radiating tubes. This set of tubes is inclosed in a casing through which a sufficient quantity of cold water is driven. The steam, being led by the exhaust-pipe to one end of the set of tubes, is condensed as it passes through them, and arrives in a condensed state at the other end of the apparatus, whence it is pumped away by the air-pump.

The *surface-condenser* was designed especially for marine engines, to avoid the mixing of the cold salt-water with the water of the condensed steam, which takes place by the use of the injection-condenser, usual in land engines. With marine engines, the cold-water cistern is supplied from the sea, and the constant addition of salt-water in the form of injection, which eventually passes from the hot-well to the boiler, causes the accumulation of salt in the boiler, which is got rid of by occasional *blowing-out* or by a pump. See BRINE-PUMP.

Brunel's surface-condenser was patented in England in 1822, and consists of clusters of pipes communicating with steam-mains and surrounded by the water of the cold-water cistern.

Napier's condenser was a casing around the engine-room, around which the sea-water flowed, entering before and passing out abaft.

Fig. 6075.



Church's Condenser.

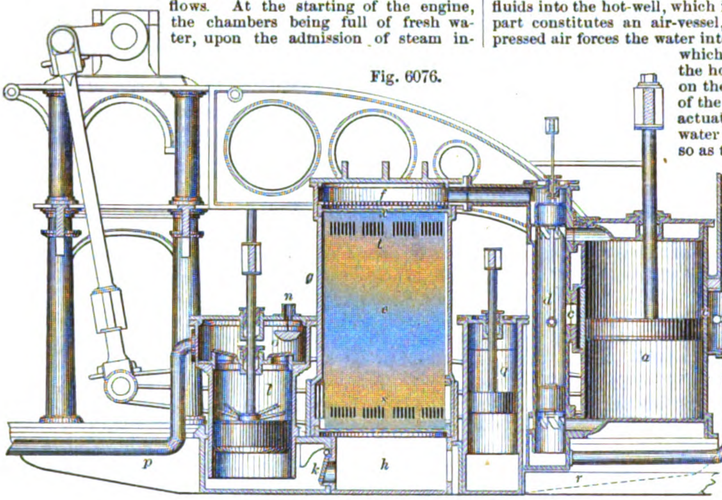
Fig. 6075 is an instance of a surface-condenser for the injection-water of a condensing steam-engine, and may be termed a combined *injection* and *surface* condenser, the surface-refrigeration being applied to the fresh water, which is injected into the condenser to condense the steam.

As has been stated, the cold-water cistern is the usual source of supply for the jet of cold water which is injected as a spray into the condenser. This cistern is supplied from the sources at hand on land, and on our rivers and lakes it is furnished with fresh water, and at sea its contents are salt water.

When the latter is used as injection-water, salt gradually accumulates in the boiler, and on reaching a certain degree of saturation must be removed by "blowing out." (See SALINOMETER.) This condenser aims to keep the contents of the boiler fresh by returning the condensed fresh water to the boiler unmixed with salt water; the latter only being used to cool the condensed water, so that it may be used for the purpose of an injection-spray.

The *refrigeratory* consists of three compartments, the upper one being connected with the lower one by means of a number of small pipes which traverse a cistern, through which a stream of cold sea-water constantly flows. At the starting of the engine, the chambers being full of fresh water, upon the admission of steam in-

Fig. 6076.



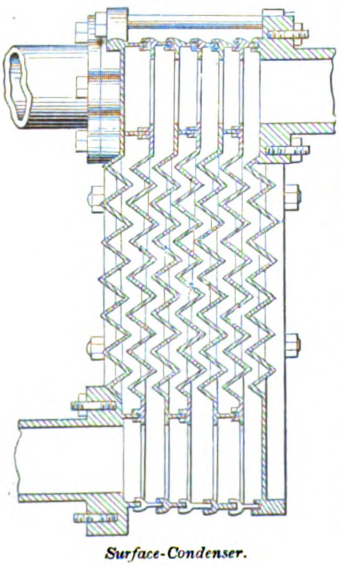
Hall's Condenser.

to the condenser by the pipe, the injection-cock is opened, and the injection-water is distributed in a shower amidst the steam by the rose; the condensed and injection pass together through the foot valve-way into the chamber beneath the air-pump, by whose bucket they are lifted and discharged by another valve-way into the upper chamber, to be again cooled in descending through the pipes which are surrounded by the cold sea-water in the cistern. Here the temperature is again reduced, so that the water becomes again effective in an injection-spray.

Hall's condenser (English) consists of a cast-iron vessel *f g h* divided into three compartments by two horizontal tube-plates. Into these plates are secured the ends of a vast number of copper tubes *e* of small diameter, which form a communication between the upper chamber *f* and the lower chamber *h*. Through the middle compartment *g* a stream of cold sea-water is maintained by means of a cold-water pump *q* and the passages *r s t*, of which the former is the cold-water induction-pipe, and the other two are respectively the induction and eduction ports by which the water enters and leaves the compartment *g*, from whence it is discharged into the sea.

The upper chamber *f* communicates with the eduction steam passage from the cylinder *a* and valve-chamber *d*; and the lower chamber *h* communicates by the foot valve-way *k* with the well of the air-pump *l*.

Fig. 6077.



Surface-Condenser.

The steam from the eduction-pipe, entering the upper chamber *f*, is instantly dispersed through the condensing-tubes *e*, which are surrounded by cold sea-water, and is thereby brought into a liquid condition, and falls in a shower into the lower compartment *h*, from whence it is drawn, together with the air and uncondensed vapor, by the air-pump *l*, which delivers the said fluids into the hot-well, which is closed at top, so that the upper part constitutes an air-vessel, and the elasticity of the compressed air forces the water into the boiler through the pipe *p*, which proceeds from the lower part of the hot-well to the feed-valves or cocks on the face of the boiler. On the top of the hot-well is placed a *snift*-valve *n*, actuated by a float *o* to maintain the water in the hot-well at a certain hight, so as to prevent air from entering the boiler along with the water. If the air accumulate at the upper part of the hot-well and the water sink below a certain level, the float descends and opens the valve, when a portion of air escapes and restores the desired condition.

The whole of the steam is condensed and the water returned to the boiler, but, to compensate for loss at the safety-valve and leakage, a still is inserted in the top of the boiler, and connected by a pipe and cock with the upper chamber *f* of the condenser. This still is charged with sea-water, and when the water in the boiler is too low, the cock is opened, and, a communication being thus established with the condenser, a partial vacuum is formed in the still. This causes the water to boil rapidly at a much lower temperature than it would otherwise, and the steam, rushing into the condenser, is condensed along with the steam from the cylinder. The additional water thus obtained is delivered to the boiler by the action of the air-pump. See STILL.

a is the steam-cylinder.

b, the steam-pipe from the boiler.

c, a belt or channel surrounding the cylinder and conveying the steam to the slide-valve chest *d*.

e, the tubes of the middle chamber *g* of the condenser.

f, the upper chamber of the condenser communicating with eduction steam-port.

g, the middle chamber, containing cold sea-water and traversed by the tubes *e*.

h, the lower chamber of the condenser, collecting the water dropping from the tubes.

k, the foot-valve.

l, the air-pump.

m, the hot-well.

n, the snift-valve.

o, the float operating the snift-valve.

p, the feed-pipe leading to the boiler.

q, the cold-water pipe, placed between the valve-chest and the condenser.

r, the cold sea-water supply-pipe.

s, the apertures in the wall of the chamber *g* by which the cold water enters.

t, outlet passages by which the water in chamber *g* is returned to the sea.

u, the throttle-valve.

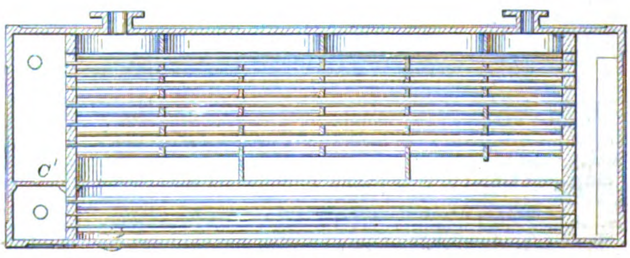
w, the blow-through valve.

x, a distributing plate in the upper chamber of the condenser.

Fig 6077 shows a form in which the steam and the water follow sinuous courses flowing in opposite directions.

In Fig. 6078, a partition C' is placed in the chamber in which the cooling water is received, for the purpose of compelling

Fig. 6078.



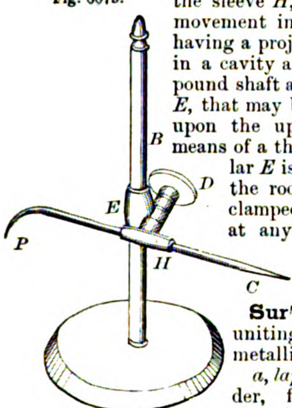
Condenser.

water to pass the tubes of the lower or cooling section of the condenser, and return it through the upper or condensing series of tubes; the object being to more thoroughly cool the condensed water than could be done if the cooling water entered both the condensing and cooling tubes at the same time. The induction and eduction nozzle for the steam and water and the division plates are arranged at the same end of the condenser, whereby the steam and water are each made to traverse the entire length of the instrument in opposite directions before being discharged therefrom.

2. A steam-heated apparatus consisting of pipes or chambers over which a solution is conducted in order that its watery particles may be driven off. Such is the Degrand (Derosne) condenser. (See CONDENSER.) Such also is the EVAPORATING CONE of Belgium. (See EVAPORATOR.) Useful hints on construction may be gathered from LIQUID-COOLER, BEER-COOLER; apparatuses which differ from these surface-condensers merely in the fact that a refrigerating liquid instead of steam occupies the hollow trunk.

Sur'face-gage. An implement for testing the accuracy of plane surfaces. In that illustrated (Fig. 6079), the pointer *P C* slides in the sleeve *H*, which is capable of movement in a vertical plane by having a projection loosely fitting in a cavity at the end of a compound shaft attached to the collar *E*, that may be raised or lowered upon the upright rod *B*. By means of a thumbscrew *D* the collar *E* is tightly held against the rod *B*, and the pointer clamped in the sleeve *H*, at any positions to which they may have been previously adjusted.

Fig. 6079.



Surface-Gage.

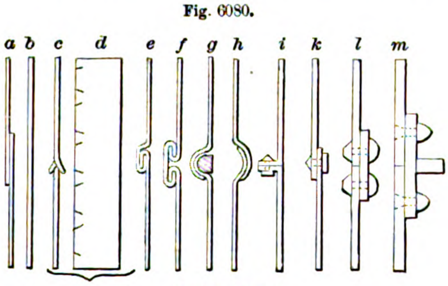
Sur'face-joint. A joint uniting the ends or edges of metallic sheets or plates.

a, *lap*-joint, with solder, for tin plates, sheet-lead, etc.

b, *butt*-joint, for sheet-metal plates and tubes.

c d, *cramp*-joint, for thin works requiring strength. The edges are thinned with the hammer, one being left plain and the other notched, forming the cramps; these are bent alternately up and down, and the plain

Fig. 6080.



Surface-Joints.

edge of the other sheet inserted, after which they are hammered down and brazed, when the joint may be made smooth with the hammer and file.

e, *lap*-joint, without solder, used for works not requiring to be steam or water tight.

f, sometimes called the *patent strip overlap*, avoids the double bend of the preceding joint; used for zinc, etc.

g, *roll*-joint, for lead roofs; the metal is folded over a wooden rib, and is not soldered; a somewhat similar joint, though the two plates do not extend over the roll, is employed for zinc, in which case the top is protected by a strip nailed to the wood.

h is a hollow crease used in vessels for making sulphuric acid; the crease is filled with lead, which is united to the edges of the sheets by means of a red-hot iron.

i is a flange-joint for pipes; the flanges are secured to each other by bolts.

k is a lapped and bolted joint employed in boilers and tubes.

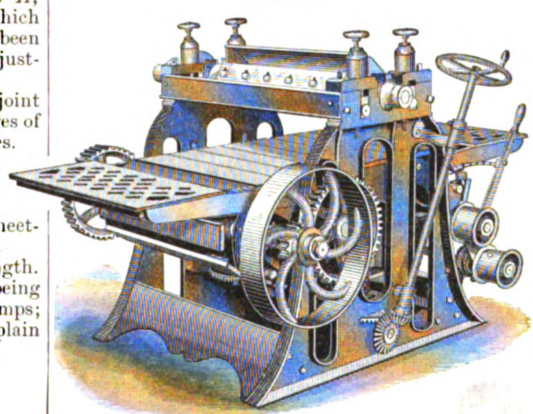
l, with rivets, is the common mode of uniting the marine boilers and other works required to be flush externally.

m is a similar mode, employed in the construction of large iron steamships; the outer skin-plates *m* form a butt-joint, and are bolted to the T-shaped iron rib, which has been bent to the proper curve.

Sur'face-plane. (*Wood-working.*) A form of planing-machine for truing and smoothing the surface of an object run beneath the rotary cutter on the bed of the planer.

The illustration shows a surface-planing machine with a traveling bed, on which the stuff is carried beneath the cylinder, which has three cutters. The front roll has independent weights. The machines will plane $\frac{1}{8}$ inch to 10 inches in thickness, and 24 to 30 inches width, according to size of machine.

Fig. 6081.



Rotary-Bed Surface-Planer.

The bed-rail is gibbed on the frame, and is raised or lowered by screws according to the thickness of the work.

Sur'face-print'ing. Printing from an inked surface in contradistinction to the plate-printing process, in which the lines are filled with ink, the surface cleaned, and the ink absorbed from the lines by pressure upon the plate. See COPPERPLATE-PRINTING.

The latter is universally adopted by the bank-notes of the United States, except some of the minor details, which are put on by a surface-printing.

The Bank of England notes, since January 1, 1855, have all been surface-printed.

Books, newspapers, woodcuts, and lithographs are all surface-printed. See BANK-NOTE ENGRAVING; STEEL-PLATE ENGRAVING.

Plate LXVII. illustrates several features of en-

graving, as well as affording a specimen of *surface-printing*.

The interior is a medallion head of Commodore Perry, engraved on a peculiar form of medallion-machine invented and made by G. W. Casilear of the United States Treasury Department, adapted to give several series of lines, thereby forming a network.

The usual form of medallion-machine is cited on pages 1417, 1418, and need not be re-described. Speaking in the most general terms, a tracer is made to follow the contour of the relief on the medal, and governs the motions of the diamond scriber which moves over the plate to be engraved, the ascents and descents of the tracer resolving themselves into deviations from the straight line on the engraved plate, the tracer and scriber being connected, and moved simultaneously over their respective surfaces, and being set forward a given and equal distance between each stroke.

In Casilear and Smith's medallion ruling-machine, for ruling two or more lines, there are two right-angle slides crossing at $22\frac{1}{2}°$, each slide with a screw and index, to give the proper width of line to the ruling. The medallion and plate to be ruled are placed on the table of the top slide; in ruling the cross lines, the movement is given either at the angles of $22\frac{1}{2}°$, 45°, or $67\frac{1}{2}°$. The selection of the angle determines the form of mesh of the network produced, whether square or lozenge. The portrait (Plate LXVII.) is the production of this machine.

The border around the portrait is the production of the rose-engine, or geometric lathe, described on pages 1983, 1984, and 963. The action of the cutting-tool in the rose-engine is to make lines the product of a combination of motions of the bed-plate, and the possible variations are almost infinite. Plate LXIV., STEEL-ENGRAVING, shows a number of specimens of its work: the ornamental panel behind the letters "Washington"; the oval immediately above the work on the upright sides of the border. Plate LXIV. is printed, not as a *surface*-plate, but in the manner usual with steel-plates, by filling the lines with ink, cleaning and polishing the surface of the plate, and then laying the paper upon it and passing both through the press (Fig. 1445), when the paper absorbs the ink from the lines of the plate.

The rose-engine work around the portrait, if printed from by the surface-process directly as it was engraved, would give a black surface with a fine tracery of white lines; but, to adapt it to show its fine lines colored on a white ground, a counterpart impression in steel must be made, in which the lines are salient, not depressed, and this by transfers is made so to appear in the plate, that by printing the portrait and its border in a single operation of *surface-printing*, we have the *portrait* white-line work on a dark ground, and the *border* dark-line work on a white ground.

The author is indebted for this unique specimen to G. W. Casilear.

Sur′face-roll′er. (*Calico-printing.*) The engraved cylinder used in calico-printing.

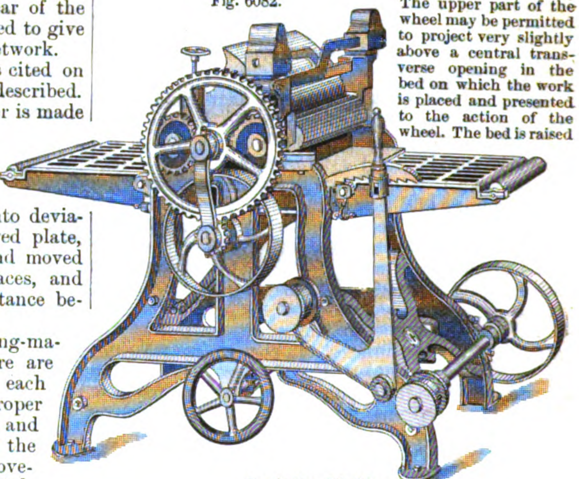
Sur′fac-ing-ma-chine′. 1. (*Wood-working.*) A machine for planing timber. The piece is fed by weighted corrugated feed-rolls to rotary cutters, which smooth its surface; bearing rollers at each end of the machine steady and equalize the motion of the piece (Fig. 6082).

The belt of the driving-pulley is thrown in or out of action by a tension-roller connected with a hand-lever manipulated by the operator. The table or platen may be raised or lowered by two screws gearing with a cross-shaft operated by a hand-wheel.

2. (*Metal-working.*)

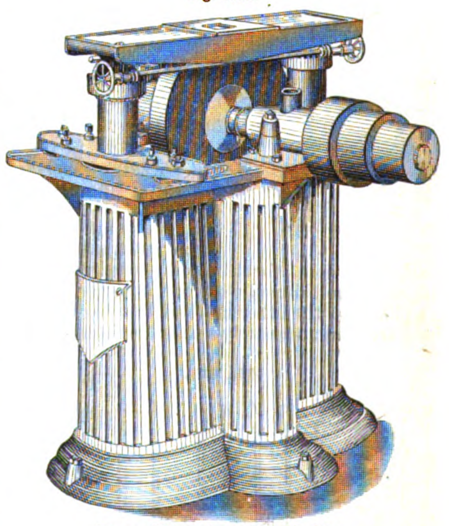
The machine (Fig. 6083) is designed for finishing off metallic surfaces by grinding. It is provided with a wheel faced with tanite. (See TANITE.) The upper part of the wheel may be permitted to project very slightly above a central transverse opening in the bed on which the work is placed and presented to the action of the wheel. The bed is raised or lowered by means of two worms which engage worm-wheels at the upper ends of two screw-standards entering circular openings at either end of the compound pillar which forms the base of the machine.

Fig. 6082.



Surfacing-Machine.

Fig. 6083.

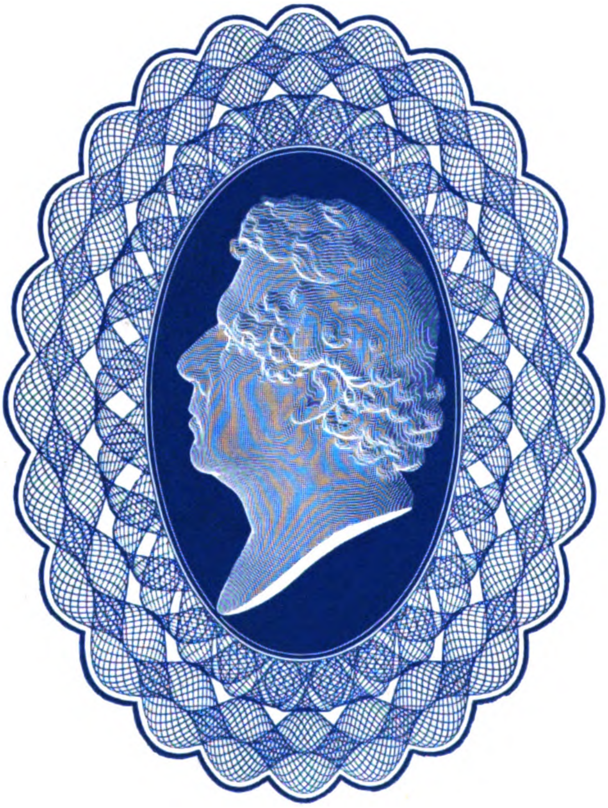


Emery-Wheel Surfacing-Machine.

Surf-boat. A peculiarly constructed boat for landing or pushing off through the surf. See CATAMARAN; LIFE-BOAT; MASSOOLAH-BOAT.

Surge. (*Nautical.*) The swell on a windlass-barrel upon which the cable or messenger *surges* or slips back.

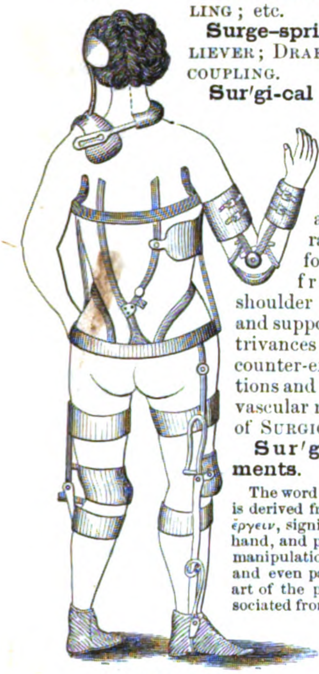
Surge-re-liev′er. A spring interposed between an object subjected to sudden strain and a relatively immovable object or one difficult to start. Such are placed on some pulley-blocks, to prevent their being snatched away; in harness, between the trace and the wagon; in cables, to take off suddenness of the jerk upon the bitt, windlass, capstan, or cable-stopper. See patent 27,505, March 13, 1860. See also



MEDALLION HEAD OF COMMODORE PERRY.

PLATE LXVII. SPECIMEN OF SURFACE PRINTING. *See pp.* 2458, 2459.

Fig. 6084.



Surgical Appliances.

DRAFT-SPRING; SPRING-COUPLING; etc.

Surge-spring. See SURGE-RELIEVER; DRAFT-SPRING; SPRING-COUPLING.

Sur'gi-cal Ap-pli'an-ces. (*Surgical.*) Apparatus — perhaps rather as distinct from instruments — embracing bandages, splints, apparatus for weak, deformed, luxated, or fractured limbs; shoulder and spinal braces and supporters; specific contrivances for extension and counter-extension; for deflections and local muscular and vascular relaxation. See list of SURGICAL INSTRUMENTS.

Sur'gi-cal In'stru-ments.

The word *surgeon*, or *chirurgeon*, is derived from the Greek χείρ and ἔργειν, signifying to work with the hand, and plainly indicative of the manipulations, topical treatment, and even palmistry. The healing art of the physician was early dissociated from that of the operative surgeon, as appears in the oath of Hippocrates, who forbade the practice of lithotomy to the physician. In a condition of things still more remote, the medicine-man was a priest, as he is to-day in Egypt, India, China, and Japan, and among savage and half-civilized peoples.

The surgeons of Egypt are the earliest of whom we have record. The *basso-rilievos* of Thebes display instruments and operations similar to those of the present. Venesection and circumcision are among the earliest mentioned. The art of embalming, as of healing, was practiced by the priests, and the physicians of note were deified both in Egypt and in Greece. Asclepias in the former, or Esculapius, in the latter, were demi-gods, the latter being reputed to be the son of Apollo, and to have accompanied Melampus and Chiron as surgeons on a warlike expedition, about 1242 B. C., fifty years before the fall of Troy. Machaon and Podalirius, two sons of Esculapius, were army surgeons with the Greeks in the Troad. Damocedes, 600 B. C., was taken prisoner by the Persians, and became court physician in Persia, reducing a dislocation of the ankle for Darius, and removing a cancer for his queen Atosa. Herophilus and Erisistratus, of Alexandria, made that school famous in the third century, B. C., and are reputed to have dissected the human body. The tourniquet, catheter, lithontriptor, and ecraseur were probably used by them. Galen practiced in Rome in the second century, A. D.

Fig. 6085 shows a number of surgical instruments discovered by the Russian physician, Dr. Savenko, in 1819, in the Via Consularis, Pompeii. The instruments are in the Museum of Portici. They were discovered in a house supposed to have belonged to a surgeon. They are, —

a b, two probes (*specillum*) respectively six and four and a half inches long.

c, a cautery of iron, four inches long.

d e, two lancets (*scalpellum*) of copper, four and a half and three inches long.

f, a small copper amputating-knife, with a wavy edge. The illustration (taken from *Revue Médicale*, for 1821, Vol. III. page 427) shows it out of proportion; it is two and a half inches long, one inch broad, and has a thick back adapted to be struck by a mallet.

g, a scalpel, with a probe point.

h, an iron needle.

i, an elevator for raising depressed portions of the skull.

j j k l, different kinds of forceps; *l* is a tenaculum forceps, with a running ring.

m, hair tweezers.

n, esophagus forceps.

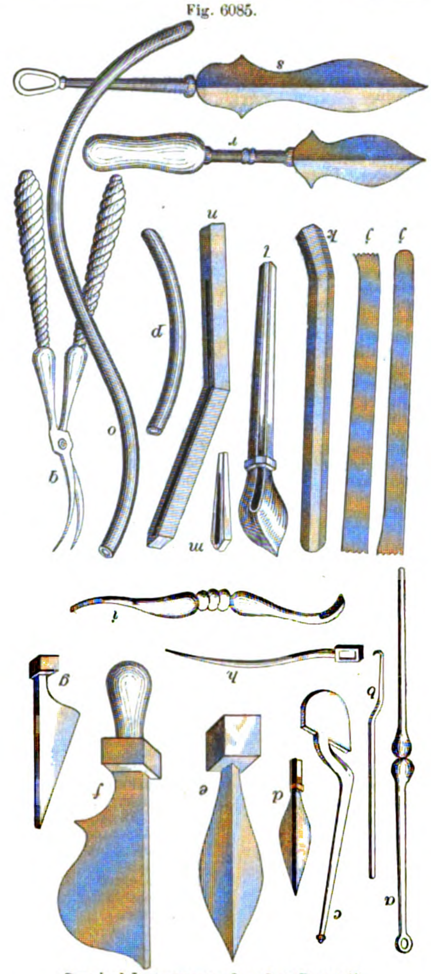
o p, catheters (male and female).

q, uvula forceps.

r s, spatulas.

The library of the Surgeon-General's office, Washington, D. C., has been formed since the close of the war, and now contains about 39,000 volumes, besides about 20,000 pamphlets.

Fig. 6085.



Surgical Instruments found at Pompeii.

It is really the National Medical Library of the United States, is catalogued and managed like the Congressional Library, and is intended for the benefit of the entire profession of the country. It is a very good practical working library, and is especially rich in periodicals.

From the priests the profession of surgery seems to have passed to the barbers, the term *barber-surgeon* being much older than that of surgeon. The fourth Lateran council, in 993, forbade the "shedding of blood" by the priests, and thus continued in force the old distinction between medicine and surgery which was enforced by Hippocrates, and is yet jealously maintained in European countries. Farther papal interference by the seventh Lateran council in 1131, and the Council of Tours in 1163, disassociated the clergy from medicine, which then fell to the apothecaries, as surgery had to the barbers, who were also keepers of the baths. French and English charters and municipal regulations show that the profession was gradually assuming systematic proportions, court and army surgeons becoming of note, the *chirurgeon* proper, who also studied medicine, gradually edging away from the mere *barber-surgeons*, who simply shampooed, bled, blistered, cupped, drew teeth, and bound up the wounds of the victims of the frequent frays. The chirurgeon proper wore a robe and cap, when, in 1572, bluff King Harry granted the Royal College of Physicians of London the power of licensing practitioners in the city of London and within seven miles thereof, — a right still extant.

The distinction between *chirurgiens* and *perruquiers* was fairly drawn by enactment in France, *temp.* Louis XIV., and in England in 1745, by act of Parliament, *temp.* George II

Sur'gi-cal In'stru-ments and Ap-pli'an-ces. See under the following heads: —

Abaptiston.	Acanthalus.
Abdominal supporter.	Accipter.

Acoumeter.
Acoustic instruments.
Acupuncturator.
Acus.
Acutenaculum.
Alphonsin.
Ambe.
Amputating-knife.
Amputating-saw.
Anæsthetic refrigerator.
Anæsthetics. Instruments for applying
Anal dilator.
Anal speculum.
Anaplastic instrument.
Anchylosis-apparatus.
Ancyclomele.
Aneurism-needle.
Aneurism-tourniquet.
Aortic compressor.
Applicator.
Arm. Artificial
Arterial compressor.
Artery-claw.
Artery-forceps.
Arteryotome.
Articulator.
Artificial arm.
Artificial auricle.
Artificial ear.
Artificial eye.
Artificial foot.
Artificial gums.
Artificial hand.
Artificial leech.
Artificial leg.
Artificial limb.
Artificial nipple.
Artificial nose
Artificial palate.
Artificial pupil.
Artificial teeth.
Artificial tympanum.
Astigmatism-apparatus.
Atomizer.
Auricle. Artificial
Auriscalpum.
Auriscope.
Auto-laryngoscope.
Auto-ophthalmoscope.
Autopsy-instrument.
Bandage.
Baromacrometer.
Bath.
Bdelometer.
Bidet.
Bistoury.
Blooding-stick.
Blunt hook.
Body-supporter.
Bone-chisel.
Bone-drill.
Bone-elevator.
Bone-forceps.
Bone-scraper.
Bone-staff.
Bougie.
Breast-cup.
Breast-pump.
Branchotome.
Bullet-extractor.
Bullet-forceps.
Bullet-probe.
Bullet-scoop.
Bullet-screw.
Burial-case.
Calculi-forceps.
Calculi-instruments.
Cane-trumpet.
Cannula.
Canon.
Caponizing-instrument.
Cardiometer.
Castrating-clamp.
Catamenial bandage.
Catamenial supporter.
Cataract-knife.
Cataract-needle.
Catarrhal syringe.
Catheter.
Catheter-gage.
Catheter-syringe.
Cathetometer.
Catling.
Cauterizing instrument.
Cautery.
Cauting-iron.
Cephalotome.
Cephalotribe.
Ceratome
Chain-saw.
Chain-saw carrier.
Chiropodic instruments.
Chondrotome.
Cionotome.
Circular saw.
Cirsotome.
Claw. Obstetric
Clinical thermometer.
Cliseometer.
Club feet. Apparatus for
Coaptator.
Coffin.
Compress.
Compressor.
Conductor.
Congestor.
Conversation-tube.
Coreotome.
Cornet.
Corn-knife.
Corns. Instrument for removing
Corpse-preserver.
Costotome.
Couching-instrument.
Counter-extension apparatus.
Cradle.
Crane-bill.
Craniotome.
Craniotomy-forceps.
Creosote appliances.
Crotchet.
Crow's-bill.
Crutch.
Cucurbitula.
Cup.
Cupping-instruments.
Cupping-pump.
Curette.
Cutisector.
Cystitome.
Cystotome.
Decantation.
Decussorium.
Dental forceps.
Dental hammer.
Dental instruments.
Denti-scalpium.
Deodorizer.
Dermal instruments.
Dermopathic instrument.
Diacaustic.
Dilator.
Director.
Disinfecting-apparatus.
Dislocation-apparatus.
Dissecting-forceps.
Dissecting-knife.
Dock-holder.
Dossil.
Douche.
Dropping-tube.
Ear. Artificial
Ear-cornet.
Ear instruments.
Ear of Dionysius.
Ear-speculum.
Ear-spoon.
Ear-syringe.
Ear-trumpet.
Ecraseur.
Ectropium.
Electro-magnetic machine.
Electro-medical apparatus.
Electro-puncturing.
Elevator. Bone
Endoscope.
Endosmometer.
Enema-syringe.
Enterotome.
Entropium.
Entropium-forceps.
Esophagus-forceps.
Esthesiometer.
Eustachian-tube instrument.
Exercising-machine.
Exsecting-saw.
Exsection apparatus.
Extension.
Extractor.
Eye. Artificial
Eye-cup.
Eye-extirpator.
Eye-forceps.
Eye-instruments.
Eyelid-dilator.
Eye-protector.
Eye-speculum.
Eye-syringe.
Fibula.
Firing iron.
Fissure-needle.
Fleam.
Fermentation-apparatus.
Foot. Artificial
Forceps.
Fourchette.
Fracture-apparatus.
Fracture-supporter.
Galvanic moxa.
Garrot.
Goggle.
Gonorrhea-syringe.
Gorget.
Gums. Artificial
Hamulus.
Hand. Artificial
Hearing-trumpet.
Hemadynamometer.
Hemorrhage-instrument.
Hemorrhoidal syringe.
Hernia instruments.
Hernia-supporter.
Hey's saw.
Hypodermic syringe.
Hysterometer.
Hysterotome.
Inhaler.
Injection-syringe.
Insufflator.
Invaginatorium.
Iriaskistrum.
Iridectomy-instrument.
Iridioscope.
Irritation-instrument.
Jaw-lever.
Keratome.
Key. Dental
Kiotome.
Knife.
Labidometer.
Lachrymal-duct dilator.
Lactoscope.
Lancet.
Langate.
Laparotome.
Laryngeal ecraseur.
Laryngoscope.
Leech. Artificial
Leg. Artificial
Levator.
Lever. Obstetric
Ligating-forceps.
Ligature-carrier.
Ligature-tyer.
Limbs. Artificial
Lint.
Lithoclast.
Litholabe.
Litholyte
Lithontriptor.
Lithotome.
Lithotomé caché.
Lithotomy-forceps.
Lithotomy-gorget.
Lithotomy-searcher.
Lithotomy-sound.
Lithotritor.
Locking-forceps.
Mallet. Dental
Manikin.
Manometer.
Masticator.
Meatuscope.
Meatus knife.
Medicator.
Medicinal cup.
Menstrual supporter.
Metacarpal saw.
Metrenchytes.
Metrometer.
Metroscope.
Metrotome.
Microcaustic.
Milking-shield.
Mortar.
Mouth-speculum.
Moxa.
Nasal irrigator.
Nasal speculum.
Needle.
Needle-forceps.
Needle-holder and tools.
Needle. Surgical
Nerve-needle.
Neurotome.
Nipple. Artificial
Nipple-shield
Nose. Artificial
Nursery-bottle.
Obdurator.
Obstetrical forceps.
Obstetric instruments.
Odontagra.
Ointment-syringe.
Operating-table.
Opsiometer.
Ophthalmometer.
Ophthalmoscope.
Ophthalmostate.
Opsiometer.
Organic vibrator.
Orthopedic apparatus.
Osmometer.
Otophone.
Otoscope.
Pad for trusses.
Pedometer.
Palate. Artificial
Parallel-knife.
Paring-knife.
Paring-scissors.
Patella-apparatus.
Pelvimeter.
Penis-syringe.
Percussor.
Perforator. Obstetric
Periodoscope.
Periosteum-elevator.
Phacocystectome.
Pharyngotome.
Pile-supporter.
Pill-machine.
Pill-tile.
Placenta-forceps.
Placenta-hook.
Plaster-machine.
Plaster-spatula.
Plate for artificial teeth.
Pleximeter.
Pneumatometer.
Polypus-forceps.
Porte-aiguille.
Porte-caustic.
Porte-cordon.
Porte-meche.
Post-mortem case.
Probang.
Probe.
Probe-syringe.
Prolapsus-instrument.
Pterygium.
Pulmometer.
Pulsometer.
Pupil. Artificial
Rachitome.
Raspatory.
Remora.
Respirator.
Retractor.
Retroversion-instrument.
Rhinoplastic knife.
Rhinoplastic pin.
Rhinoscope.
Rostrum.
Roweling-needle.
Roweling-scissors.
Rupturing forceps.
Saliva-pump.
Scalpel.
Scalper.
Scalprum.
Scarificator.
Scissors.
Scissors. Canalicula
Scissors. Conjunctiva
Scissors. Dissecting
Scissors. Harelip
Scissors. Iridectomy
Scissors. Pterygium
Scissors. Roweling
Scissors. Strabismus
Scoliosis-brace.

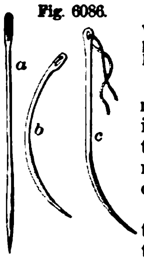
Searcher.
Searing-iron.
Segment-saw.
Serre-fin.
Serre-nœud.
Seton.
Seton-needle.
Shoulder-brace.
Solen.
Sonifier.
Sound.
Spatula.
Speculum.
Speculum-forceps.
Spermatorrhœa. Apparatus for
Spermatorrhœa-syringe.
Sphygmograph.
Sphygmometer.
Sphygmoscope.
Spinal-distortion apparatus.
Spinal supporter.
Spirometer.
Splint.
Sponge-tent.
Spoon. Medicinal
Spring for artificial teeth.
Staff.
Staphyloraphic instruments.
Steam-atomizer.
Stethometer.
Stethoscope.
Stilette.
Stomach-pump.
Stomatoscope.
Strabismus-forceps.
Strabismus-scissors.
Stricture-cutter.
Stricture-dilator.
Stylet.
Subcutaneous saw.
Supporter.
Surgical needle.
Suspension-bandage.
Suture-conductor.
Suture-instrument.
Synosteotome.
Syringe.
Syringe-case.
Syringotome.
Table. Operating
Talipes-apparatus.
Talipes-instruments.
Tampon.
Tape-worm apparatus.
Tenaculum.
Tenotome.
Tent.
Testes-supporter.
Tonsilotome.
Tooth. Artificial
Tooth. Saw
Torcular.
Tourniquet.
Trachea-forceps.
Tracheotome.
Tracheotomy-tube.
Tractor. Obstetric
Transfusion-syringe.
Trepan-saw.
Trephine.
Trilabe.
Trocar.
Truss.
Turnkey.
Tympanometer.
Tympanum. Artificial
Universal syringe.
Uranicoplastic instruments.
Urethra-cutter.
Urethra-syringe.
Urethratome.
Urinometer.
Utereotome.
Uterine dilator.
Uterine douche.
Uterine elevator.
Uterine redresser.
Uterine scarificator.
Uterine speculum.
Uterine support director.
Uterine supporter.
Uvula-forceps.
Vaccinator.
Vacuum-apparatus.
Vaginal speculum.
Vaginal supporter.
Vaginal syringe.
Vaporarium.
Vapor-inhaler.
Varicose stockings.
Vectis.
Ventouse.
Xyster.

Sur'gi-cal Knife. See under the following heads: —

Amputating-knife.
Arteryotome.
Bistoury.
Cataract-knife.
Catling.
Costotome.
Dissecting-knife.
Double knife.
Hysterotome.
Keratome.
Lancet.
Meatus-knife.
Metrotome.
Parallel knife.
Pharyngotome.
Scalpel.
Tenotome.
Tonsilotome.
Urethratome.
Utereotome.

Sur'gi-cal Nee'dle. One used for sewing up wounds and cuts. They are of various shapes and sizes.

Fig. 6086.



Surgical Needles.

A surgical needle, of the usual bent form, was disinterred at Pompeii in 1819, in company with a variety of surgical instruments: lancets, catheters, probes, forceps (Fig. 6085).

Sur'mark. (*Shipbuilding.*) *a.* A mark drawn on the timbers at the intersection of the molding-edge with the ribband-line; the stations of the ribbands and harpings being marked on the timbers.

b. A cleat temporarily placed on the outside of a rib, to give a hold to the ribband by which, through the shores, it is supported on the slipway.

Sur-vey'. *a.* An examination of a tract as to extent, contour, divisions, etc.

b. A plan showing the said features, or some of them.

A *trigonometrical* survey is one made by triangulations, as the coast survey of the United States, the ordnance survey of England.

In a *geodetical* survey, the curvature of the earth is taken into account.

Maritime or *nautical* surveying concerns the coast, and gives bearing of prominent objects, positions of shoals, depths of water, etc.

Plane surveying does not take the curvature of the earth into account, as does *geodetic*.

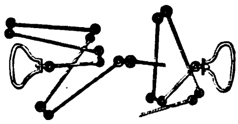
Topographical survey deals with the positions of planes on the surface of the earth.

Sur-vey'ing-in'stru-ments. See, —

Astrolabe.
Circumferentor.
Compass-prismatic.
Geometric square.
Demi-circle.
Jacob-staff.
Level.
Leveling-staff.
Object-staff.
Odometer.
Optical square.
Plane-table.
Sector.
Sextant.
Station-pointer.
Surveying-cross.
Surveyor's chain.
Theodolite.

Sur-vey'or's-chain. This chain, called *Gunter's*, after the name of the person who adapted it, is 4 rods or 66 feet long, made of Nos. 6 to 9 wire, and has 100 links. 10 of these square chains are equal to an acre. $66 \times 66 \times 10 = 43{,}560$ feet $= 1$ acre; or, counting by links, $100 \times 100 \times 10 = 100{,}000$ square links $= 1$ acre.

Fig. 6087.



Surveyor's-Chain.

The chain is divided every 10 links by notched brass marks, so that the fractions may be readily distinguished.

Chains 100 feet long, divided into 1-foot links, are also used by civil engineers.

Other apparatus is used where extreme accuracy is required.

The *decempeda*, or 10-foot pole, was the standard land-measure of Rome.

The base line for the trigonometrical survey of Great Britain was laid down by General Roy on Hounslow Heath, and is 5.2 miles long, nearly. It was measured at first with pine rods; but as these were found to be affected by the hygrometrical changes of the atmosphere, it was again measured with glass tubes 20 feet in length, furnished with a peculiar apparatus for making the contacts. In the subsequent measurement of the same line for the Ordnance Survey, two steel chains of 100 feet in length, and made by Ramsden, were employed. One of these was kept as a measuring-chain; the other was kept for the purpose of comparing the measuring-chain with it before and after the operation. In the act of measuring, the chain was laid in a trough supported on trestles, and was stretched with a weight of 56 pounds. The same apparatus was employed in measuring five other bases in different parts of the country, for the purpose of verifying the accuracy of the work.

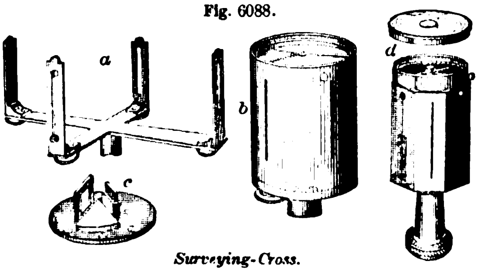
For the measurement of the Lough Foyle base in the survey of Ireland, nearly 8 miles in length, Colonel Colby employed a compensating apparatus formed of bars of different metals, so arranged that the distance between the two points viewed by compensation microscopes remains constant under all changes of temperature. For account of measurements of degrees of latitude, see ODOMETER.

"The method of triangulation in a great survey, by means of quadrilaterals, is purely American in its origin, having been first introduced by the late Professor Bache." — PROF. PEIRCE.

Sur-vey'or's-com'pass. The measuring-compass was invented by Jost Bing of Hesse, in 1602. See CIRCUMFERENTOR; THEODOLITE.

Sur-vey'or's-cross. An instrument employed for establishing perpendicular lines in surveying. It has four sights fixed at right angles upon a brass

Fig. 6088.



Surveying-Cross.

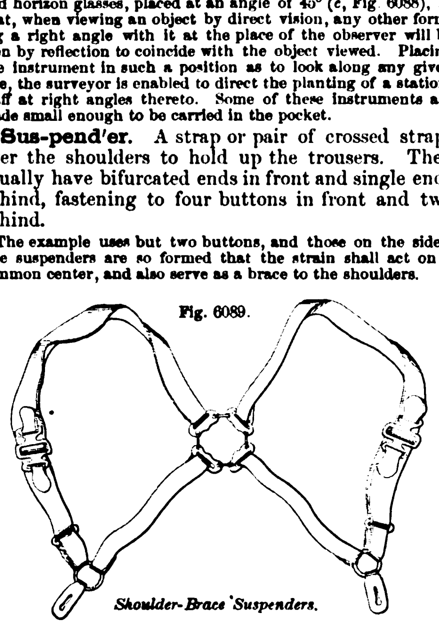
cross, which can be screwed to a tripod or single staff. The instrument is adjusted so that one pair of sights coincide with a given or base line, when a line perpendicular to the former can be easily observed, traced, or set out by viewing through the other pair of sights (a, Fig. 6088).

A cylindrical or octagonal box of brass, called the *optical square*, *b d*, is used for the same purpose as the instrument with four sights on the brass cross. The box has four vertical slits answering to the four sights just mentioned, and inside the box are the two principal glasses of the sextant, the index and horizon glasses, placed at an angle of 45° (c, Fig. 6088), so that, when viewing an object by direct vision, any other forming a right angle with it at the place of the observer will be seen by reflection to coincide with the object viewed. Placing the instrument in such a position as to look along any given line, the surveyor is enabled to direct the planting of a station-staff at right angles thereto. Some of these instruments are made small enough to be carried in the pocket.

Sus-pend'er. A strap or pair of crossed straps over the shoulders to hold up the trousers. They usually have bifurcated ends in front and single ends behind, fastening to four buttons in front and two behind.

The example uses but two buttons, and those on the sides. The suspenders are so formed that the strain shall act on a common center, and also serve as a brace to the shoulders.

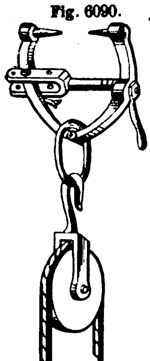
Fig. 6089.



Shoulder-Brace Suspenders.

Sus-pend'ing-clutch. A grapple to be fixed to a beam in a barn or warehouse, for the purpose of suspending hoisting-tackle.

Fig. 6090.



Suspending-Clutch.

Sus-pen'sion-bridge. A bridge sustained by flexible supports secured at each extremity.

Suspension-bridges have been used from a period of great antiquity in China, Thibet, and South America. Turner, in his "Voyage to Thibet," gives an account of one at Tchin-chien, near the fort of Chuka, about 140 feet long, and which afforded passage for equestrians. It was supported by five chains, covered with pieces of bamboo. These bridges have also been mentioned by old travelers in China.

A bridge over a river in the province of Yunnan, China, is said to have been first built 2,000 years ago. A much larger one, spanning the river Pei, was built during the Ming dynasty. It consists of a number of chains stretched across the river and secured to the rock on each side; these are stayed and strengthened by other chains attached at various parts of the span and fastened to points above and below, to prevent swaying. A plank-floor is laid on the chains, and is repaired at intervals of three to five years by the Imperial government. Its span is said to be several hundred feet. One of this kind, mentioned by Kirchen, is 330 feet long, and is said to have been built A. D. 65.

Bamboo-bridges exist in Japan. One over the Fujikaira River is stated to be about 100 feet above the river; its span being 60 and width 4 feet.

Humboldt refers to the bridges of ropes used by the native Americans, and called *cimppacha*, from *cimppa*, ropes; and *chaca*, a bridge. The ropes of one, referred to by this distinguished German, were 3 or 4 inches in diameter, and made from the fibrous roots of the American agave. They are anchored by fastening on the shore to the trunks of trees, and the track is formed of bamboos laid transversely. They are subject to dangerous lateral swaying, and Humboldt advises to cross them on a run, keeping the body well forward, and in single file. He says that a guide and traveler walking at different rates, especially if the latter stop and grasp the balustrade-ropes, will throw the bridge into convulsions.

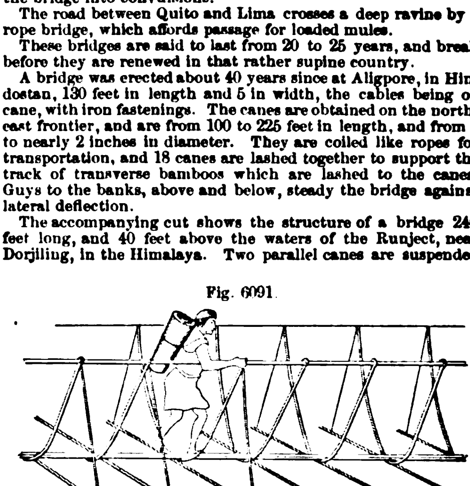
The road between Quito and Lima crosses a deep ravine by a rope bridge, which affords passage for loaded mules.

These bridges are said to last from 20 to 25 years, and break before they are renewed in that rather supine country.

A bridge was erected about 40 years since at Alligpore, in Hindostan, 130 feet in length and 5 in width, the cables being of cane, with iron fastenings. The canes are obtained on the north-east frontier, and are from 100 to 225 feet in length, and from 1 to nearly 2 inches in diameter. They are coiled like ropes for transportation, and 18 canes are lashed together to support the track of transverse bamboos which are lashed to the canes. Guys to the banks, above and below, steady the bridge against lateral deflection.

The accompanying cut shows the structure of a bridge 240 feet long, and 40 feet above the waters of the Runject, near Dorjiling, in the Himalaya. Two parallel canes are suspended

Fig. 6091.



Cane-Bridge, Nepal, India.

between a fig-tree on one side of the stream and strong posts on the other side. From these canes are suspended loops in which are the canes forming the floor, and the proper relations of the parts is maintained by cross-ties, which stretch apart the suspension-canes, which are formed by a species of rattan, 20 or 30 yards long, and knotted together, the other pieces being fastened together by strips of the same plant.

Several suspension-bridges, formed of iron chains supporting loops on which planking is laid, are mentioned by Hooker in his "Himalaya Journals." One crossed the Mywa, a western affluent of the Tambur in Nepal; another the Newa, in which the chains were clamped to the rocks on either shore, and the suspended loops occurred at intervals of 8 or 10 feet.

Suspension-bridges in Europe are mentioned by Scamozzis in his "Del Idea Archi," 1615.

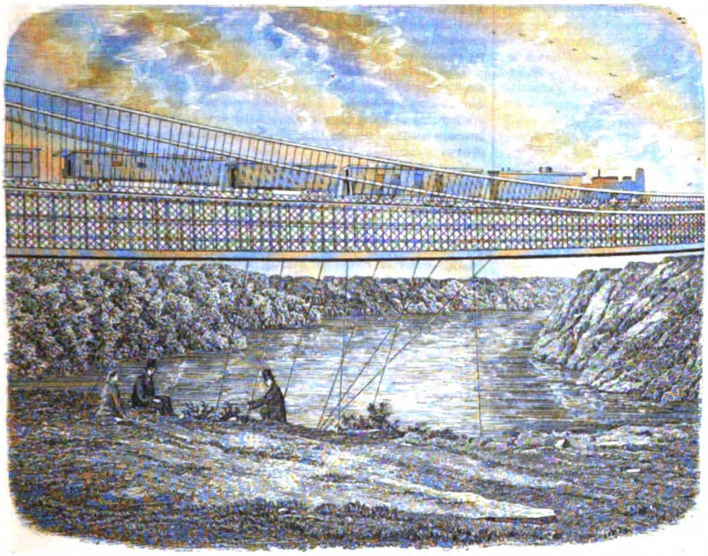
The principles of their construction were laid down by Bernouilli (born at Bâle, Switzerland, 1654; died in same city, 1705).

The first chain-bridge in England appears to have been laid across the river Tees about the year 1741; its length was 70 feet, and breadth rather more than two; it was a mere foot-bridge, and seems to have been a very rude affair. Finlay constructed a chain-bridge in this country in 1796, over Jacob's Creek, between Uniontown and Greensburg, Pa., taking out a patent in 1801; in 1811 eight bridges had been built on his plan, which does not seem, however, to have recommended itself to the public generally, as we hear no more of it after that date. In 1819 a bridge, supported by cables, was constructed across the Tweed at Berwick, Eng., by Sir Samuel Brown; it had 449 feet span. Telford's bridge, over the Menai strait, was finished in 1826. It was suspended by rods of iron, 5 in a set, 4 of these constituting a link of the chain; these were connected by bolts and chain-plates. The entire length of the chain was 1,710 feet, weight 3,876,784 pounds. (See plate at TUBULAR BRIDGE.) The distance between the centers of the pyramids at each end was 579 feet 10 inches; the deflection of the chains in the middle 43 feet; and the hight of the roadway above high-water mark 102 feet. It was calculated to bear a burden of 782 tons, in addition to its own weight, without injury. The bridge at Fribourg in Switzerland was opened for travel, August 23, 1834; its span from pier to pier is 880 feet, and hight above the water 167 feet. It is supported by four iron wire cables, each consisting of 1,056 wires, and cost about $ 125,000. 15 pieces of artillery, drawn by 50 horses, and accompanied by 300 people, were crowded together as closely as possible, first at the center, and then at each extremity, causing a depression of 39½ inches, but no sensible oscillation was experienced.

The Roebling Niagara suspension railway-bridge has a span of 821 feet; it is suspended by wire cables, and stiffened by timber trussing, containing between the abutments 600 tons of wood and 400 tons of iron. The passage of an ordinary train, estimated to weigh 80 tons, caused a deflection of .41 foot, of which Mr. Barlow computed .182 foot was due to the elongation of the cables (a, Fig. 6096).

This bridge has two floors, one 19 feet above the other, leaving a clear space of 15 feet between them. The lower one is used for ordinary purposes, while the upper one is laid with a

Fig. 6092.



Niagara Suspension-Bridge, from the Top of the Bank on the Canadian Side.

railway-track and provided with footpaths; the flooring of this is 245 feet above the surface of the water. Two cables support each roadway, making four in all, which are mutually connected, so that the strain of a load is distributed among the whole. These are 10¼ inches in diameter, composed of 7 strands of 520 wires each, every wire being calculated to bear a strain of 1,648 lbs., or 12,000 tons in all.

The upper cables are brought, by means of braces, to within a distance of 13 feet from each other at their centers, and the suspenders inclined inward, so as to give a broader base to the structure and assist in assuring its stability.

Instead of a pier at each end, a separate tower is provided for each pair of cables, thus greatly reducing the amount and cost of the masonry.

The upper and lower floors are connected by wooden posts arranged in pairs, and having between them sufficient room for the passage of diagonal truss-rods of wrought-iron 1 inch in diameter, passing from the top of one pair of posts to the bottom of the fourth pair from it, and distributing the pressure, the posts being 5 feet apart, over a space of 20 feet on each side; these have screw threads and nuts on their ends, so as to be capable of being screwed up in case of shrinkage of the timber. There are also a number of diagonal wire stays extending from the top of each tower, and intended to prevent vertical oscillation. Smaller stays attached to the under side of the bridge are anchored to the rocks below.

The new bridge, near to the Niagara Falls, is designed for carriages and foot-passengers. On the United States side, the towers are within a few hundred feet of the falls. In length it exceeds the lower bridge 450 feet, being 1,250 feet in the span. The towers are 105 feet high, and are built in pairs 13½ feet apart. Unlike the heavy stone columns of the lower bridge, they are light wooden trestles, 28 feet square at the base and tapering to the top. They are roofed and weatherboarded.

The bridge is sustained by two cables, which were swung in the winter of 1867-68, when the ice filled the river below the falls. The lower bridge is sustained by four cables, the upper one by two, each of which is composed of seven strands of twisted steel wire, each strand measuring 2⅜ inches in diameter, which together form a cable about 9 inches thick.

The dimensions of the bridge are: The span from rock to rock is 1,190 feet. The span between the centers of the towers is 1,268 feet. The length of the suspended platform is 1,240 feet. Hight above the surface of the river, 190 feet. The length of the central portion of the platform resting on cables is 635 feet. The deflection of cables at center causes a rise and fall of the bridge from changes in temperature of 3 feet. The length of the cables between the points of suspension is 1,286 feet; length of the cables between anchorages is 1,828 feet. Length of cables and anchors, 1,888 feet. Hight of towers above rock on Canada side 105 feet, and on American side 100 feet. Base of towers, 28 feet square, and top 4 feet square.

The width of the roadway between the parapets is 10 feet. The bridge is supported by two cables, composed of two wire ropes each, which contain respectively 133 No. 9 wires, of 9 pounds to the linear foot; the diameter of the cable is 7 inches. The total weight of the suspended portion of the cables is 82 tons net. The aggregate breaking strain of the cable is 1,680 tons net, and that of the stays 1,320 tons net, making the total supporting strength of the cables and stays 3,000 tons. The number of suspenders is 480, with an aggregate strength of 4,800 tons. The weight of the suspended roadway, including weight of cables and stays, is 250 tons. The ordinary working load is 50 tons, and the maximum load is 100 tons; permanent and transitory load, 350 tons (*d*, Fig. 6093).

The first bridge over the Ohio was the suspension-bridge at Wheeling, erected by Ellet, in 1848; this was blown down in 1854; it had a span of 1,010 feet.

The present Wheeling bridge is 21 feet 8 inches lower at the Bridgeport, O., end than at the Wheeling, West Va., end.

The Nashville, Tenn., bridge has a similar inequality.

The suspension-bridge over the Cumberland, at Nashville, has a span of 650 feet; the roadway being 22 feet 8 inches wide, consisting of a carriage-way, with a foot-path on each side. It is supported upon two cables, each 8 inches in diameter.

The Cincinnati suspension-bridge was built by John A. Roebling of Trenton, N. J., who has constructed so many others on the suspension principle. The piers are of stone, 200 feet high, and 86 by 52 feet at the base, containing 32,000 perches of masonry. Roadways of massive stone-work, arched part of the way, form the approaches to the bridge at each termination, and constitute the shore supports for the cables, which are anchored far below the ground surface and the ends of these abutments. Each of these contains 13,000 perches of stone, which, added to the 64,000 perches contained in the two towers, gives a total of 90,000 perches of stone-work in the bridge. The distance from abutment to pier is 281 feet; that of the main span across the channel-way of the river is 1,057 feet, the total length of the roadway being 2,252 feet, with a width of 36 and hight above low water of 100 feet (*c*, Fig. 6093).

The bridge is suspended from two cables, each composed of seven strands, each strand containing 740 wires, ⅛ inch in thickness, each wire of which is computed to have a tensile strength of 1,700 lbs., the whole forming a cable of 12½ inches diameter.

Imbedded nearly fifty feet below the surface, under each side of both abutments, are the large, square cast-iron plates to which are fastened the anchor-bars connecting these plates with the shoes at the ends of the cables. These anchor-bars are 10 feet long, 9 inches wide, and 1¼ inches thick, laid in rows of sixteen, side by side, in eight or nine lengths, and connected to each other, and to the shoes and anchor-plates by sockets and cross-bars.

The total cost of the bridge is estimated at $ 1,750,000.

The cables pass through grooves in saddles, supported by iron plates imbedded in the tops of the piers, and having rollers beneath them so as to allow a slight motion to the plates.

The bridge-way is suspended from the cables by suspenders, placed at distances of five feet on each side, the center ones being 1¾-inch iron rods, and those toward the ends 1⅛-inch wire ropes, attached to iron straps passing around the cable.

The roadway is of wood, having a carriage-way in the center and foot-paths at each side.

The bridge over the East River, now in progress, connecting the cities of New York and Brooklyn, is to have a total length of about 5,862 feet from the foot of Chatham Street in New York to the corner of Main and Fulton Streets in Brooklyn. The foundations for the piers on each side are obtained by sinking caissons in the river, near the shore, and excavating until the solid rock is reached. (See CAISSON.) The towers will be 280 feet high; the clear span between them 1,600 feet. The cables are, however, to be carried back 1,337 feet on the New York side, and 837 feet on the Brooklyn side, and anchored in solid walls; their total length will thus be 3,794 feet. They are four in number, each composed of parallel steel wires, forming a bundle nearly one foot in diameter, and, besides being anchored at the ends, are supported by stays from the tops of the piers. The bases of the piers at the water line will be 134 feet long and 56 feet wide; their dimensions at top 120 × 40 feet. Two arches in each, 32 feet wide, afford entrance to the bridge; these are designed to be 120 feet in hight. The piers will be of granite, and hollow, each containing over 900,000 cubic feet of stone, and weighing over 70,000 tons (*c*, Fig. 6093. See also FRONTISPIECE to Vol. I.).

The anchorages will be masses of stone 129 × 119 feet at bottom, and 117 × 104 at top, and carried up to a hight of 89 feet above the river. The cables will enter the masonry at an

elevation of 82 feet, and, after passing 25 feet into the wall, will be connected with the chains. These consist of cast-steel bars, 13 feet long, 10 inches wide, and 1¼ inches thick, arranged in ten sections, each containing 19 bars, forming four curved lines, extending from the cables to the anchor-plates, and connected by cast-steel pins six inches thick.

The four anchor-plates are located at the base of the masonry; they are cast-iron plates, with radial arms, and weigh about 25 tons each The anchor-walls have each two interior spaces 80 × 20 feet, divided into six stories, serving for warehouses above and an underground-railway passage on the lower story.

The roadway of the bridge will be 130 feet above high water, and 80 feet in width. It is proposed to have upon it two lines of track for passenger-cars, to be drawn back and forth at a high rate of speed, by a stationary engine on the Brooklyn side. The weight of the bridge is calculated at 8,483 tons; the maximum weight which could possibly be put upon it at 1,270 tons, and the average about 400 tons; the strain required to break the four cables, nearly 60,000 tons.

The cost is estimated at $ 6,675,000.

In Fig. 6093, the bridges represented are drawn to the same scale.

***a*, railway-bridge, Niagara River (1855).**

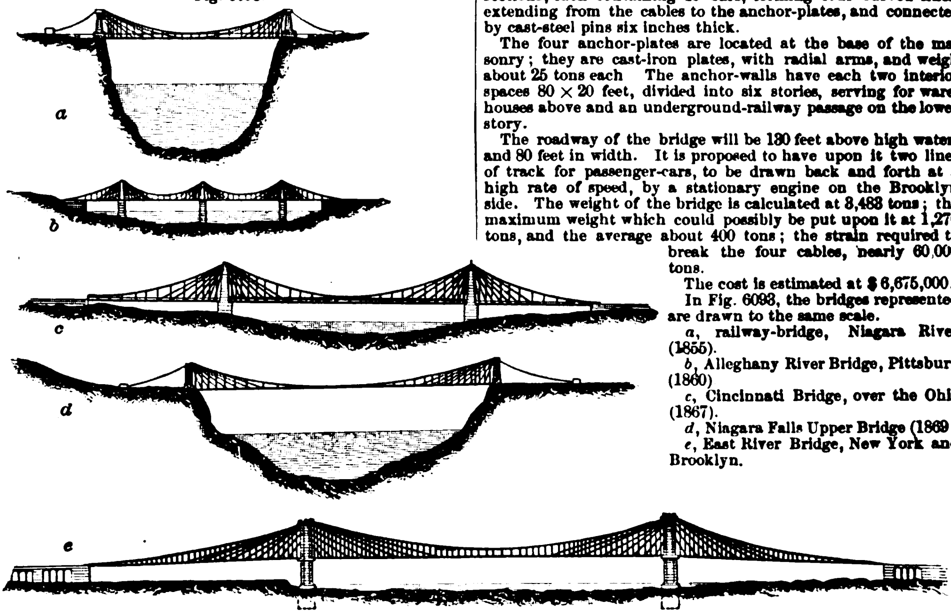
***b*, Alleghany River Bridge, Pittsburg (1860)**

***c*, Cincinnati Bridge, over the Ohio (1867).**

***d*, Niagara Falls Upper Bridge (1869).**

***e*, East River Bridge, New York and Brooklyn.**

Fig. 6093.



Relative Spans of Suspension-Bridges in the United States.

DIMENSIONS OF SOME OF THE PRINCIPAL SUSPENSION-BRIDGES IN THE ORDER OF THEIR LENGTH OF SPAN.

Name.	River.	Place.	Span.	Deflection.	Date.	Engineer.
			Feet.	Feet.		
New York and Brooklyn.	East River, New York.	New York and Brooklyn.	1,600	..	In progress	Roebling.
Niagara (upper).........	Niagara.............	Niagara Falls...........	1,250	..	1869	....
Cincinnati..............	Ohio................	Cincinnati..............	1,057	..	....	Roebling.
Wheeling................	Ohio................	Wheeling................	1,010	..	1848	Ellet.
Fribourg................	Sarine..............	Fribourg................	870	63	1834	Chaley.
Niagara.................	Niagara.............	Niagara River...........	821.4	75	1848	Roebling.
Clifton.................	Avon................	Somersetshire, England..	702	..	1864	....
Charing Cross...........	Thames..............	London, England.........	676.5	50	1845	I. K. Brunel.
....	Danube..............	Pesth...................	666	45	1850	Clarke.
La Roche Bernard.......	Vilaine.............	La Roche Bernard, France	650.4	50	1846	Leblanc.
Nashville...............	Cumberland..........	Nashville, Tenn.........	650	..	....	Foster.
Menai...................	Menai Straits.......	Wales...................	570	43	1826	Telford.
Union...................	Tweed...............	Great Britain...........	449	30	1820	Sir S. Brown.
Montrose................	Este................	Scotland................	432	42	1829	Sir S. Brown.
Hammersmith.............	Thames..............	London, England.........	422.25	29.5	1824	Tierney Clarke.
Albert *................	Thames..............	Chelsea, England........	400	..	....	....
....	Danube..............	Vienna..................	334	21.4	1828	Von Mitis.
Conway..................	Arm of the sea......	Wales...................	327	22.33	1826	Telford.
Chain Pier..............	....	Brighton, England.......	255	18	1823	Sir S. Brown.
Invalides...............	Seine...............	Paris...................	236.5	26.33	1829	Navier.
....	....	Isle of Bourbon.........	220.8	25.48	1823	Brunel.
....	Dnieper.............	Kieff, Russia...........	7 spans.	Total length, 2,562 feet.†		

* 3 spans; 150, 400, 150. † Plate IX., page 519.

Sus-pen'sion-drill. (*Metal-working.*) A vertical drilling-machine having a frame which may be bolted to the ceiling, so as to be out of the way. Useful in locomotive and boiler work, etc.

Sus-pen'sion-hook. A portable hook to enable articles to be conveniently suspended from a nail.

In the example, a curved and a flat-bottomed hook are connected by a swivel, so that either can be turned down to suit the article to be suspended.

Sus-pen'sion-rail'way. A railway in which the carriage is suspended from an elevated track, one carriage on each side of a single track, so as to balance; or suspended between two tracks.

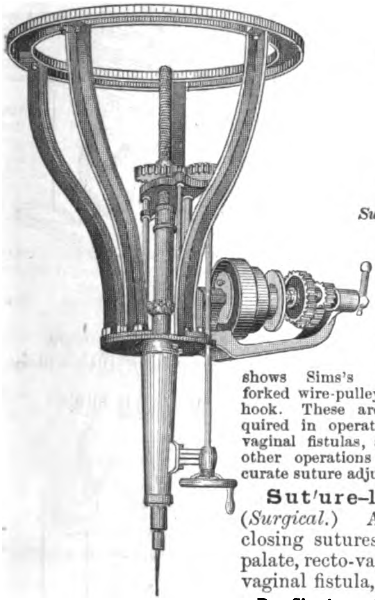
Patents representing each of these forms were taken out in England from 1821 to 1825. See ELEVATED RAILWAY; WIRE-WAY.

Sus-pen'sion-scale. One swung by pendent rods from levers above, in contradistinction to the usual platform-scales, whose levers are beneath. In the former case, the rod to the steelyard-lever comes from above; in the latter, it comes upward from the pit beneath. See also WEIGHING-SCALE.

Sus-pen'so-ry Band'age. A bag attached to a strap or belt, and used to support the scrotum, that the weight of the testes may not draw upon the spermatic cord.

Sut′ure-in′stru-ments. (*Surgical.*) Instruments employed for guiding and securing the wires

Fig. 6094.



Suspension-Drill.

Fig. 6095.

Suspension-Hook.

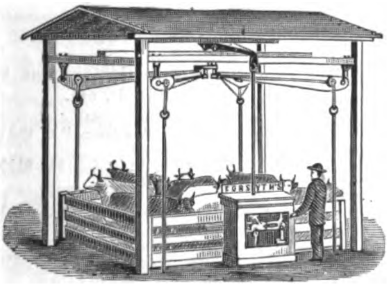
employed for holding together the edges of an incision.

Fig. 6097 shows Sims's wire-adjuster, forked wire-pulley, and a blunt hook. These are specially required in operations on vesico-vaginal fistulas, and useful in other operations requiring accurate suture adjustments.

Sut′ure-lig′a-ture. (*Surgical.*) A device for closing sutures, as in cleft-palate, recto-vaginal, vesico-vaginal fistula, etc.

Dr. Sims's method is as follows: The thread is passed through both sides of the incision; the two ends are brought out together, passed through a small hole in a *shot* (say size No. 1); the shot is then seized with a pair of strong forceps and pushed up the ligature until it comes in close contact with the incised edges, bringing them

Fig. 6096.



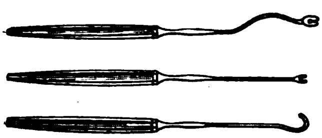
Forsyth Suspension Wagon-Scale.

in apposition or contact. The shot is then squeezed or pressed flat by the forceps, so that the suture is held tight. See also STAPHYLORAPHIC INSTRUMENTS.

See Dunglison's "Dictionary" for instances of capital operations in ligating.

Sut′ure-nee′dle. Fig. 6098 shows three of several different sizes; straight and more or less curved.

Fig. 6097.

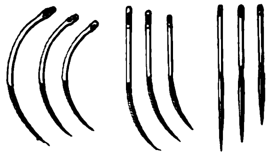


Suture-Instruments.

Sut′ure-pin Con-duct′or. (*Surgical.*) An instrument for guiding a pin or wire employed for holding together the edges of a wound, particularly in operations on the lips and face, where it is specially desirable to avoid leaving a conspicuous scar.

It consists of a slightly curved needle fixed in a handle, and somewhat eularged for a half-inch near its point. Its extremity is beveled off to a sharp point and perforated on the concave side. The edges of the wound having been brought together, the needle is passed through them with one band, and the pin or a soft iron or silver wire is engaged by its point in the perforation at the end of the conductor, and held there while the conductor is withdrawn, thus compelling the pin to follow the course of the conductor.

Fig. 6098.

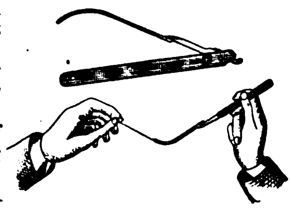


Suture-Needles.

Swab. 1. (*Nautical.*) A bundle of yarns used as a mop upon the decks.

2. (*Founding.*) A soft brush made of some strands of gasket tied together at one end and beaten and combed out at the other. It is used by the molder to wet the parting edge before *drawing* the pattern, and also to moisten parts of the mold requiring repairs.

Fig. 6099.



Suture-Pin Conductor.

3. (*Surgical.*) A pledget of lint or a spatula covered with cloth; used to clean or moisten the mouth of the sick, or cleanse a wound.

4. (*Ordnance.*) A cleaner or sponge for the bore of a gun. In the example, the disk of rubber is expanded laterally by vertical compression, and maintained in that condition by the springs which engage the shoulders of the recesses.

Fig. 6100.

Gun-Swab.

Swab-pot. (*Founding.*) An iron vessel containing water and the founder's swab.

Swad. (*Mining.*) A thin layer of stone or refuse coal at the bottom of the coal-seam.

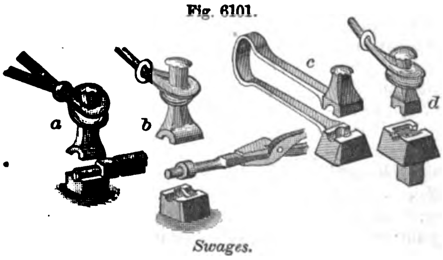
Swage. (*Forging.*) A tool having a face of a given shape, the counterpart of which is imparted to the object against which it is forcibly impressed.

When used by blacksmiths and other forgers in metal, it is either placed on the anvil so as to impress the hot metal, which is laid thereon and struck by a hammer or monkey; or, the work being laid on the anvil, the face of the swage is held upon it, and the back of the swage receives the blow.

Swages (and other tools), whose tangs fit into square holes in the anvil, are the *bottom tools* of the blacksmith. Those with a withe around them, operating *on* the metal and *struck* by the hammer, are *top tools*; together they form *collar-tools*, or *collar-swages* (*a b*, Fig. 6101).

c is a spring-swage; *d*, a *guide-swage*.

Fig. 6101.



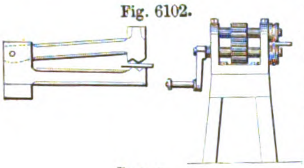
Swages.

Long swages are used in rounding and welding gun-barrels and other wrought-iron tubing.

Other swages operate in drop or lever presses upon sheet-metal; forming the *struck-up* tinware, such as pie-pans, lids for vessels, and a great variety of domestic and ornamental articles.

Swages of various ornate forms are used by jewelers in drop-presses for making links of chains, jewelry, etc., especially that cheap kind which is made of hollow plates soldered at the edges, and sometimes filled with a cheap metal.

Fig. 6102.

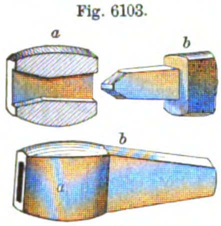


Swage.

Fig. 6102 shows a swage for raising beads on the edges of sheet-metal. The tail is held in the jaws of a vice; the upper jaw of the swage is pivoted, and is struck with a hammer while the metal is drawn beneath it.

The other figure is a device for effecting the same result in a neater and more expeditious manner. The metal is drawn between two grooved rolls; one is turned by a crank, and has a gear-wheel on its shaft meshing with a second wheel on the shaft of the other.

Fig. 6103.



Saw-Swage.

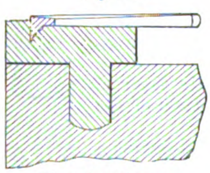
The device, Fig. 6103, is used for spreading the teeth of saws. The tooth is inserted into one side of the splayed aperture through the block *a*; the other side serves as a guide to the swage *b*, which, while the saw is firmly held, is struck with a mallet, spreading and turning up the point of the tooth and enabling it to bite into the wood more readily.

Fig. 6104 is a swage for making calks on horseshoes. The upper side is struck by a hammer, driving the metal into the depressions.

Fig. 6105 is a swage and block for making watch-backs. The bezel is made continuous with the back by the annular rebate on the cameo-die.

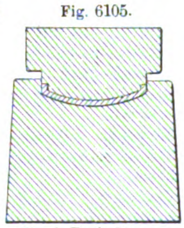
Fig. 6106 is a swage for sharpening saw-teeth. The transverse pin which passes through the end of the stock has notches or dies corresponding to the width and shape of the teeth. The dies operate upon the under side and two edges of the tooth, and the projecting jaw of the stock operates upon the upper side.

Fig. 6104.



Horseshoe-Swage.

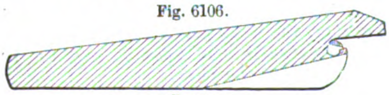
Fig. 6105.



Watch-Back Swage.

Fig. 6107 is a swage for bending nozzles of milk-cans, etc.

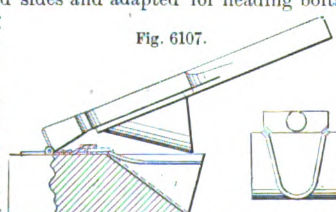
Fig. 6106.



Swage.

Swage-block. A large perforated block of iron, having grooved sides and adapted for heading bolts and swaging objects of larger size than can be worked in the ordinary heading tools and swages fitted to the anvil (Fig. 6108).

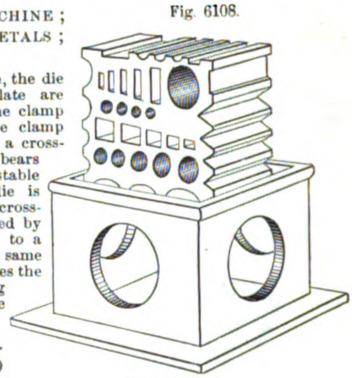
Fig. 6107.



Die for Bending Nozzles.

Swag'ing-ma-chine'. (*Metal-working.*) A machine for bringing sheet-metal to form by means of a blow or pressure in a direct line. See STAMPING-MACHINE; SPINNING-METALS; etc.

Fig. 6108.



Swage-Block.

In the example, the die and its bed-plate are raised against the clamp and plunger, the clamp being secured to a cross-plate which bears against adjustable springs. The die is secured to a cross-head, reciprocated by link attachment to a crank on the same shaft which carries the eccentric giving motion to the die.

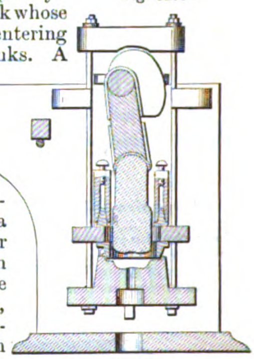
Swal'low. 1. (*Nautical.*) The groove around a tackle-block for the strap. Also called the *score*.

2. (*Mining.*) A cavern or opening into which water disappears.

Swal'low-tail. 1. (*Fortification.*) An advanced work whose salient portion has a re-entering angle and converging flanks. A *priest's cap*.

2. The points of a burgee.

Fig. 6109.



Swaging-Press.

Swan-pan; Schwam-pan. The abacus or counting-table of the Chinese. It consists of a square frame of wood or bamboo, with a division across it, and 10 transverse wires, upon each of which, above and below the division, are 5 beads; each bead representing a number (as the digits do with us), and each wire giving a particular value to the number, like units, tens, hundreds, etc.

The *yow-yow* is a smaller kind of *swan-pan*.

The abacus was the usual "reckoning-board" of the Greeks and Romans. (See ABACUS.) It is now the principal means of computation in China, Tartary, and Thibet. The Abbé Huc relates: —

Fig. 6110.

Swallow-Tail.

"The Thibetans, for small amounts, count on their chaplets; shopkeepers use the Chinese *swan-pan*, but the learned employ Arabic ciphers, which appear very ancient in Thibet. We [Mons. Gabet and himself] have seen Lamanesque manuscripts containing tables and astronomical calculations in this notation." They use the "5" reversed, resembling our cedilla (ç).

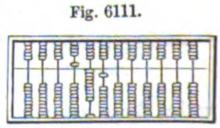
The adoption of the Indian numerals with *place value*, and the cipher, made the abacus unnecessary. Abbé Huc gives an amusing instance of the collision of the Arabic numeration and the *swan-pan*, at Kou-kou-kho-ton (Bluetown), in Chinese Tartary, where the Chinese merchant, in dealing with the Abbé as a supposed Tartar, had purposely made a mistake on the *swan-pan* to the extent of 1,000 sapecks, equal to 50 cents. The Abbé showed him his calculation in figures, which were utterly incomprehensible to the merchant; but a third party verifying the Abbé's computation by a correct manipulation of the *swan-pan*, the wonder became a marvel.

The Indian (Arabic) figures and numeration were introduced by Roman missionaries into the astronomical college of Pekin.

The knotted cord was used as a means of notation in the reign of the Chinese Emperor Fuh-hi 2852 B. C. (DU HALDE.)

Hence the rosary, common in Thibet and in Europe. See ROSARY; PRAYING-MACHINE.

Fig. 6111.



Swan-Pan, or Chinese Abacus.

In addition to what is said under ABACUS (which see), it may be stated: Upon a bas-relief of the Capitol is a Trajan and a Plotina, and near them a young man holding an abacus, upon which are three ranks of counters, 7, 1, and 6; his forefinger touches one of the second row. The counters, *calculi*, were of ivory or bone, a little convex; others of porcelain of various sizes, covered with green or blue enamel, pierced, and ornamented with figures on each side. Another set are square, round, toothed, and of different sizes, some with a cross.

Fig. 6112.

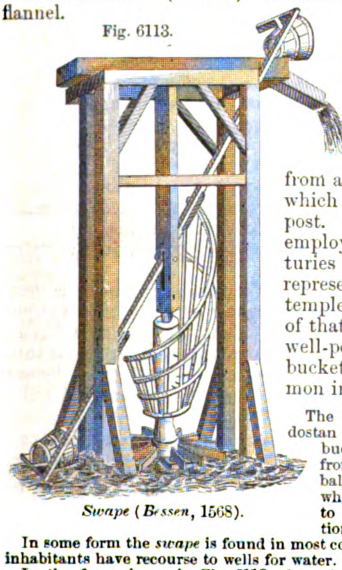
Swape (Asia Minor).

Swan's-down. (*Fabric.*) *a.* A trimming in which the fine, soft feathers of the swan and other aquatic birds are set with the quill end in the meshes of the goods, so as to make the down as a nap upon the backing of fabric.

b. A fine, soft, thick woolen cloth, made in imitation of *swan's-down*, a long nap being raised upon the surface.

Swan-skin. (*Fabric.*) A kind of fine twilled flannel.

Fig. 6113.



Swape (Bessen, 1568).

Swape. 1. The *shadûf* of the Arabs. See SHADOOF.

A bucket on the end of a line from a balanced pole which rests on a post. It has been employed for 40 centuries in Egypt; is represented on the temples and tombs of that country. The well-pole and oaken bucket are yet common in America.

The *picotah* of Hindostan is a pole and bucket suspended from the end of a balanced stage, on which a man walks to give the oscillation. See Fig. 3701.

In some form the *swape* is found in most countries where the inhabitants have recourse to wells for water.

In the form shown in Fig 6113, the pole is oscillated by a spiral bar on a vertical post, which is rotated by a horizontal water-wheel. The buckets ascend alternately, and each is emptied as it reaches the edge of the trough, the contact with which tips it and discharges the water.

2. A sconce, or light-holder.

3. A pump-handle.

4. A long oar, or *sweep*.

Sward-cut'ter. 1. (*Agriculture.*) A plow to turn over grass lands.

2. A mower for lawns. See LAWN-MOWER.

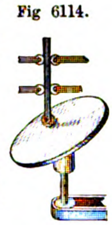
Swarf. Iron filings.

Swash-bank. (*Hydraulic Engineering.*) The crowning portion of a sea-embankment.

The lower portion is the footing, which has five base to one perpendicular. This supports the *outburst bank;* base two to perpendicular one. The *swash-bank* has the same proportions, and a level top four to five feet wide, if not required for a road. In Holland the *swash-bank* can hardly be said to exist, as the name is derived from the fact that the crest of a breaker occasionally *swashes* over. In that low country the dikes are of enormous size, more elevated than the common sea bank of other countries, and form sites for roads and canals. See DIKE; SEA-WALL.

Swash-plate. (*Machinery.*) A rotating, circular plate, inclined to the plane of its revolution so as to give a vertical reciprocation to the rod, whose foot rests thereupon, and which moves between lateral guides.

Fig 6114.



Swash-Plate.

Swath'er. (*Agriculture.*) A device attached to the front of a mowing-machine for the purpose of raising the uncut fallen grain and marking the line of separation between the cut and uncut grain. See Figs. 31–36, Plate XXXIII., page 1492.

Sway-bar. (*Vehicle.*) A bar on the hind end of the fore hounds of a wagon; the sway-bar rests on the coupling-poles and slides thereon as the wagon turns. A *slider;* a *sweep-bar*.

Sway-brac'ing. The guys of a suspension-bridge to prevent lateral swaying.

Sweat'ing-bath. A vapor-bath for sweating persons. A *stove* or *sudatory*.

Sweat'ing-fur'nace. (*Metallurgy.*) A liquation furnace of peculiar construction, in which a

Fig. 6115.

Swather for Mowing-Machine.

Fig. 6116.

Sweating-Furnace.

matte of copper and argentiferous lead is heated to deprive the copper of the metals combined therewith. The cupreous masses are placed upon the sole above the channels *f f*, which are filled with wood. The door being closed, the wood is fired, the draft being regulated by flues opening into the chimney. The argentiferous lead is separated by liquation, and the lead is oxidized, converting it into litharge, and falls to the bottom of the channels *f f*. The black copper which results is treated in a reverberatory furnace, and the argentiferous lead is cupelled.

Sweat'ing-house. A separate apartment, where vapor-baths are obtained.

Sweat'ing-ir'on. A scraper to remove sweat from horses. A similar instrument used by the

gymnasts of a former age was known as a STRIGIL (which see).

Sweat'ing-room. A room devoted to the use of a vapor-bath.

Sweep. 1. A counter-weighted pole, poised upon a fulcrum-post, and used to raise and lower a bucket suspended from the longer end. It is also written *swape*.

It is the shadûf of the Nile, and is known with us as the *well-pole* or *well-sweep*. See SHADOOF.

2. The lever of a horse-power or pug-mill.

3. (*Shipwrighting.*) The mold of a ship where she begins to compass in at the rung-heads. A part of the mold curved in the arc of a circle.

4. (*Nautical.*) *a.* A long oar used on board ship to assist the action of the rudder during a calm, or

Fig. 6117.

Sweep.

in an emergency; or to assist the motion of the ship, as in the ancient galley.

b. A circular frame on which the tiller traverses in large ships.

5. (*Founding.*) A movable templet used in loam-molding. See Fig. 3189.

6. (*Metallurgy.*) A name formerly applied to the *Almond* (*Allemand*) furnace.

Sweep-bar. (*Vehicle.*) A name sometimes applied to the *sway-bar* or *slider* of a wagon. See SWAY-BAR.

Sweep'ing. (*Nautical.*) *a.* Dragging an anchorage ground with the bight of a rope to recover an anchor, or to ascertain the position of a wreck.

b. Propelling a vessel by means of large oars.

Sweep'ing-ma-chine'. See STREET-SWEEPING MACHINE; CARPET-SWEEPING MACHINE.

Sweep'ing-ta'ble. (*Metallurgy.*) A form of ore-separator in which the slime, after agitation by fans in a chest with water, is flowed on to a sloping table and sorted by gravity by means of a sheet of water passing over the table. See Fig. 2096.

Sweep-net. One of considerable extent for drawing large areas.

Sweep-saw. A saw having a thin blade stretched by a frame or bow, and capable of cutting in a *sweep* or curve. (See FRAME-SAW; BAND-SAW; SCROLL-SAW.) Otherwise known as a *bow-saw*, or *turning-saw*. See also JIG-SAW.

Sweep-wash'ings. The refuse of shops in which gold and silver are worked. These metals are separated by mechanical means and amalgamation.

Sweet'en-ing-cock. (*Nautical.*) A faucet attached to a pipe passing through a ship's side, and admitting water to wash out the bilge-water passages.

Sweet'meat. (*Leather.*) The paint applied to leather in making what is called PATENT-LEATHER (which see).

Sweet-po-ta'to Cul'ti-va'tor. A form of cultivator adapted for hilling up the plants by passing each way, throwing the earth right and left.

Swell. 1. (*Music.*) *a.* A contrivance for giving a gradually increasing and diminishing sound to a wind-instrument by varying the volume of air which passes to the pipes or reeds.

This is accomplished by varying the size of the blast aperture, by a *knee-stop*, as in the parlor organ, or by a pedal in the church organ.

b. One of the three aggregated organs which are combined in an instrument of large power. The other two are the *great* organ and the *choir* organ. The key-boards form three banks; the *swell* above, the *great* organ, the *choir* organ below. The *swell* consists of an organ shut up in a box on three sides, and on the other side inclosed by *louvres*, which are opened and shut by a pedal, so as to give a *crescendo* and *diminuendo* effect. The *great* organ has the most important and powerful stops. The *choir* organ has light and solo stops.

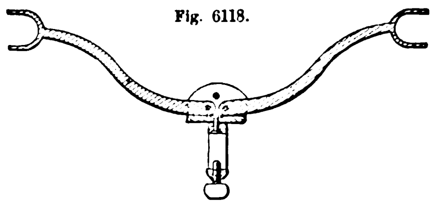
2. (*Ordnance.*) An enlargement of a gun near the muzzle. It is now suppressed in many forms of ordnance.

3. An enlarged or thickened portion of a gun-stock.

Swift. 1. A revolving reel with arms parallel to the axis, and affording a frame whereon to wind yarn, silk, or other thread.

Specifically: a hexagonal frame on which *hank-silk* is reeled, preparatory to winding on bobbins;

Fig. 6118.



Silk-Swift.

and from which it is unwound by the traction of the revolving bobbins.

In Fig. 6118, the swift is clamped to the table, and its arms may be swung up to receive any sized skein.

2. The main card-cylinder of a flax-carding machine.

3. (*Nautical.*) *a.* A tackle used in tightening standing rigging.

b. A rope encircling the ends of the capstan bars to prevent their flying out of their sockets.

Swift'er. (*Nautical.*) *a.* A rope used to confine the bars of the capstans in their sockets.

b. A rope encircling a boat, parallel to its water line, or on the shear line. It stiffens the boat, and acts as a fender. The girth ropes, spoken of by St. Luke, were passed around the vessel like hoops, to prevent the spreading of the frames. "They used helps, undergirding the ship." — Acts xxvii. 16.

c. A shroud from the head of a lower mast to the ship's side, before the other shrouds, and not confined by the cat harpings.

Swig. (*Nautical.*) A pulley with ropes which are not parallel.

Swim'ming-ap'pa-ra'tus. In the sculptures of Nimroud the soldiers are represented swimming across rivers by the aid of inflated skins.

A float or dress to sustain a person in the water. See LIFE-PRESERVER.

Webb's swim across the Straits of Dover, without artificial floats, and Boynton's trip with a life-preserver dress, are recent feats (1875). The former, which is by far the more remarkable, occupied three tides; his point of landing was 21¼ miles distant, but the length of ground swum over was 39½ miles. Time, 21 hours 22 minutes.

As an aid in teaching swimming, a stout wire resembling a telegraph-wire is now hung just above the water, and drawn tight. On this travels a grooved pulley or "door hanger," and from this hangs down an elastic cord that is fastened to a belt worn by the swimmer. This permits free use of his limbs, gives sufficient support, and allows him to move forward along the length of the wire with ease.

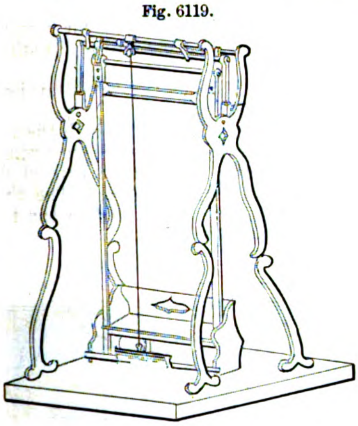
Swim'ming-tub. (*Calico-printing.*) A tank of colors, with a floating diaphragm of fabric, on

which a block is laid to color its surface. Also used in making paper-hangings.

Swing. 1. A seat suspended in the loop of a rope attached overhead.

In the example, the seat is suspended from rods, and the movable footboard is connected by a rope

Fig. 6119.



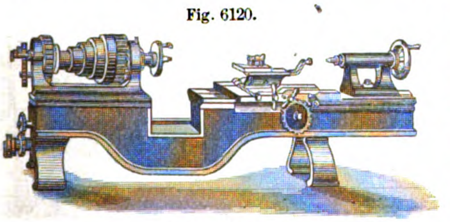
Swing.

with a vibrating-frame, and actuates springs which oscillate the swing.

2. (*Vehicle.*) The tip outward from the vehicle of the top of a wheel.

This becomes necessary, owing to the taper of the *spindle* on which the wheel runs. The lower side of the spindle is made horizontal, to obviate any tendency of the wheel to slip in or out, and enable it to

Fig. 6120.



Gap-Bed Lathe.

rest squarely in the box of the hub. This gives a tip to the wheel, which is more or less, according as the taper is greater or smaller; no swing being necessary where the spindle is cylindrical. See DISH; GATHER.

The wheel is made *dishing*, so that each spoke, as it arrives at the bottom, may stand perpendicularly beneath the axle.

3. (*Lathe.*) The distance from the *head* center of a lathe to the bed or ways, or to the rest. The *swing* determines the diametric size of the object which is capable of being turned in the lathe; anything larger would interfere with the bed. This limit is called the *swing of the bed*. The *swing of the rest* is the size which will rotate above the rest, which lies upon the bed. In the illustration is shown a *gap*, the bed being cut away to increase the *swing*.

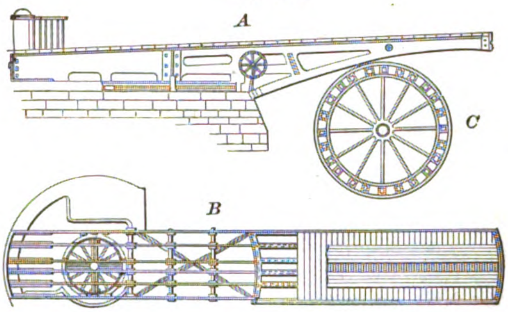
Swing-beam. 1. (*Railway Engineering.*) A cross-piece suspended from the truck, and sustaining the car-body, so that it may have independent lateral motion.

2. (*Carpentry.*) A cross-beam supporting an overhead mow in a barn.

Swing-bridge. A swivel-bridge, spanning a canal or dock entrance, and opening horizontally to allow a vessel to pass.

It was invented by Nicolas Bourgeois for the ditch

Fig. 6121.



Swing-Bridge.

of the Tuileries. His reward was a pension of 1,200 livres per annum.

Draw or *swing bridges* are required over dock entrances, canals, or other navigable waters, to allow the passage of vessels with standing masts.

The *swing-bridge* is balanced, and rotates in a horizontal plane. It is usually in two sections, each of which, when opened, is landed on its own side of the dock, the extended ends of the two meeting in the middle when brought into line, and affording a bridge across the water-course.

The tail of the bridge at the St. Katharine's docks, London, works around 240°; the clear opening between the walls is 44 feet 9 inches; the rise in the middle is 3 feet. The turning is effected by a wheel, running horizontally on a number of rollers that run upon a circular cast-iron bed. It is worked by a winch and pinion operating on a segment-rack. The bridge is well balanced, and easily swung upon its central pivot by a single attendant.

A, Fig. 6121, is an elevation; *B*, a plan; *C*, an enlarged view of the circular bed.

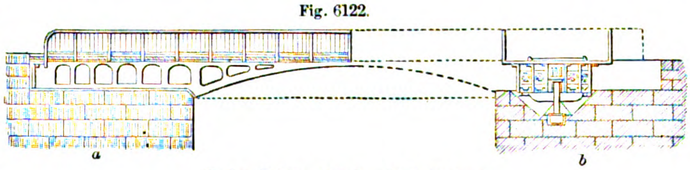
A swing-bridge on a large scale was constructed on the Great Western Railway of Ireland, to cross the entrance to Lough Atalia. It has two spans of 60 feet each, and is balanced on a central pier of 34 feet diameter.

See Humber, "On Iron Bridges."

Fig. 6122 is the iron swing-bridge over the entrance-lock to the West India Docks, London.

Plate XLI., page 1721, is a view of a swing-bridge on the Amsterdam, Utrecht, and Cologne Railway where it crosses the Yssel, near Westervoort, Holland.

Fig. 6122.



Swing-Bridge, London Dock Entrance.

Fig. 6123 is a view of the swing section of the Mississippi bridge at Keokuk, Iowa.

Swin'gel. The swinging piece of a flail. The *swipel*.

Swing'ing-boom. (*Nautical.*) The span which distends the foot of a lower studding-sail.

Swing'ing-saw. A saw swinging in an arc from an axis overhead.

A weight assists in the effective stroke. (Fig. 6124; see also Fig. 6127.)

Swing-jack. A jack for replacing cars on the track; the bottom of the standard is a cylindrical segment, and has a toe working in a slot in the base of the jack.

A pair are used, and the car being lifted while the standards are vertical, the latter are canted to or *swung* over, bringing the wheels of the car in line with the rails. (Fig. 6125.)

Swing-knife. A wooden sword $1\frac{1}{2}$ to 2 feet long, and 8 to 10 inches broad, used to scrape the woody portion from flax, a handful of which hangs over a groove in a standing board known as the *swing-stock*.

Swin'gle. 1. The effective end-piece of a flail. A *swiple*.

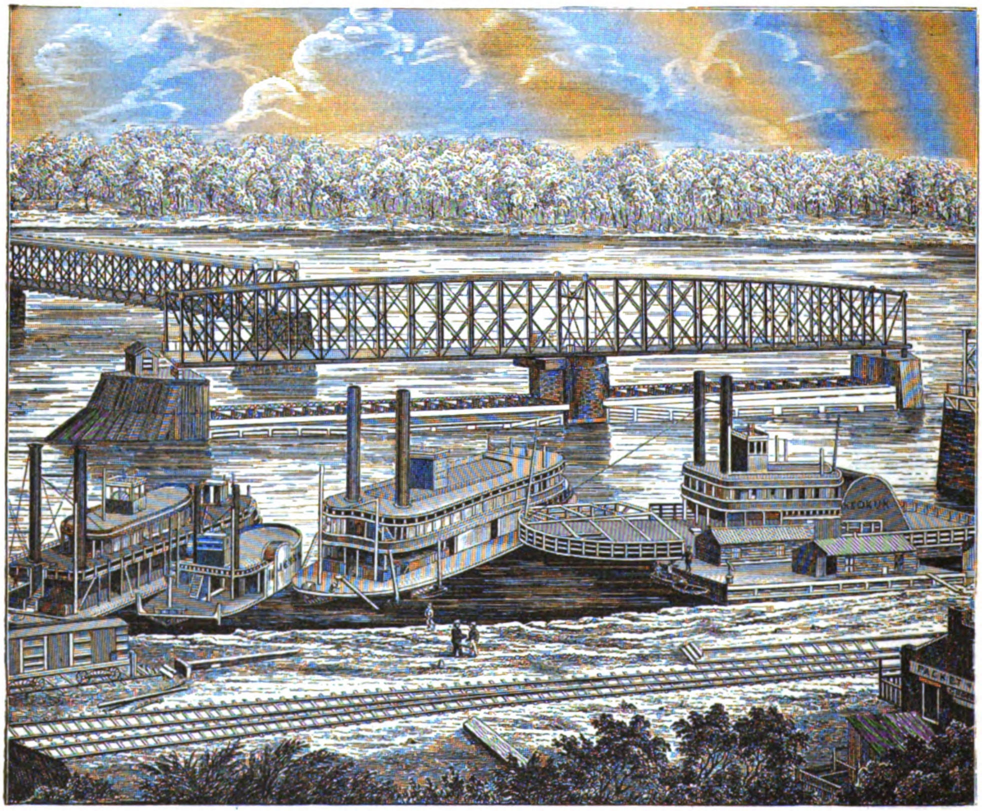
2. An instrument, like a sword, for beating flax; hence the terms, *swingling-knife*, *swingling-staff*, *swingling-wand*.

3. The wooden spoke of the wire-drawing barrel, or the roller of a plate-press.

Swin'gle-tree. The bar to which the ends of a horse's traces are attached. See SINGLE-TREE.

Swin'gling-tow. The coarse part of flax, removed by the *swingle* or *scutcher*. The *shives* are removed from the *hare* in the brake; the *tow* from the finer flax in the *scutcher*.

Fig. 6123.



Railway-Bridge over the Mississippi, Keokuk, Iowa.

Swing Mold-board Plow. A plow whose mold-board may be shifted to throw the soil to the right or to the left as may be required.

There are several modes of accomplishing this: —

1. By making the plow double, and lowering one or the other to work.

2. By turning the iron portion on an axis, so as to make the sole the landside, and *vice versa*, the mold-board officiating for each in either relation, in one case turning the soil to the right, and in the other to the left.

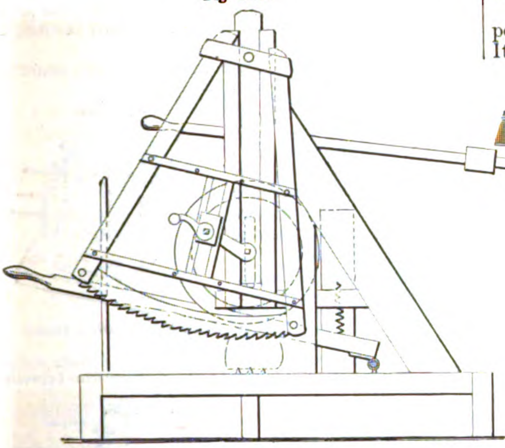
3. Plows having no special mold-board, and in which the colter merely is shifted so as to loosen the furrow slice on that side to induce it to tip over on the other as the share lifts it.

The object is to enable the team to return in and alongside the furrow last made, — an object which is especially desirable in plowing steep hillsides where the furrow can only be thrown *down* hill. See HILLSIDE-PLOW; TURN-WREST PLOW.

Swing-nose Ba'sin-fau'cet. A faucet for standing washbowls. The water is turned on or off by rotating the spout on its vertical axis. In the example, the tube answers the fourfold purpose

of handle, plug, cap, and outlet. The hub is screwed

Fig. 6124.

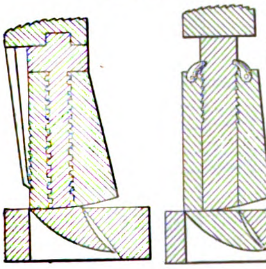


Swinging-Saw.

and packed upon the stand-pipe, upon whose top its valve is compressed to close the outlet.

Swing-pan. (*Sugar-making.*) (Fr. *Chaudière à bascule.*) A hinged sugar-pan with a spout. When the sirup is to be discharged, the pan is tipped by lifting one edge.

Fig. 6125.



Swing-Jack.

Swing-plow. 1. A turn-wrest plow. See HILLSIDE-PLOW.

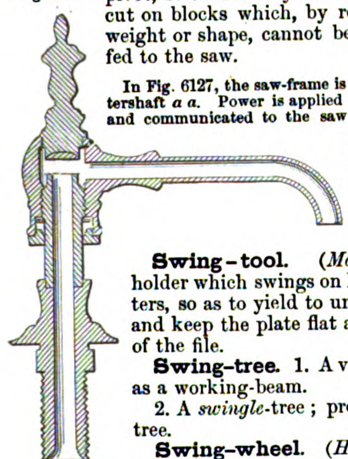
2. A plow without a gage-wheel. See PLOW.

Swing-press. A form of baling-press in which the box is suspended from above by a screw on which it winds as it is rotated. See Fig. 4744, page 2070.

Swing-saw. A buzz-saw hung on a pivot, so that it may be swung down to cut on blocks which, by reason of their weight or shape, cannot be conveniently fed to the saw.

In Fig. 6127, the saw-frame is pivoted by countershaft *a a*. Power is applied at the pulley *b*, and communicated to the saw through a belt from *c* to *d*. The saw is thus free to swing through an arc of about 70°, and is equally operative at all points of the arc.

Fig. 6126.



Swing-Nose Basin-Faucet.

Swing-tool. (*Machinery.*) A holder which swings on horizontal centers, so as to yield to unequal pressure and keep the plate flat against the face of the file.

Swing-tree. 1. A vibrating beam, as a working-beam.

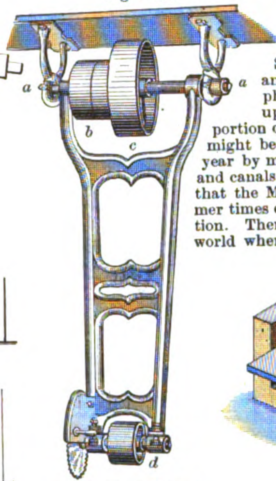
2. A *swingle*-tree; preferably *single*-tree.

Swing-wheel. (*Horology.*) The balance-wheel of a watch.

Swing-wheel File. (*Watchmaking.*) A file for dressing out the openings in the steel disk from which a balance-wheel is made. A *cross-file*.

Swipe. A water-elevator; the well-known well-pole and bucket. Known also as a swipe or SHADÛF. It was common in ancient Egypt, as in the modern; also in the country watered by the Tigris and Euphrates.

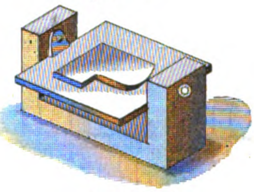
Fig. 6127.



Swing Cut-Off Saw.

So abundant is the supply and rapid the fall of the Euphrates and Tigris in their upper course, that the greater portion of the intervening country might be supplied during the whole year by means of dams at intervals, and canals. It was by careful method that the Mesopotamian Valley in former times carried such a large population. There is perhaps no part of the world where remain the evidences of

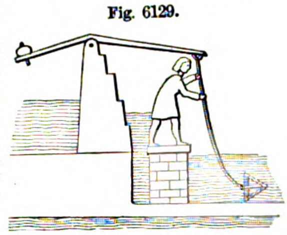
Fig. 6128.



Swing-Tool.

such a large population to the territory. For instance, in the tract of country between the Tigris and the upper Zab, which, says Rawlinson, is the only part of Assyria that has been strictly examined, are distinct remains of an Assyrian canal which has been carried through the more elevated ground by tunneling, and has been led for eight miles in a direction contrary to every other stream in the district. Sluices and dams regulated the supply. The hand-swipe, or *shadûf*, carried the supply to still higher levels. See SWAPE; SHADOOF.

Fig. 6129.



Swipe on the Tigris (Ancient Assyria).

Swip'le. The beating end of a flail.

Swiss Mus'lin. (*Fabric.*) A fine, open, transparent cotton goods.

Switch. 1. (*Railway.*) The movable rails which connect one line of rails with another.

Switches are known as *stub*-switches and *split*-switches.

In the *stub*-switch the switch-rail has square butted ends, as at *A*, Fig. 6130. The switch-rails require to be moved in direct apposition, or a train running in direction *a b* on rails *a a* would run off the track, were the switch-rails *b b* in connection with the siding, as shown.

In the *split*-switch, *B C*, the switch-rail is pointed, and somewhat automatic. *B* shows it as applied to a main track and siding; *C*, to three tracks, with either of which it may be made to coincide. A train on either of the tracks *c c c* will force over the switch, so as to run on to the main track *d*. A train going in the direction *d c* will run upon such one of the rails *c c c* as may at the time be adjusted in connection by means of the switches.

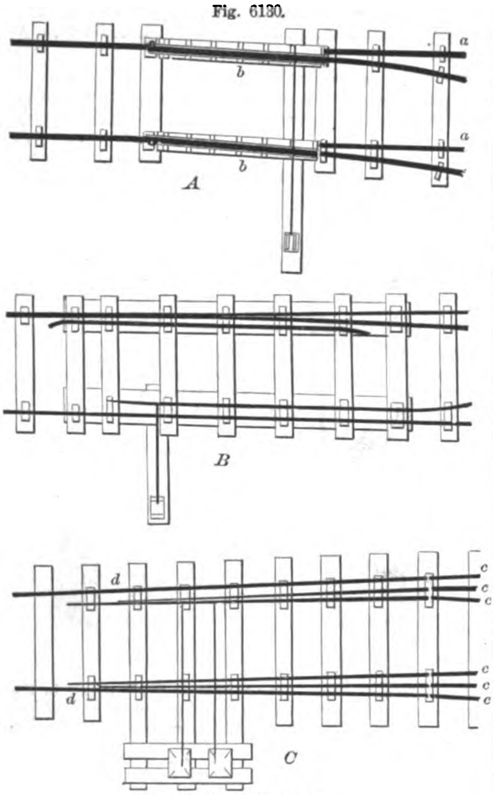
A Y-switch consists of a simple divergent track, which does not again run into the main track.

Switches have been designed to be set in motion by the approaching engine, the object being to restore the main-line connection when a switch has been carelessly left open to a siding. The idea has not been acceptable.

A *portable* switch is one which affords a temporary passage from one track to another, bridging the inside rails.

2. (*Telegraphy.*) A device for connecting one circuit with another, or for dividing a circuit into

Fig. 6130.



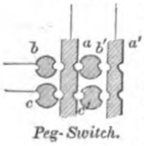
Railway-Switches.

two parts, or, in short, for altering any of the connections of a line or circuit. The ordinary *ground* or *lever* switch is a small metallic strip pivoted at one end, the pivot being connected by a wire to one portion of an electrical circuit. The other end of the strap can be turned to rest on an anvil or bed connected with the line desired to be brought into circuit.

The *plug*-switch is one made of pieces of metal connected each to its appropriate wire or part of circuit, but slightly separated from each other, so that the insertion of a plug or pin in the interval between them connects them.

Fig. 6131 illustrates the *peg-switch*. *a a'* are vertical notched bars, the first being connected with the line wire entering a station, and the second with the wire going out. *b b'*, *c c'* are metallic buttons to which are connected the instrument wires; all the buttons on the same horizontal line are connected together at the back of the switch. The cut shows the circuit open. To close it, with the office instrument in circuit, metal pegs are inserted in the orifices at *a b* and *a' c'*, causing the current to flow through *a b* to the instrument, and thence through *c' a'* to the main line. If desired to send through circuit without connecting the instrument, a peg is inserted only at *b' a'* or *c' a'*. By a modification of the connections, this form is adapted for a terminal station.

Fig. 6131.



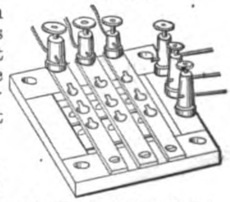
Peg-Switch.

By this means also any desired amount of battery power may be applied to one or more circuits by simply inserting metallic pegs in a graduated scale. Every new position in which the peg is placed changes the number of cups brought into connection with that particular line. The same apparatus is also arranged with spring catches, to enable the chief operator to make a connecting loop with any line, or to join two or more lines together by inserting metallic clips connected with the loop lines into the catches. Each line has two catches, and each will hold four clips, so that eight messages may be taken from one line at once. By joining other circuits with these, a still larger number of copies may be made of any one message. This system of switches enables the chief operator to place himself in connection with any wire, and to study the work of the operator without his knowledge. The apparatus is so simple and compact that the wires for several hundred lines may be brought within easy reach of one operator.

3. A key on a gas-burner to regulate the amount of gas passing, and, consequently, the light.

Switch-board. An aggregation of switches upon one base, so that any instrument in an office may be connected with any wire or any battery, or cut out altogether.

Fig. 6132.

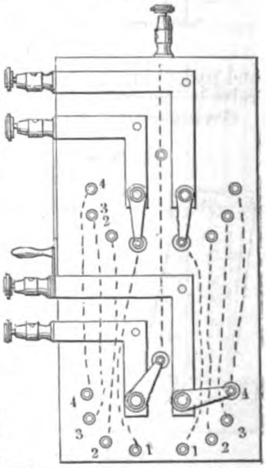


Telegraphic Switch-Board.

Fig. 6132 represents a switch-board made of wooden strips (non-conducting) and metallic strips (conducting), so joined in the shape of a frame as to bring the longitudinal metallic strips and the lateral metallic strips across each other for the purpose of making connections between them.

In Fig. 6133, the switch buttons are arranged in pairs corresponding to the number of batteries employed, including the buttons of each pole of a battery in one pair. The battery-pole and its button are connected by a wire.

Fig. 6133.



Telegraph-Battery Switch-Board.

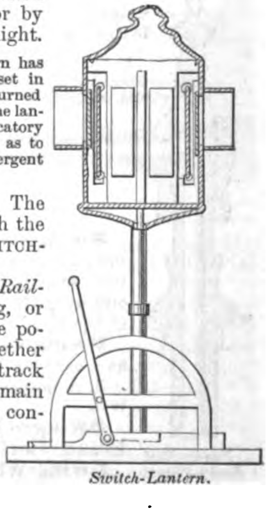
Switch'ing-en'gine. A *yard*-engine, or *donkey*-engine, used about a station or depot for making up trains or moving engines which have not steam up.

In Europe, tank-engines are commonly used, rendering unnecessary the tender which carries the water and fuel for the longer journeys of the usual locomotive duty. The European locomotive-engines for switching purposes have box frames made of wrought-iron plates made water-tight, and used to carry the water required by the engine. See TANK-LOCOMOTIVE.

Switch-lan'tern. A lantern on the lever of a railway-switch, to indicate the condition of the switch either by its position or by the display of a colored light.

In the example, the lantern has glasses of different colors set in tubes, so that only the one turned directly in front is visible. The lantern is rotated by the reciprocatory motion of the switch-bar so as to indicate which of several divergent tracks is open.

Fig. 6134.



Switch-Lantern.

Switch-lev'er. The handle and bar by which the switch is moved. See SWITCH-STAND.

Switch-sig'nal. (*Railway.*) A lantern, flag, or signboard indicating the position of a switch, whether open to the main or side track or to one of several main tracks. It is frequently constructed so as to be set by the motion of the switch, certain lights or

signals indicating the respective switches. See SWITCH-LANTERN.

In the example, the ends of the switch-rails lie in the recess beneath the tread, so that the flange of the wheel does not come in contact therewith. The counter weight restores the switch to position after movement. The switch-lever shaft is connected by cog gearing with the turning signal-shaft.

Fig. 6135.

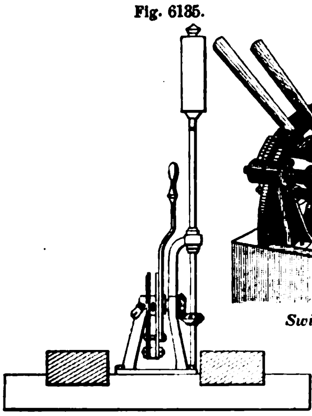
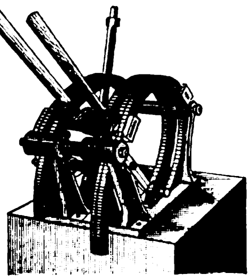
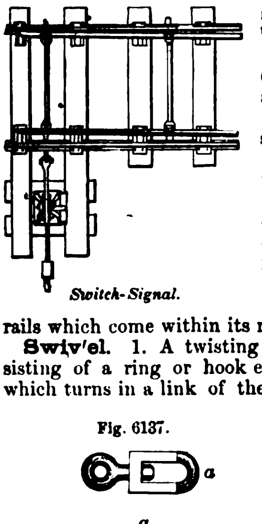


Fig. 6136.



Switch-Stand.

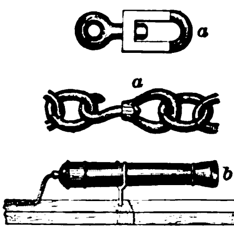


Switch-Signal.

Switch-stand. (*Railway.*) A fulcrum and locking-device for the levers whereby switch-rails are moved. The levers move in slots in arc-shaped guides, which latter have notches to hold the levers in certain positions which indicate the apposition of the switch-rails with one or another line of rails which come within its range of adaptation.

Swiv'el. 1. A twisting link *a* in a chain consisting of a ring or hook ending in a headed pin which turns in a link of the chain. The object is to avoid *kinking.*

Fig. 6137.



Swivels.

2. A small cannon *b*, whose trunnions are placed in a carrier, which is pivoted in a socket, so that by the two adjustments the gun may be pointed in any direction. A pivot-gun. See page 1722.

3. (*Nautical.*) A rest, having adjustment in azimuth, for supporting a small piece of ordnance on the gunwale of a boat or vessel.

4. (*Saddlery.*) A loop or runner through which the check-rein passes.

Swiv'el-bridge. A bridge which rotates on an axis, moving in a horizontal plane. See SWING-BRIDGE; PIVOT-BRIDGE.

Swiv'el-gun. (*Ordnance.*) One mounted on a pivot to traverse horizontally in a circle. See PIVOT-GUN, page 1722.

Swiv'el-hang'er. A form of shaft-hanger invented by Edward Bancroft, R. I., in which, to ensure the weight of the shaft being received over the entire length of the box, he hung the box on a universal joint, and made its axis of vibration coincide with the center of the box. This permitted the use of longer boxes than were before practicable, and the pressure per square inch on the surface was lessened.

Swiv'el-hook. (*Nautical.*) A turning hook strapped to a tackle-block.

Swiv'el-hook Block. A pulley block in which the suspending hook is swiveled to the block, so that the latter may turn to present the sheave in any direction.

Swiv'el-joint. A section in a chain or a joint on a rod, which allows the parts to twist without kinking or distortion.

Swiv'el-loom. A kind of loom (formerly) used for the weaving of tapes and narrow goods.

Swiv'el-plow. A plow having its land-side, sole, and mold-board on an axis, so that the combined portions may be turned over to throw the furrow to the right or to the left. Known in England as a *turn-wrest* plow; in the United States as a SIDE-HILL PLOW (which see). See also TURN-WREST PLOW, the British name for the implement.

Sword. 1. A cut and thrust weapon. Its use is of a very remote antiquity, dating as far back as the bronze age. Stone is not adapted for weapons of this kind, and they have not been found among the relics of peoples unacquainted with the use of metals. Artificers in flint could produce nothing better than a short knife. Swords of iron were made by the Chinese, 1879 B. C. This was about the era of Isaac, and three centuries before Cecrops.

Herodotus speaks of an "antique iron sword" as planted on the top of the mound of worship, used by the Scythians. The position was *phallic*, a form of deification familiar to that whole region. The sword found in the great tomb of Kertch was of iron. Their weapons, however, were usually of bronze.

The swords of the bronze age are always more or less leaf-like in shape, double-edged, sharp-pointed, and intended for stabbing and thrusting rather than for cutting. They have no hand-guards. (LUBBOCK.) *a* is an ancient iron sword, introduced to show the difference in shape. *e* to *k* have solid handles. *b c d* have thin handles intended to have *scales* of wood to round out the hand-hold. The handles are short, and are adapted for the use of a smaller-handed people than the present inhabitants of the lands where these specimens were gathered. *a* is an iron sword from a Saxon tomb, England; *b*, bronze sword from Ireland; *c*, from Sweden; *e*, Switzerland; *f*, Neufchatel; *g*, Scandinavia; *g h i j k*, Denmark.

For the sake of comparison are added: —
l m, spear-heads from Ireland
n o, Irish bronze daggers.
p q, bronze knives from Switzerland.
r, bronze razor-knife from Denmark.

The Egyptian sword was straight and short, from 2½ to 3 feet in length, having a double edge and a sharp point. It was used, as the monuments show, for cut, thrust, or as a dagger. The handle was hollowed in the center, increasing in thickness toward each end, and the end was surmounted by an emblem, such as a hawk's head or the symbol of Phrah.

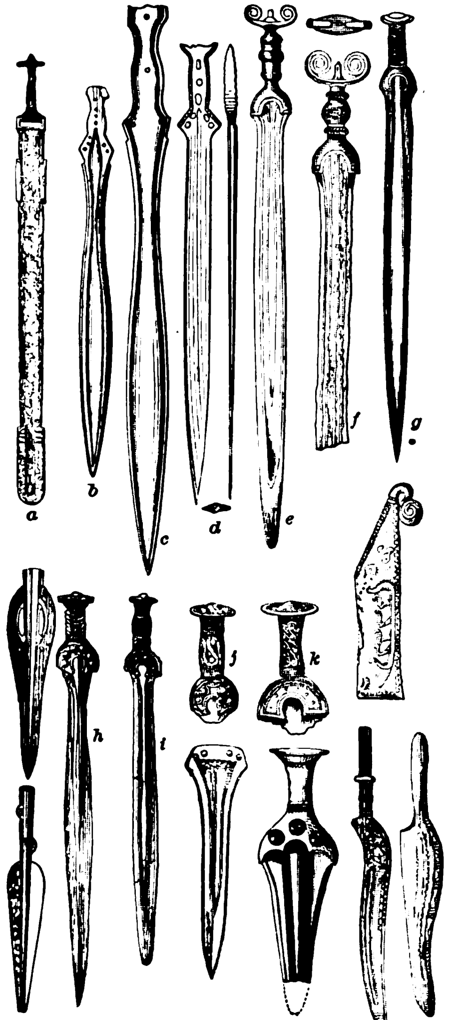
Ages ago the superiority of Damascus blades was proverbial. They were very thin, took an exceedingly keen edge, and were so elastic that they could be bent into a circle without retaining a permanent set. Their surface exhibited a series of fine wavy and spiral lines, which were apparently removed by grinding, but restored by the application of acids. From this circumstance it is inferred that they were, like their modern imitations, made by welding together thin laminæ or wires of iron and steel. The art is said to have been lost to Damascus when it was taken by Tamerlane, who carried away the artificers; and though swords are still made there, they do not enjoy the reputation which tradition assigns to those of the ancient manufacture. See DAMASK; STEEL.

When, A. D. 802, Nicephorus, son of Irene of Byzantium, attempted to throw off the yoke of the Saracens, he sent a letter to the Khalif Haroun al Raschid, in which, alluding to the game of chess, he said, "The queen considered you as a rook, and herself as a pawn," and accompanied the letter with a bundle of swords, which his messengers threw down at the foot of the throne. The Khalif smiled, and drawing his scimeter (*samsamah*), cut asunder the Greek swords before him; then dictated this answer: —

"In the name of the most merciful God! Haroun al Raschid, Commander of the Faithful, to Nicephorus, the Roman dog. I have read thy letter, O thou son of an unbelieving mother. Thou shalt not hear, thou shalt behold my reply."

He ravaged Asia Minor at the head of 800,000 soldiers, and

Fig. 6138.



Ancient Swords, etc.

dictated a humiliating peace. About this time Charlemagne was subduing the Slavi of the Elbe and the Avars of Hungary. The king of the Franks at Aix-la-Chapelle received from the great Haroun of Bagdad presents, consisting of the keys of the holy sepulcher, a consecrated standard of Jerusalem, a wheel-clock that struck the hours, an organ, an ape, and an elephant.

Scott, in the "Tales of the Crusaders," describes a meeting between Richard Cœur de Lion and Saladin. Saladin asks Richard to show him the strength for which he is famous, and the Norman monarch responds by severing a bar of iron which lies on the floor of his tent. Saladin says, "I cannot do that," but he takes a down pillow from the sofa, and, drawing his keen blade across it, it falls in two pieces. Richard says: "This is the black art; it is magic; it is the Devil; you cannot cut that which has no resistance." And Saladin, to show him that such is not the case, takes from his shoulders a scarf which is so light that it almost floats in the air, and, tossing it up, severs it before it can descend. George Thompson states that he saw a man in Calcutta throw a handful of floss silk into the air, and a Hindoo sever it into pieces with his saber.

Europe wondered much at the gorgeous profusion of the Orient, and even the "brand *Excalibur*" must have been of Eastern make, —

> "My brand Excalibur
> Which was my pride"
>
> "For all the haft twinkled with diamond sparks,
> Myriads of topaz-light, and jacinth-work
> Of subtlest jewelry."

No wonder Sir Bedivere coveted the sword of this old British chief and hid it "in the many-knotted water-flags," as related in the chronicle of the old harper who is always a little below concert pitch.

The famous sword of Orlando was said to have been the work of the fairies, and its name *Durandal* (*dur en diable*, "as hard as the devil") is indicative of its origin, and accounts for the fact (?) that he was able to cleave the Pyrenees with it. It was also called *Durandarte*, *Durindana*, *Durlindana*.

Curtana was another famous sword of Orlando. Its name was given to the "first royal sword" of England from a very early period; in the wardrobe accounts for 1488 it is so designated.

Morglay (*glaive de la mort*) was the sword of Sir Bevis of Southampton.

Tizona was the famous sword of the Cid.

Andrea Ferrara, so long believed to be the name of a celebrated Italian sword-maker, must be given up. *Andrea* is only an occasional prefix, and *Ferrara* is most probably a corruption of *ferrarium*, a weapon-smith, or cutler.

The Lord Mayor of London used to bear three swords, — a *common*, a *Sunday*, and a *pearl* sword. These were *not* famous in chivalric records.

Japanese officials of a certain grade wear two swords, the hilts projecting out a foot in front of the person of the wearer. One of them is a heavy, two-handed weapon, pointed, and sharp as a razor; the other short, like a Roman sword, and kept in the same serviceable state.

Swords and sabers have a *blade*, either straight or curved, with a *tang*, which is inserted into a spindle-shaped piece of wood, covered with leather, and wrapped around with brass wire; these form the *gripe*, which, with the brass knob at the end called the *pommel*, constitutes the *hilt*. The hand is protected by the *guard*, which is a curved piece of metal, consisting of from one to three branches, and usually provided with a broad plate of metal, the guard-plate, at the point where it is attached to the blade.

The scabbard is the case, usually of leather or steel, into which the blade is inserted.

The blade of a sword consists of: The *tang*, which enters the hilt; the *shoulder*, which abuts against the end of the hilt; the *forte*, the half of the blade nearest the hilt; the *faible*, or *foible*, the half part nearest the point; the *point*; the *back*; the *flat*; the *edge*.

The hilt consists of (the parts varying in different kinds of swords): The *pommel*, or back piece; the *gripe*; the *bars* of the basket, in sabers; the *stool*, or *guard*-plate; the *bow*, in sergeants' swords and horse-artillery sabers; the *cross*, as in the old Highland claymore; the *linguets*, in foils and rapiers.

The successive operations in sword-making are forging, hammering, swaging, hardening, tempering, setting, grinding, glazing, hilting, and proving.

In the process of making swords, as practiced at the factories, pieces of Sheffield steel called *double molds*, each of the length of two blades, the ends for the tangs being of iron, are employed. These are cut or broken in the middle, the tangs are forged first, and afterward the blade. the furrow or furrows being formed at the same time. Twenty-five reheatings are required for this purpose. The blade is then heated and plunged into cold water, rendering the metal extremely brittle; again heated, and the distortions caused by the hardening corrected by rehammering, when it is again heated till its surface assumes the proper color, of which the workman is the judge, to insure its having the due hardness and flexibility when tempered, which is done by plunging it at this stage into cold water.

It is next ground. The stones employed for finishing the furrows have raised flutings suited to the furrows of the particular kind of blade to be operated on.

The polishing is performed upon wheels of various sizes, with lard-oil and flour of emery, the blade being frequently dipped into lime-dust during the operation. A brush-wheel, sprinkled with fine crocus-powder, imparts the final polish. The scabbards, if of metal, the hilts, and other metallic parts are treated in like manner.

In making the metallic scabbard, a piece of sheet-steel is laid over the top of an open vise, and beaten with a wedge-shaped wooden mallet, causing the edges to approach each other. The sides are then beaten on each side until the edges nearly unite, and the scabbard is slipped upon a mandrel and hammered until the joint is closed; it is then soldered, and the tip, or *drag*, and the bands are put on.

The *gripe*, or handle, is made of walnut, with a metallic strip at the back; it is shaped by files, a tenon for the ferrule made at the end, and *balled*, that is, surrounded with grooves, by means of a triangular file; the edges of these grooves being afterward rounded, or "balled," with another file. It is then drilled in a lathe, with a longitudinal hole for the tang, after which it is covered with dogfish-skin, secured by winding cord or wire around the gripe in the grooves between the balls.

The hilt, or guard, is cut from sheet-metal, and hammered into shape, then polished, and finally fixed to the sword. This operation is called mounting.

Sword-blades, resembling those of Damascus, are made at Solingen, in Germany. A fagot is first formed of alternate fine bars of iron and steel. It is drawn out, doubled, and twisted several times, and then formed into a ribbon. Two such rib-

bons are welded together, inclosing between them a thin blade of the best-cutting English steel. After polishing it, it is dipped in diluted sulphuric acid, to give it a pattern.

Sword-blades, resembling in appearance the Oriental blades, and equal to them in quality, have been made in Germany, by the process of Prof. Crevilli, of Milan.

"A long, flat piece of malleable steel, 1½ inches in breadth and ¼ inch in thickness, is first bound with iron wire, at intervals of ½ inch. The iron and steel are then incorporated by welding, and repeated additions (10 to 20) of iron wire made to the forging, in the same manner as the first. The forging is then stretched, doubled, and welded; and the process is repeated as often as may be desired, when the material is brought to the shape required by the hammer on the anvil.

"By filing semicircular grooves on both sides of the blade, and again subjecting it to the hammer, a beautiful rosette-shaped damask is obtained. By special manipulation the pattern may be made to assume other forms. The pattern is brought out by the application of aqua fortis and vinegar. An idea of the extraordinary tenacity of these blades may be formed from the fact, that out of 210 blades examined by a military commission, and each of which was required to bear three cuts against iron and two against a flat wooden table, not a single one snapped or had its edge indented." (See WOOTZ; DAMASKEENING.)

2. (*Weaving.*) One of the bars dependent from the *rocking-tree* and supporting the *lay*.

3. The scutching-blade of the flax-dresser. See SCUTCHER.

Sword-bay'o-net. A bayonet with a blade like a sword, and capable of being detached from the barrel and used like a sword.

Sword-belt. The waist-belt from which a sword is slung.

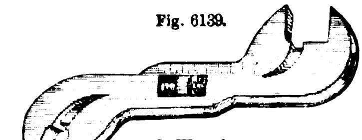
Sword-cane. A cane with a concealed sword.

Sword-knot. A knotted ribbon on a sword-hilt.

S-wrench. A spanner or wrench of an S-shape, to enable it to reach parts not so readily approached by the ordinary monkey-wrench. It has two jaws of different angles, and an adjusting screw in the stock.

In Fig. 6139, the respective pairs of jaws are operated by a right and left screw and thumb-piece. Scales are placed on the

Fig. 6139.



S-Wrench.

respective halves, which have a motion on each other, each piece having an inner and outer jaw of the respective pairs.

Sym'bol-print'ing. (*Telegraphy.*) A system of printing in dots and marks (see MORSE ALPHABET) or other cipher, as distinct from printing in the usual Roman letter. (See PRINTING-TELEGRAPH.) The *dots* and *dashes* of the Morse, or similar system, may be produced by pressure on, or penetration of the paper (Morse), or by a chemical action at the point of contact of the styles (Bain), or the passage of the electric current.

Sym'pa-thet'ic Ink. A colorless ink, the writing made with which is made visible by a subsequent operation, — warmth, or other reacting stimulant. See INK, page 1187.

Sym-phys'e-o-tome. (*Surgical.*) Fr. *Couteau symphysien.* A knife used in operation of the division of the *symphysis pubis* to enable the pelvis to open and permit delivery; the *Sigaultian section.*

Sym'pi-e-som'e-ter. Invented by Mr. Adie of Edinburgh. It consists of a column of oil supported by atmospheric pressure, and rising, not like the mercury of the barometer into a vacuum, but against a body of hydrogen gas, which acts like a spring against the column of oil; and as the elasticity of the hydrogen varies with every change of temperature, a movable thermometer-scale is attached for making the necessary corrections.

The glass tube *b* is about 18 inches in length and $\frac{7}{100}$ of an inch in internal diameter. At the upper extremity is a cylindrical vessel *a*, 2 or 3 inches long and half an inch in internal diameter. The lower extremity is turned upward, and terminates in a vessel *c*. The hydrogen is contained in the space *b a*, and the oil, colored red with alkanet, occupies the space between *b c*.

The sympiesometer is graduated by placing it together with a standard barometer and thermometer in a glass vessel, in which the pressure of the air can be varied at pleasure. The top of the column is marked at the points where the barometer shows 27, 28, 29, 30, 31 inches respectively. The spaces between the marks, coinciding with the inches of mercury, are then subdivided into 100 equal parts each, and the great range makes the instrument valuable for recording minute variations, subject to correction, depending on the variation in the volume of the hydrogen due to changes of the temperature. A graduated sliding scale assists in reaching the corrected result.

Fig. 6141 is another form of the instrument.

Fig. 6140.

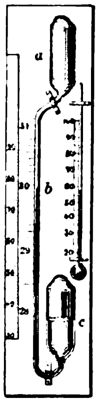
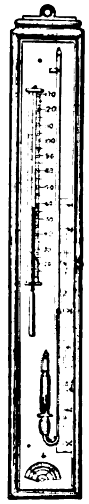


Fig. 6141.



Sympiesometers.

Syn-cli'nal Line. (*Mining Engineering.*) The axis of valley curvature of strata, at which the beds which are tilted in opposite directions are supposed to meet. Opposed to *anti-clinal.*

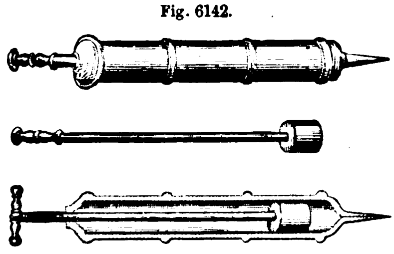
Syn-os'te-o-tome. (*Surgical.*) A dismembering-knife.

Sy'pher-ing. (*Shipwrighting.*) Lapping the chamfered edge of one plank over the similarly chamfered edge of another, so as to form a joint with a plane surface.

Sy'pher-joint. (*Carpentry.*) A lap joint for the edges of boards, leaving a flat or flush surface.

Sy'ren. See SIREN. See also "Tyndall on Sound," London, 1875, pages 61, 82, and frontispiece; also "London Engineer," January 21, 1876.

Fig. 6142.



Syringe, by Hero.

Syr'inge. 1. A small hand-pump for ejecting water. Well described by Hero in his "Spiritalia." He describes it for injecting a liquid, or, by an inverse operation, withdrawing pus from a wound. Fig. 6143 shows the squirts which formed a part of the horse-play of the carnivals and sports of the Middle Ages.

See under the following heads: —

Catarrhal syringe.
Catheter-syringe.
Condensing-syringe.
Ear-syringe.
Elastic-bulb syringe.
Enema-syringe.
Exhausting-syringe.
Eye-syringe.
Garden-syringe.
Hemorrhoidal syringe.
Hypodermic syringe.
Injection-syringe.
Ointment-syringe.
Penis-syringe.
Probe-syringe.
Squirt.
Transfusion-syringe.
Universal syringe.
Vaginal syringe.

2. (*Surgical.*)

Fig. 6143.

Squirts.

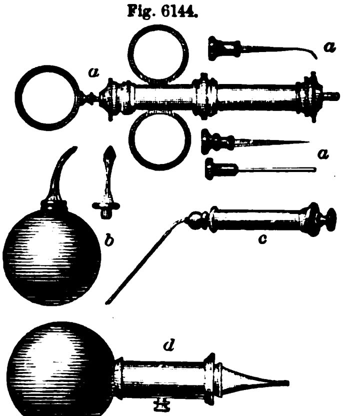
a. Anel's silver eye-syringe with silver and gold points.
b. Liebold's subpalpebral syringe.
c. McFarlan's lachrymal syringe.
d. Rubber-bag ear-syringe.

Clotworthy's syringe, August 24, 1875, has a removable nozzle over the rounded end of a vaginal syringe. It may be used for either sex.

Wheelock's, April 11, 1865, has orifices to discharge the liquid backwardly.

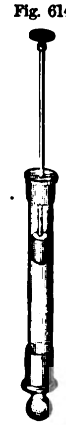
The pneumatic syringe is an instrument for illustrating the compressibility of gases. It consists of a strong glass tube hav-

Fig. 6144.



Syringe.

Fig. 6145.



Pneumatic Syringe.

ing a tightly fitting piston, which, on being forced down, compresses the gas into a bulb proportional to the amount of pressure applied.

Reed's syringe for cattle is used for injecting medicine, or as a stomach-pump. It does not differ materially except in size from the ordinary surgical apparatus for an analogous purpose. When used as an injector, the induction end of the syringe is plunged in a bucket containing the medicament, and the injection-tube is introduced through the esophagus into the paunch, to which the medicine is directed. When used to relieve a distended paunch, the long tube is secured to the induction end of the syringe, and the fermenting pultaceous mixture and gas are ejected at the side of the cylinder.

Syr'inge-case. A box for the compact stowage of the surgical syringe. The injecting-tubes rest in the notches of a tray, which has an aperture to allow the projection of the upper part of the bulb.

Syr'inge-en'gine. One used as a fire-engine some centuries since.

Syr'inge-valve. A peculiarly constructed valve used in syringes. The valve-guide stem has an end knob, by which its falling out is prevented.

Syr-ing'o-tome. (*Surgical.*) A bistoury, concave on its edge, and terminated by a long, flexible, probe-pointed stylet. Formerly used for *fistula in ano*, by incision.

Syr'inx. (*Music.*) A wind-instrument, consisting of a row of parallel reeds of varying lengths, and played by blowing into their open, upper ends. Their varying lengths determine their pitch. The usual number was seven, but some are found having from three to nine.

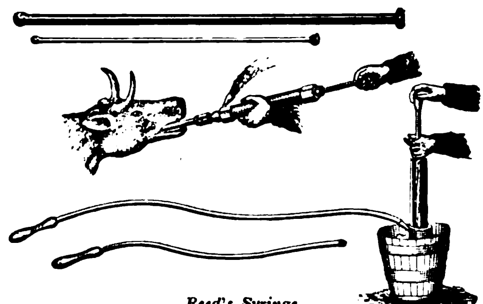
Probably the *ugab* of the Hebrew Bible, which in our version is rendered *organ*. The *sumphonia* of the Hebrew (*zampogna* is the Italian bagpipe) was probably a syrinx with bellows, — the rudimentary organ.

The pandean pipes, eight in a row, and of graduated lengths, are shown on old monuments and gems.

A syrinx with bellows is shown on one of the ancient terra-cotta exhumed at Tarsus, Asia Minor. It is supposed to be 2,000 years old, as coins of the second century B. C. were imbedded in the earth in its vicinity.

The Peruvians had a syrinx with eight pipes. One specimen of the instrument was about four inches wide, the longest

Fig. 6146.



Reed's Syringe.

pipe having also about that length. They were made of cane or stone. The one above referred to was made of a talcose stone, and was peculiarly ornamented. It was found on the breast of a skeleton in one of the *huacas*, or Peruvian tombs. Four of the tubes had lateral finger-holes, by stopping which the tones were lowered a semitone. It appears to have been called the *huayra-puhura*, whatever that may mean. It had one more pipe than the classical or the modern instrument.

Fig. 6147.

Syringe-Engine.

The *syrinx* is shown in English MS. of the ninth and tenth centuries. In one of the eleventh century, the tubes are inserted in a boat-shaped box.

The syrinx was used by the Romans as a noisy improvement on hissing, in condemning bad actors; the English *cat-call* and the American *whistle* are its legitimate successors. The occupants of our peanut galleries, however, use it indiscriminately for praise or blame.

It may be said of them, as Quince the carpenter says of Pyramus, —

"He goes but to see a noise."

Syr'up-stand. See SIRUP-STAND.

T.

Tab. 1. (*Fulling.*) One of the revolving arms which lift the beaters of a fulling-mill.

2. (*Shoe.*) A latchet or flap of a shoe or half-boot, formerly fastened with a buckle, of late by a string.

3. The metallic binding on the end of a shoe or corset lace. A *tag.*

Tab-a-ret′. (*Fabric.*) A stout, satin-striped silk goods.

Tab′by. (*Fabric.*) Silk or other stuff having an irregularly waved or watered surface produced by pressure, usually between engraved rollers in the mode of calendering, known as *tabbying.* There is but little difference between *tabbying, watering,* and *moiré,* the effect in each case being produced by the flattening of some of the fibers while the others remain undisturbed, causing the different parts to reflect the light unequally.

"My false taby wastecote with gold lace." — PEPYS, 1661.

Tab′by-ing. Passing fabrics between engraved rollers to confer a wavy or watered appearance. Analogous to *watering,* or *moiré.* See TABBY.

Tab′er-na-cle. (*Nautical.*) An elevated socket for a boat's mast; or a projecting post to which a mast may be hinged when it is fitted for lowering to pass beneath bridges.

Tab-i-net′. (*Fabric.*) A goods of silk and wool, adapted for window-curtains.

Ta′ble. 1. (*Furniture.*) A piece of furniture on which viands or work is placed, so as to be readily reached by persons sitting adjacent thereto.

Tables are known by size, shape, construction, material, purpose, etc., as,

Card,	Dining-room,	Self-waiting,
Carving,	Extension,	Steam-heated,
Center,	Folding,	Toilet,
Chess,	Ironing,	Work, etc.

The Egyptians used chairs and tables in what we consider the regular civilized way; neither reclining on couches, as in the lazy way of the later Romans, nor squatting on a rug, as the modern Oriental. Their tables were supported by central stems or by legs, the latter terminating in carved feet like those of lions or dogs. They were of metal, stone, wood, or ivory; were carved, painted, and gilded; square, round, or oblong.

The annexed cut shows one with a central post, where

Fig. 6148.

Egyptian Table (*from Wilkinson*).

Fig. 6149.

Egyptian Table (*from Salt's Collection*).

the figure of a captive forms the shaft, and a flat base the foot.

Fig. 6149 is a table in the collection of Mr. Salt, and is inlaid with ornaments of vines and the peculiar serpent figure that is represented in connection with wine. Possibly to suggest that it "stingeth like an adder," as they were fond of moralizing at their feasts.

The Romans used three-legged, four-legged, and central-stem tables (*monopodium*); also semicircular, lunette, and S-shaped tables (*sigmata*). Tablecloths do not appear to have been used by the Greeks or Romans.

A revolving table, to present the viands to the guests in rotation, was used in Varro's villa at Casinum.

For ancient tables, see Fosbroke's "Ency. Antiq.," I. 380 *et seq.*

2. (*Glass-making.*) *a.* The flat disk of crown glass which is made from a bulb on the end of a *blowing-tube,* transferred to a *ponty,* gradually and finally *flashed* into a disk by rotating in front of a FLASHING-FURNACE (which see).

b. The flat plate with a raised rim, on which plate glass is formed. See Fig. 1181.

3. A chess or backgammon board.

4. (*Diamond-cutting.*) *a.* A form of diamond-cutting. The top of the stone is ground flat with a corresponding flat bottom of less area, with its four upper and lower faucets cut parallel to each other. See DIAMOND-CUTTING.

b. The upper flat surface of a brilliant cut diamond; the zone facets around it are known as the *bizet.* The lower flat face, the *collet,* which converts the *culasse* into a truncated pyramid, is $\frac{1}{5}$ of the size of the table, and parallel therewith. See BRILLIANT.

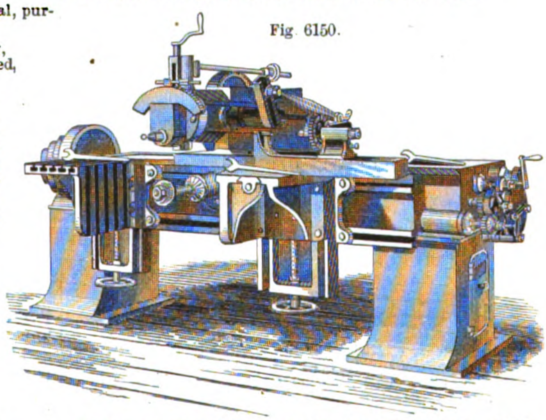
5. (*Architecture.*) *a.* A smooth, simple member or ornament of various forms, but most usually in that of a long square.

b. Table or *tablet moldings,* horizontal bands or moldings, such as base-moldings, strings, cornices, etc.

6. A tablet. Formerly a board, slab, or leaf to contain writing. The term is nearly obsolete as a writing surface, but is still useful as indicating lists and calculations, generally in lines and columns.

7. (*Weaving.*) The board or bar in a draw-loom to which the tails of the harness are attached.

Fig. 6150.



Shaping-Machine (*N. Y. Steam-Engine Co.*), *with Two Tables.*

8. (*Machinery.*) The part on which work is placed to be operated upon; the term *bed* is also used to designate the large flat table of a planing-machine. Shaping-machines have single or double beds, the latter being lighter than one continuous one of equal reach, besides having an additional adjustability, as shown in the figure, where an object of irregular shape may be supported to present an accurately horizontal surface while it rests upon two tables of varying hights.

The shaping-machine shown in Fig. 6150 has a cutting-bar with 16 inches stroke, and the head has a traverse of 6 feet, with quick return-motion. The stroke is adjustable to anything less than 16 inches. It has two tables for holding work, both of which are movable up and down by screw and hand-wheel, and longitudinally by means of rack and pinion, with ratchet-lever.

Fig. 6151.

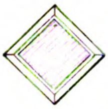


Table-Diamond.

Ta'ble-an'vil. A small anvil adapted to be screwed to a table for bending plates of metal or wires, making small repairs, etc. See STAKE.

Ta'ble-di'a-mond. (*Diamond-cutting.*) *Table-cutting* is adopted with flat, thin gems, which have not sufficient protuberance to be cut as *rose diamonds* or brilliants.

Ta'ble-fork.

The table-fork is a modern invention. Many centuries before its common use the article was known. It appears to have been a matter of taste and cleanliness with some persons in Constantinople as early as the eleventh century. One of silver, from a ruin on the Via Appia, is engraved by Caylus, as a classical antique. They are stated to have been brought from China to Italy, where, in Coryatt's time, they were of silver, iron, and steel, and used by gentlemen. They are mentioned in a charter of Ferdinand I., king of Spain, A. D. 1101, and in the wardrobe accounts of Edward I. of England. See also FORK.

Forks are made from rods of steel, about ⅜ inch square. The tang and shank are first roughly formed, and cut off with about an inch of the square rod, which is drawn out flat to the length of the prongs. The shank and tang are then heated and shaped by means of a die and swage. The flat part is then brought to a white heat and swaged between two corresponding dies, one on an anvil and the other upon the face of a drop-hammer, like that of a pile-driver, which is let fall from a hight of 7 or 8 feet; the thin film left between the prongs is afterward cut out with a fly-press. The forks are then annealed, their prongs filed, bent to the proper curve, reheated, hardened by plunging in cold water, and afterward tempered at the heat at which grease inflames.

Fig. 6152.

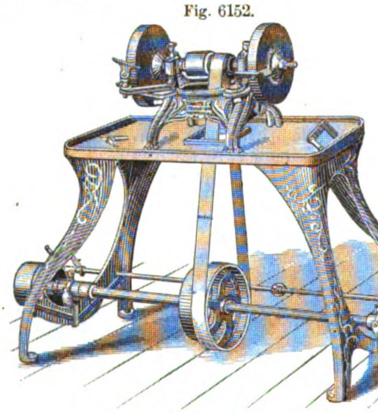


Table-Grinder.

Ta'ble-grind'er. A form of grinding-bench.

Ta'ble-knife.

Sharon Turner ("History of the Anglo-Saxons") observes, that "in all ancient pictures of eating, etc., knives are seen in the hands of the guests, but *no forks*." Their use at table was, no doubt, coeval with that of the table itself. Forks are of very modern introduction. Coryatt, in his "Crudities," published 1611, says: "I obserued a custome in all those Italian cities and townes through which I passed that is not vsed in any other country that I saw in my traules, neither doe I think that any other nation of Christendome doth vse it, but only Italy. The Italians and also most strangers that are commorant in Italy, doe alwaies at their meals vse a little forke when they cut their meate. For while with their knife, which they hold in one hand, they cut their meate out of the dish, they fasten their forke, which they hold in their other hand upon the same dish so that whosoever he be that sitting in the company of others at meate, shoul vnaduisedly touch the dish of meate with his fingers from which all others at the table doe cut, he will give occasion of offence unto the company as hauing transgressed the laws of good manners, in so much that for his error he shall be at least broue-beaten, if not reprehended in words."

Even when Heylin published his "Cosmography," 1652, they appear to have been a novelty in England, as, after speaking of the chopsticks used by the Chinese, he adds, "The use of silver forks, which is by some of our spruce gallants taken up of late, came from thence into Italy, and from thence into England."

In a curious class of knives of the sixteenth century, the blades have on one side the musical notes to the benediction of the table, or grace before meat, and on the other, the grace after meat. (See CARVING-KNIFE, page 492.)

The set of these knives usually consisted of four. They were kept in an upright case of stamped leather, and were placed before the singer, according to the adaptation of each part to the voice, indicated upon them.

In forming a table-knife, the blade is forged at the end of a bar of shear-steel, and then cut off. To it is then welded a piece of iron, which is shaped to form the bolster, shoulder, and tang. The bolster is formed between swages. The blade is then reheated and finished on the anvil, or smithed, as it is termed, stamped, tempered, and ground. The handle is then attached.

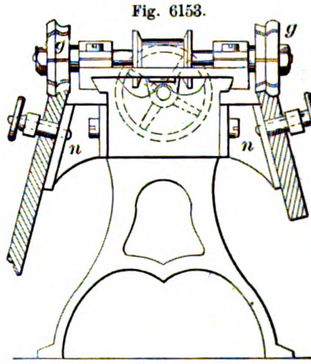
The manufacture of table-cutlery has of late years been introduced into this country, where a machine has been invented for forming knife-blades. This machine has been adopted in Europe.

Ta'ble-lathe. A small lathe attached by a clamp to a table and run by hand, or by a driving-wheel in a movable frame. See HAND-LATHE.

Ta'ble-leaf Joint. A peculiar form of furniture joint used in desk and table leaves, rules, and in some kinds of shutters. It has a molded edge, forming a *quarter-round*, the respective portions being *hollow* and *swelling*, so as to move on each other in manner of a knuckle-joint. The pintle occupies the position of the axis of the curved surfaces. Also known as a *rule*-joint.

Fig. 6153 shows a machine for planing the molding edges; the cutter-heads *g g* have the shape the converse of the one required on the material. The cutter-heads and mandrel are upon a sliding carriage, the work being dogged to the rests *n n*, whose inclination secures the proper presentation of the staff to the cutters.

Fig. 6153.

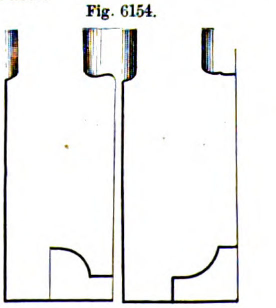


Machine for making Table-Leaf Joints.

Ta'ble-plane. (*Joinery.*) A furniture-maker's plane for making those joints on the flaps of table and side-boards called *rule-joints*.

The respective parts have *rounds* and *hollows*, and the planes are made in pairs, counterparts of each other.

Fig. 6154.



Pair of Table-Planes with Fence.

Fig. 6155.

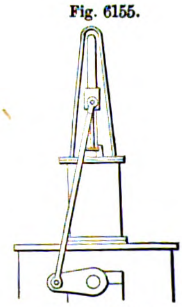


Table-Engine.

Ta'ble Steam-en'gine. A form of engine in which the cylinder is fixed upon a *table-like* base.

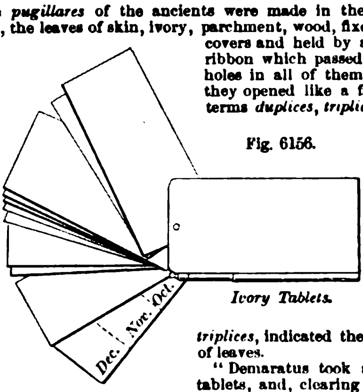
The piston-rod has a cross-head working in straight, slotted guides on the top of the cylinder, and is connected, by rods at each side, with two parallel cranks on the shaft under the *table*.

Tab'let. 1. (*Architecture.*) A coping on a wall or scarp.

2. A plate or slab for writing upon.

The *pugillares* of the ancients were made in the form of books, the leaves of skin, ivory, parchment, wood, fixed within covers and held by a wire or ribbon which passed through holes in all of them, so that they opened like a fan. The terms *duplices*, *triplices*, *quin-*

Fig. 6156.



Ivory Tablets.

triplices, indicated the number of leaves.

"Demaratus took a pair of tablets, and, clearing the wax away from them, wrote what the king [Xerxes] was purposing to do, upon the wood whereof the tablets were made; having done this, he spread once more the wax over the writing, and so sent it" — HERODOTUS, VII. 239.

Ivory is now commonly used.

Ta'bling. 1. (*Nautical.*) An additional thickness of canvas on portions of a sail exposed to chafing, or to strengthen the sail at certain points, as the edges.

2. (*Carpentry.*) A *coak* or tenon on the scarfed face of a timber, designed to occupy a counterpart recess or mortise in the chamfered face of a timber to which it is attached. See SCARF.

Ta'bor. (*Music.*) A small shallow drum used to accompany the pipe, and beaten by the fingers.

Tab'ou-ret. 1. An armless seat.

2. An embroidery frame.

Tab'ret. (*Music.*) A musical instrument of the small drum or tambourine class.

The word rendered *tabret* or *timbrel* in the King James version of the Bible is the *toph* of the Hebrew Scriptures; a word which is probably allied to *doff*, *diff*, or *adufe*, a small hand-drum of the East. The *toph* was evidently a tambourine or hand-drum, like the Egyptian *darabooka*, and is interesting in connection with the rejoicing of Miriam and the sad episode of the daughter of Jephthah.

Tache. A pan in a *battery* of sugar-pans.

All the pans in a battery are termed *taches*. The term is, however, often especially applied to the *smallest* of the five; that immediately over the fire from which the concentrated juice is transferred to the cooler, also called the *striking-tache*.

Ta-chom'e-ter. An instrument for measuring the velocity of moving bodies. Woltmann's, for measuring the speed of flowing liquids, has several spiral vanes on a shaft carrying an endless screw, which turns a series of geared wheels. On being placed in a current, the vanes assume a position perpendicular thereto, and their rotation actuates the clock-work mechanism which is graduated to indicate the velocity in miles per hour, or other units of measurement.

See SPEED-GAGE; SPEED-RECORDER; VELOCIMETER, etc.

Tack. 1. (*Nautical.*) *a.* The lower forward corner of a fore-and-aft sail.

b. The lower, weather corner of a *course*, or lower square-sail.

c. The rope by which the forward lower corner of a course or stay-sail is drawn forward and confined.

d. A rope by which the lower corner of a studding-sail is drawn outward and held to the boom.

2. *a.* A small, flat-headed, sharp-pointed nail. At the principal seat of the tack manufacture in England, it is not an uncommon feat for the workmen to forge 1,200 tacks so small as to be contained in the barrel of an ordinary goose-quill; their weight being about 24 grains. Tacks are known as *carpet*, *leathered*, *gimp*, *brush*, *broom*, *felting*. Their size is designated by the weight of 1,000, as 3 ounce, 6 ounce, 8 ounce, etc.

b. A short pin with a large flat head, used by draftsmen to hold a sheet of paper on the drawing-board; a *thumb-tack*; called also *drawing-pin*.

Tack-block. (*Nautical.*) A block for the tack of a sail. The studding-sail tack-blocks are at the ends of the booms.

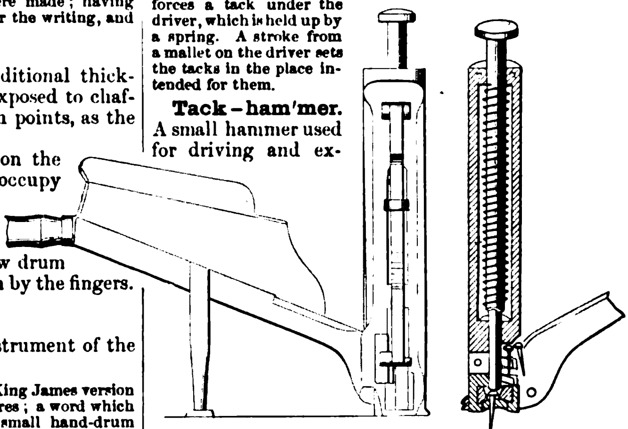
Tack-claw. (*Saddlery.*) A bifurcated tool for drawing tacks. It is especially used by saddlers and other workers in leather.

Tack-driv'er. 1. A tack-hammer.

2. A tool with devices for automatically presenting the tacks in succession, and driving them into place.

The example shows one which has an inclined plate serving as a hopper, by which the tacks fall into an inclined guide open at the bottom, which causes them to fall with their points downward. Two dies direct the tacks, and a slide forces a tack under the driver, which is held up by a spring. A stroke from a mallet on the driver sets the tacks in the place intended for them.

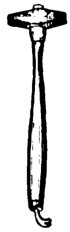
Fig. 6157.



Tack-Driver.

Tack-ham'mer. A small hammer used for driving and extracting tacks. The peen usually has either a thin edge, which may be inserted beneath the head of the tack, or is divided, to form a claw. In Fig. 6158 the claw is at the end of the handle.

Fig. 6158.



Tack-Hammer.

Tack'ing. 1. (*Metal-working.*) Uniting metallic pieces by drops of solder, to hold them in place until the solder is regularly applied to the joint.

2. Securing by tacks temporarily; as the pieces of a saddle or boot to the tree or last, to hold them in position for sewing.

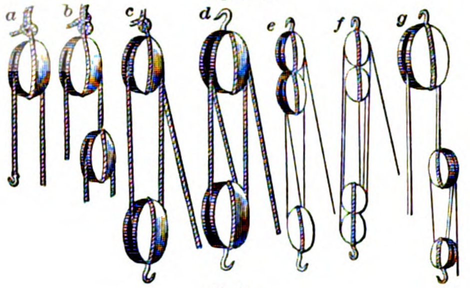
3. (*Nautical.*) Directing a vessel on to another tack when beating against the wind, so that the wind comes on the other bow.

Tack'ing-mill. A name of a kind of fulling-mill, *temp.* Edward IV.

Tack'le. An apparatus, or that part of an apparatus, by which an object is grasped, moved, or operated: as *gun-tackle*; *ground-tackle*; *fishing-tackle*; *plow-tackle*; *hoisting-tackle*; *reef-tackle*; *luff-tackle*; etc.

1. (*Nautical.*) A *simple tackle* consists of one or more *blocks*

Fig. 6159.



Tackles.

rove with a single rope. When two blocks are employed, one is the *standing block*, and the other the *running block*. The rope is termed the *fall*, and runs over the *sheaves*. The fast end of the *fall* is the *standing end*, the other the *running* or *hauling end*.

To *overhaul* a tackle is to separate the blocks by running out the rope.

Fleeting a tackle is to bring the blocks close together by hauling on the *fall*.

The block is bound with a *grommet* in the direction of its length. This is called the *strap*, and lies in the *score* of the block. If the strap be continued, so as to form a tail, it constitutes the block a *tail-block* or *jigger-block*. When a tackle has a *running block* of this character, it becomes a *jigger-tackle*.

As to kinds, the names founded upon structure: —

A *single whip* (*a*, Fig. 6159) is the simplest tackle. It consists of one *single* block and a fall. The standing block is made fast to a stationary object. The hook is applied to the load, and the power to the *fall*.

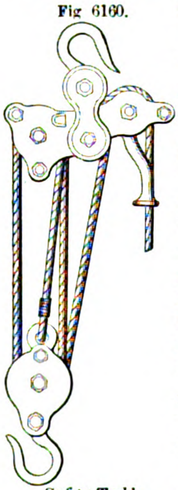
The *whip-on-whip*, or *whip-and-runner* (*b*), has two single blocks, one of which is a *standing* and the other a *running* block. The *fall* of the *standing* block is spliced round the block of the lower *whip*. The power is double that of a *single whip*.

The *double purchase*, or *gun-tackle purchase* (*c*), has two single blocks, the fall being rove through both, and the standing end being made fast to an eye on the bottom of the standing block.

The *reef-tackle* is a *double* purchase.

The *treble purchase*, or *luff-tackle purchase* (*d*), has a double and a single block, the fall being rove through one of the sheave-holes in the double block, then through the single block, then through the other sheave-hole in the double block, and is secured by splicing, or by an eye to the top of the lower block.

Fig. 6160.



Safety-Tackle.

The *yard-tackle* is a *treble* purchase.

A *twofold purchase* has two double blocks.

A *threefold purchase* has a *treble* block and a *double* one.

A *top-burton tackle* (*e*) is rove in the same manner as a luff-tackle purchase; the upper block of the burton is a fiddle-block, while that of the luff is a double one.

A *long tackle* (*f*) is composed of two long blocks, each of which resembles a pair of single blocks joined at their ends.

A *runner-tackle* (*g*) is the same purchase as a luff-tackle applied to a runner. A runner is a thick rope rove through a single block, and has usually a hook attached to one of its ends, and one of the tackle-blocks to the other; in applying it, the hook of the runner, as well as the lower block of the tackle, is fixed to the object intended to be removed.

The *garnet*-tackle is swung from the mainstay and used for getting boats or cargo on board or ashore.

The *jigger* is a block with a tail, for convenience of fastening it to an object.

A *tail*-block is also known as a *jigger*.

A *jeer* is a fourfold purchase used in swaying or striking the lower yard of a ship.

Fig. 6160 is a safety-tackle. To hold in suspension a load at any given elevation, a vibratory frame is hung in a suitable link of the stationary block, so that upon the cessation of pull upon the rope to raise the weight, the rope is swayed into a recess or gorge, and compressed there with a force proportionate to the weight. Upon the resumption of the pull upon the rope, it is swayed out of the recess, and the weight caused again to ascend.

As to kinds, the names founded upon place or purpose: —

Boom-tackle; used for rigging out or in the studding-sail booms, and consisting of a double and single block and fall.

Bowline-tackle; used to bowse out the main bowline.

Fish-tackle; one used in getting the anchor on to the gunwale.

Ground-tackle; anchors, cables, etc.

Gun-tackle; a purchase of two single blocks and fall, used for running guns in and out on shipboard.

Luff-tackle has a double and a single block and a fall. The *luff* is the weather leach of a sail.

A *pendant*-tackle is rigged from a pendant of the mast-head; used for hoisting cargo in or out of the fore or main hold, and for other purposes.

Port-tackle; used in tricing up the ports of the lower deck.

Quarter-tackle; used in hoisting aboard water, etc.

Reef-tackle; for rousing the reef-cringles of a sail up to the yard for reefing.

Relieving-tackle; a substitute for a disabled wheel and wheel-rope.

Rolling-tackle; used to steady the yards in a heavy sea.

Rudder-tackle; hooked to the rudder-pendant, to save the rudder if unshipped.

A *side*-tackle is used in working a gun, being hooked to a bolt on the side of the carriage.

Stay-tackle; hooked to the *triatic stay*.

Stock-tackle; hooked to the anchor-stock to rouse it on to the bows.

Tack-tackle; to bowse down the tack of a sail.

Top-tackle; used in swaying up a topmast.

Train-tackle; used in running in a gun, or to prevent its running out while being loaded.

Truss-tackle; that by which the truss of a lower yard is bowsed taut.

Winding-tackle; a purchase used in hoisting heavy articles or cargo.

Yard-tackle, a hoisting-tackle swung from a lower yard.

2. The appurtenances of a sport or work; as *fishing*-tackle, *plow*-tackle, *hoisting*-tackle, etc.

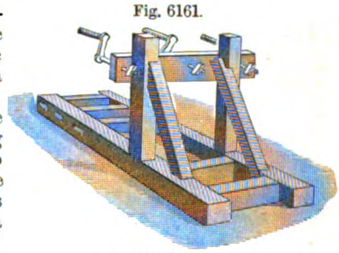
Tack-leath'er-ing Ma-chine'. A machine for attaching leather washers to carpet-tacks.

Tack'le-block. A pulley over which a rope runs. It usually consists of a sheave or sheaves in a shell. For varieties, see BLOCK; for applications, see TACKLE.

Tack'le-board. (*Rope-making.*) A frame at the head of a ropewalk containing the *whirls* to which *yarns* are attached to be twisted into *strands*. The *whirls* are also known as *winches* or *fore-lock hooks*, and there are generally three in a *tackle-board*, that being the number of *strands* which go to make a *rope*.

By another arrangement, the three whirls are rotated by a master wheel, the axes of the pinions being prolonged into hooks, and the main wheel is worked by a crank.

Fig. 6161.



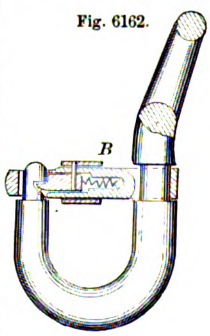
Tackle-Board.

Tack'le-fall. The rope which is rove through a block.

Tack'le-hook. The hook by which a tackle is connected to an object to be hoisted.

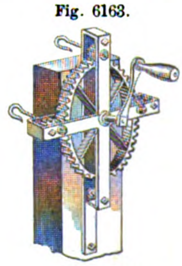
The example is provided with a

Fig. 6162.



Tackle-Hook.

Fig. 6163.



Tackle-Post.

mousing device *B* having an eye surrounding the shank of the hook, on which it has a motion both sideways and upward. An eye at the other end engages over the point of the hook, where it is held by a retractile spring-catch.

Tack'le-post. (*Rope-making.*) A post with *whirls* in a ropewalk, to twist the three strands which are laid up into a cord or rope.

Tack'ler. (*Mining.*) A small chain having a hook at one end and a ring at the other; four are made fast to the skip in order to hoist it up the shaft.

Tack-pull'er. A claw to draw tacks. A *tack-claw.* See TACK-HAMMER.

Tack-tack'le. (*Nautical.*) A purchase for hauling down the tack of a sail.

Tac-tom'e-ter. See ESTHESIOMETER; NERVE-NEEDLE.

Tæ'ni-a. (*Architecture.*) The band or fillet surmounting the Doric epistylium.

Taffe-ta. (*Fabric.*) A species of silken goods. See TAFFETY.

"Ashamed that she [Mrs. P] should be seen in a taffata gown, when all the world wears moyre." — PEPYS'S *Diary*, 1662.

Taf'fe-ty. (*Fabric.*) A rich, glossy silk stuff; plain, flowered, gold-striped, watered, or embroidered. The word is Persian.

Taff'rail. (*Shipwrighting.*) A transverse rail which constitutes the uppermost member of a ship's stern.

Tag. 1. A strip, having means of attachment to a bag or package, and on which an address may be written, printed, or stamped.

2. A metallic binding on the end of a boot-lace to stiffen and prevent raveling.

Tag-fast'en-er. A means of attaching a mark, tag, or label, to a bale, package, or other object or merchandise.

Fig. 6164 shows a number of different kinds.

***a b* are bent hooks, with barbs or catches to prevent retraction.**

***c d e* are wire clasps.**

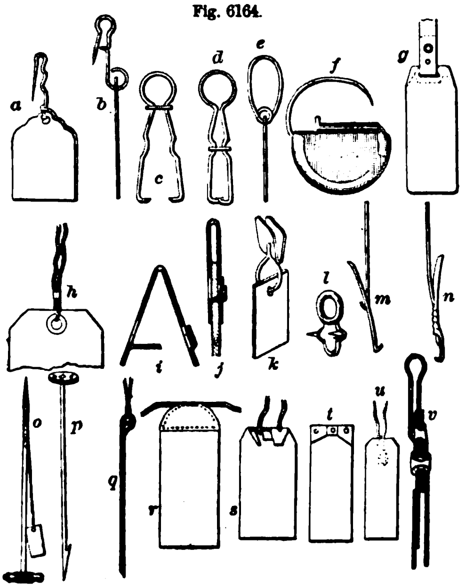
***f* is another form of clasp, with a metallic tag, in which the end of the bow locks.**

***g h k* are tied or riveted.**

***i j* are two views of a plate which perforates and locks upon a tag.**

***l* is an eye with riveting-spurs.**

Fig. 6164.



Tag-Fasteners.

***m n o p* are arrow-shaped spikes to be driven into a cotton or hay bale to hold the direction-tag.**

***q r s t u v* are tags of various kinds.**

Tag'ger. A device for removing the tag locks from sheep.

Tag'gers. Sheets of tin or other plate which run below the gage of the box or bunch to which they belong, and are consequently set aside as light, and used for other purposes.

Tag-hold'er. A device to attach a card or direction to a bale, package, or trunk. See TAG-FASTENER.

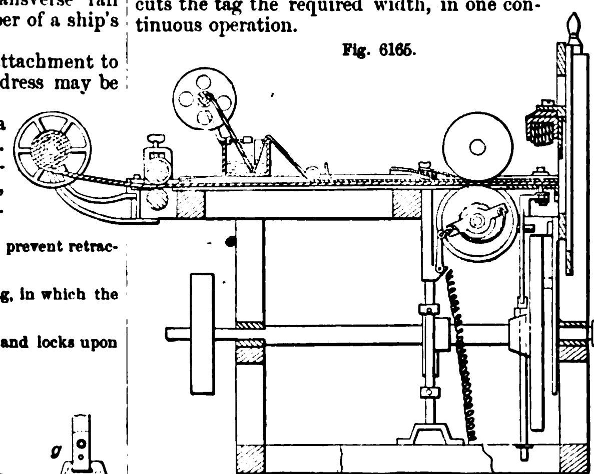
Tagl'ia. A certain system of pulleys, consisting of a set of sheaves in a fixed block, and another set in a movable block to which the weight is attached.

One cord goes around all the pulleys, one of its ends being fixed to a point in the system, and the other proceeding from one of the fixed pulleys drawn by the power.

Sometimes several are combined, so that one acts upon another, forming a compound taglia.

Tag-mak'ing Ma-chine'. The machine folds over the edge of paper required for the tag, inserts a tape, strips of fiber, or a cord, or both tape and cord at the same time; gums the fold down upon the tape, punches the eyelet, prints the address, and cuts the tag the required width, in one continuous operation.

Fig. 6165.



Machine for Making Tags.

Tag-nee'dle. A needle for securing tags to bales or bundles. The eye of the needle may be opened to the rear by so forcibly drawing the thread as to spring open the elastic piece which forms one side of the eye. See also NEEDLE, Fig. 3305; also *m, n, o, p*, Fig. 6164.

Fig. 6166.

Tag-Needle.

Tail. 1. The lower end of a slate or tile.

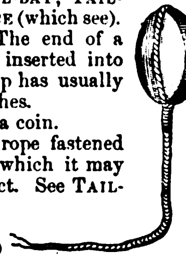
2. The end portion of a structure or work, as TAIL-BAY; TAIL-TRIMMER; TAIL-RACE (which see).

3. (*Masonry.*) The end of a stone step which is inserted into the wall; such a step has usually a *tailing* of nine inches.

4. The reverse of a coin.

5. (*Nautical.*) A rope fastened to a block, and by which it may be lashed to an object. See TAIL-BLOCK.

Fig. 6167.



Tail-Block.

Tail-bay. (*Hydraulic Engineering.*) That part of a canal-

lock between the tail-gates and the lower pond. See CANAL-LOCK.

Tail-block. (*Nautical.*) A block whose strap is prolonged into a tail, which is tapered, or the ends may be twisted into foxes and plaited together like a *gasket*. Blocks used for *jiggers* have a double tail, made in the same manner.

Tail-board. 1. (*Vehicle.*) The hind-end gate of a cart or wagon.

2. (*Shipbuilding.*) The carved work between the cheeks, fastened to the knee of the head.

Tail-crab. (*Mining.*) The capstan on which the spare rope of the crab is wound.

Tail-gates. (*Hydraulic Engineering.*) The lower pair of gates of a CANAL-LOCK (which see).

Tai'lor-ing-ma-chine'. A large sewing-machine adapted to a heavy class of goods. Several kinds of machines are made of such proportions as to adapt them to this work, and are illustrated under SEWING-MACHINE (which see).

The Wheeler and Wilson straight-needle machine is the "House" modification of the Wheeler and Wilson; preserving the Wilson feed, and the rotary hook in a modified form, in combination with a straight and vertically moving needle.

It differs from the ordinary Wheeler and Wilson, in having no *loop-check*, or other device for detaining the loop of the needle thread after it has been cast off the hook; it has an independent *take-up*, so that each stitch is completed before another is begun; its hook moves with a varying velocity, differing during each revolution from that of the main shaft, although it makes the same number of revolutions per minute. The needle is straight, and is driven by devices which cause it to pause entirely and move up and down with varying velocity at each stitch; the hook carries the upper thread around the bobbin, which contains the lower thread, interlocking the threads.

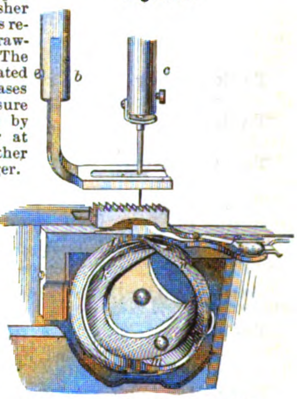
On the iron case is mounted the arm *a*, which holds the presser-bar *b* and the needle-bar *c*. The needle-arm *d* and take-up lever *e* are pivoted to the arm *a*, and actuated by cams on the main shaft beneath the iron plate forming the top of the case.

The upper or needle thread passes from the spool *f* along the bracket arm and by the thread-guide *g*, the tension-pulley *h*, the controller *i*, the jack *j*, over the front end of the take-up lever *e*, and through the eye of the needle. The lower thread is wound on the bobbin *B* (Fig. 6170), which is placed within the bobbin-case, and they are held in the cavity of the hook *k* by the ring-slide, the thread being drawn out in front.

In operating, the needle descends and thrusts a bight of the upper thread through the material, and then, rising to clear the hook-disk, it stands while the hook-point, having entered this loop, enlarges it by a quick motion, and carries it forward, at the same time the take-up descends and gives out the upper thread, which is drawn through the eye of the needle below the fabric. A half-revolution of the hook having now been quickly made, and the loop cast off over the bobbin (see *A*, Fig. 6170), and the needle, being entirely out of the material, the take-up rises quickly and draws up the loop. At the moment of drawing up the stitch, the apparatus for securing and regulating the under tension comes into play. A part of the hook-washer projects over the hook, and at each revolution presses upward against a bar attached to the frame of the machine. Through a hole in this bar (called the tension-finger) the lower thread passes.

While the stitch is drawing up, as soon as the loop has passed through the tension-finger, the under thread is clamped between the hook-washer and tension-finger, and is released as soon as the drawing up is completed. The under tension is regulated by a lever, which increases or diminishes the pressure upon the hook-washer by being brought to bear at will upon one or another point of the tension-finger.

Fig. 6169.



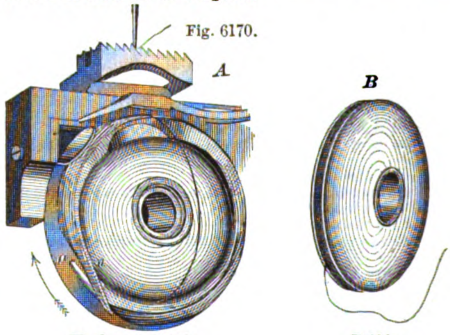
Hook and Feed, without Bobbin.

The thread is drawn through the needle while it is out of the material, giving it an advantage in sewing leather and starched fabrics with a small needle.

The presser-foot may be flat or a wheel, and is hinged or attached by a set-screw to the presser-bar.

In the Wheeler and Wilson family machine, the loop of one stitch is drawn up through the agency of the rotary hook in expanding the loop for the next stitch. In the House machine, each stitch is completed separately, the drawing up being done while the needle is out of the goods.

Fig. 6170.



Hook and Bobbin. *Bobbin.*

The rotating-hook differs from the ordinary Wheeler and Wilson hook in having a deeper cavity for the thicker bobbin, and in the cut *m*, which gives free course to the loop upon its being cast off and drawn up just as this cut revolves to the needle (*A*, Fig. 6170). The tail *n* of the hook overlapping the point *p* of the hook a trifle in front of it, acts as a guard in keeping off the bobbin-thread while the hook enters the loop of the needle-thread. It also draws a little thread from the bobbin, so as to leave it slack for free play.

Tai'lor's Chair. A legless chair, with seat, back, and knee-rest (Fig. 6171), adapted to the cross-legged position of the trade.

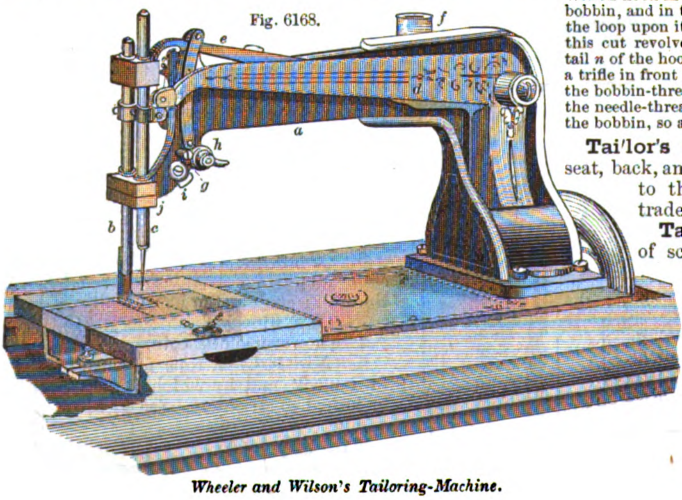
Tai'lor's Shears. A large style of scissors used in cutting woolen goods.

In the example (Fig. 6172), the upper blade and handle move upon a slotted fulcrum, which gives a *draw* cut. The edges are kept in contact by a spring. See also SHEARS; SCISSORS.

Tail-piece. 1. (*Lathe.*) The set-screw of the rear lathe-spindle.

2. (*Music.*) The block of a violin, guitar, or similar in-

Fig. 6168.



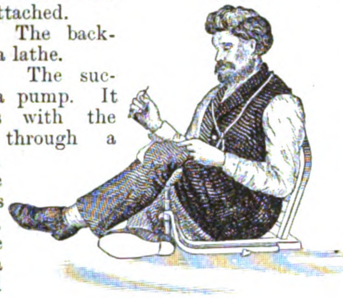
Wheeler and Wilson's Tailoring-Machine.

strument, to which the strings are attached.

Tail-pin. The back-center pin of a lathe.

Tail-pipe. The suction-pipe of a pump. It communicates with the pump-stock through a clack-valve, and in the case of metal pumps is in two parts, the upper one of which has a screw-thread at its lower end, by which it is secured to the lower part, the latter being cut to a suitable length.

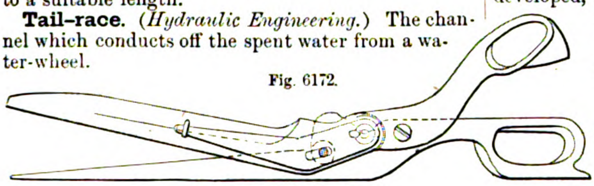
Fig. 6171.



Tailor's Chair.

Tail-race. (*Hydraulic Engineering.*) The channel which conducts off the spent water from a water-wheel.

Fig. 6172.



Tailor's Shears.

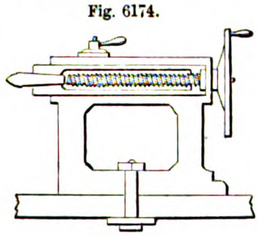
Tail-screw. (*Lathe.*) The screw which advances or retracts the back center.

In the commoner description of lathes the back center is at the end of the tail-screw, but in superior lathes the center is formed on a plug fitted in the end of a plunger, which is simply advanced and retracted in the barrel of the tail-stock by the rotation of the screw. The back center is held to its adjustment by the set-screw above.

Fig. 6173.

Tail-Pipe.

Fig. 6174.



Tail-Screw.

Tail-stock. (*Lathe.*) That head of a lathe which contains the non-rotating spindle, called the *dead-spindle.* At the other end of the lathe is the *head-stock*, in which is the *live-spindle.* The *tail-stock* is also called the *dead-head*, as containing the *dead-spindle.* See LATHE.

Tail-tack'le. (*Nautical.*) A luff-tackle, with a hook in the end of the single block, and a tail to the upper end of the double block. A *watch-tackle.* See TAIL-BLOCK.

Tail-valve. (*Steam.*) *a.* An air-pump valve in one form of condenser, opened by the steam entering the condenser, but closed by atmospheric pressure when a partial vacuum exists in the condenser.

b. The *snifting-valve* of a marine steam-engine.

Tail-wa'ter. The waste water discharged from the buckets of a water-wheel in motion.

Tain. 1. Thin tin plate. *Taggers.*

2. Tin-foil for mirrors.

Take. (*Printing.*) A portion of copy taken by a compositor at one time.

Take-horse. (*Mining.*) A vein of ore is said to *take horse* when it divides on each side of a body of non-metalliferous rock, called *dead-ground.*

Take-up. 1. (*Weaving.*) That motion of the cloth-beam in a loom by which the web is wound up as fast as the weaving proceeds. The *let-off* is the paying off of the yarn from the beam, and proceeds coincidently with the take-up. See LET-OFF.

2. (*Steam Navigation.*) The part between the smoke-box and the bottom of the funnel of a steamship.

3. (*Sewing-machine.*) A device in a sewing-machine to draw upon the upper thread to *take up* its slack while the needle is rising, or resting at its highest point, to tighten the stitch. The *independent take-up* is one which acts in its own time without being actuated by the needle-bar.

Tal'bo-type. (*Photography.*) A process invented by Fox Talbot, in which paper was sensitized by iodide of silver and exposed in the camera. The surface became the recipient of a latent image, which was developed, and was fixed by hyposulphite of soda. It was named by its originator, CALOTYPE (which see). It is the basis of the present photographic process. See PHOTOGRAPHY.

Talc. A mineral which occurs in granular and flaky conditions; a silicate of magnesia, or of magnesia and alumina; usually with the addition of iron. See Dana's "Mineralogy," ed. 1868, pages 452, 453.

The *massive* is known as *steatite*, *soapstone*, or *potstone*; the foliated approaches the character of mica, from which it is hardly distinguishable. The distinguishing test is that the thin laminæ of *talc* are flexible but not elastic; *mica* is very elastic.

Asbestus, or *amianthus*, is another closely allied mineral, occurring in many forms, the most characteristic of which is fibrous. See ASBESTUS.

Soapstone is used in slabs for stoves, and when powdered in composition for porcelain and for crayons.

Tal'i-pes-ap'pa-ra'tus. Club-foot is produced by eversion, inversion, or retroversion of the foot; and is known as *Talipes Valgus, Varus*, or *Equinus.* See CLUB-FOOT APPARATUS.

Talk'ing-ma-chine'. An acoustic instrument in which articulate differences of sound are produced.

Kempelen and Willis gained celebrity in this line.

Wolfgang von Kempelen, the inventor of the so-called automaton chess-player, which was only an ingenious deception, contrived a talking head, which contained wind-tubes and vibrating reeds, the latter set in motion by a bellows in the bust. The capacity of the machine was limited, but the following words and sentences were automatically enunciated without the intervention of a person to touch any keys: *opera; astronomy; Constantinople; vous êtes mon amie; Romanorum imperator;* etc. Tubes to imitate nostrils produced "*m*" and "*n*"; a funnel and a reed changed "*s*" into "*z*," "*sch*," and "*j*." Parts of the mechanism imitated the movements and action of the mouth, lips, teeth, tongue, palate, glottis, lungs, etc.

Faber's machine gives the correct pronunciation of the letters and elementary sounds, and enunciates phrases of six or eight words in the English, French, and German languages. Air is forced by a bellows, through a narrow aperture, into an iron windpipe, and thence into an artificial glottis, from whence it passes through a vent representing the human mouth, with movable jaws and a rubber tongue. Pipes and rubber tubes, operated by fourteen levers, are arranged to produce the various

Fig. 6175.

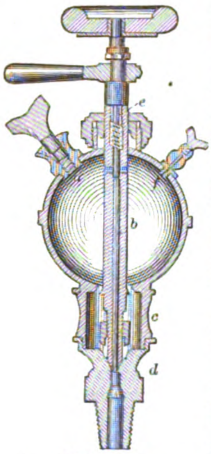
Tallow-Can.

sounds. The voice is shrill, monotonous, and unnatural, but in a majority of instances strikingly correct. Laughter is caused by a separate lever.

Tal'low-can. A vessel to hold melted tallow for lubricating purposes.

Tal'low-cup. A lubricating-device for journal-boxes, etc., in which tallow is employed as the lubricant.

Fig. 6176.



Tallow-Cup.

In that illustrated, the tallow is introduced through the aperture *a*, and steam admitted through the hollow valve-stem *b*; this melts the tallow, and when the upper valve is open, as shown, forces it down into the lower part *c* of the cup. On raising the stem, the upper valve is closed and the lower one *d* is opened, permitting the tallow to flow on to the part to be lubricated, the steam-opening in the valve-stem being closed by means of the screw-threaded rod *e*. *f* is the steam-escape opening.

Tal'ly. A notched stick employed as a means of keeping accounts.

Tally-sticks were used in ancient Egypt; one is in the Abbott Museum, New York. They were also employed by the Athenians.

In England they were long issued in lieu of certificates of indebtedness to creditors of the state. In 1696, according to Adam Smith, this species of security was at 40 to 60 per cent discount, and bank-notes 20 per cent.

Besides accounts, other records were formerly kept upon notched sticks, as almanacs, in which red-letter days were signified by a large notch, ordinary days by small notches, etc. Such were formerly common in most European countries. The Runic Clog-Almanack and the Saxon Reive Pope are of this class, and yet exist in Sweden, and in Staffordshire, England.

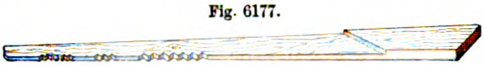
Somewhat similar was the ancient Briton *Coelbren y Beirdd*, the "billet of the signs of the bards."

The mode of keeping accounts by tallies was introduced into England by the Normans, 1066.

Seasoned sticks of willow or hazel were provided, and these were notched on the edge to represent the amount.

Small notches represented pence; larger, shillings; still larger, pounds; proportionately larger and wider, were 10, 100, 1000 pounds. The stick being now split longitudinally, one piece was given to the creditor, and the other was laid away as a record. When an account was presented for payment, the voucher was compared with the record.

Fig. 6177.



Exchequer Tally.

When paid, the *tally* and *counter-tally* were tied up together and laid away, accumulating for a long series of years. The history of the final abandonment of the system, and the catastrophe to which the disposition of this accumulation of rubbish led, is related by Charles Dickens, in a speech in favor of political and official reforms: —

"Ages ago a mode of keeping accounts in the Exchequer, by means of notched sticks, was introduced. In the course of time the celebrated Cocker was born and died; then Walkinghame, the author of the 'Tutor's Assistant'; then a multitude of accountants, actuaries, and mathematicians, who discovered and published means of account-keeping by ordinary arithmetic, far more ready, and which, in their every-day transactions, everybody used; but official routine looked upon these notched sticks as a part of the Constitution, and the Exchequer accounts still continued to be kept by these willow tallies. But, toward the end of the reign of George III., it occurred to some innovating and revolutionary spirit to suggest the abolition of this barbarous custom, and immediately all the red tape in all the public departments turned redder at the idea of so bold a conception; and it was not until the year 1826 that the custom of keeping these Exchequer accounts by willow tallies ceased. In 1834 it was found that a large accumulation of these tallies had grown up in the course of time, and the question arose what was to be done with these old worm-eaten, useless bits of wood.

"They were housed at Westminster. Common-sense would have suggested that they should be given for firewood to some of the poor miserable people who abounded in that neighborhood; but official routine could not endure that, and accordingly an order was given that they should be burned privately. They were burned in a stove in the House of Lords; but the stove being overheated by them set fire to the paneling of the room, the paneling set fire to the House of Lords, the House of Lords set fire to the House of Commons, and the two houses were reduced to ashes."

See also Clark's Commentary on Revelations ii. 17. See also BALLOT; ABACUS; ARITHMOMETER.

Tal'on. 1. (*Architecture.*) A form of molding, the same as OGEE (which see).

2. (*Locksmithing.*) The shoulder on the bolt against which the key presses in *shooting* the bolt.

Ta'lus. A slope: —

1. Of an embankment or earthwork in civil or military engineering.

2. Of a wall having a battering face.

3. A sloping heap of fragments at the base of an escarpment.

Ta'lus-wall. (*Masonry.*) A wall inclined on its face, either by decreasing its thickness toward the summit or by leaning it against a bank, as a *retaining* or *breast wall.*

Tam'bour. 1. (*Fabric.*) A species of embroidery in which threads of gold and silver are worked by needles in figures of leaves and flowers upon a silk stuff stretched over a circular frame, called a *tambour-frame.* This resembles a drum-head, and thus acquired its name. French *tambour*, "a drum."

2. A DRUM (which see).

Tam'bour-ine'. (*Music.*) An instrument of percussion, resembling a shallow drum with one head, and surrounded by small bells.

It is also known as the *tambour Basque*, and is a favorite instrument of the Italian peasants, the gypsies, and Basques. It is played in three ways: by striking; by rubbing its parchment with the ends of the finger, which gives a tremulous sound, and a jingling of the bells in the edge; by continuous rubbing with the thumb, which gives a wild, trembling sound.

The peculiar song of some insects, as the katydid, is produced in an analogous manner by the rubbing together of their wings.

On a sculpture at Dendera, in Egypt, is shown a musician playing on the tambourine. The Egyptian mode of playing was similar to the modern; and from the position in which it is held after striking, it is thought to have had the same tinkling disks in the rim. Among the ancient Egyptians its shapes were very various.

Fig. 6178.

Tambourine.

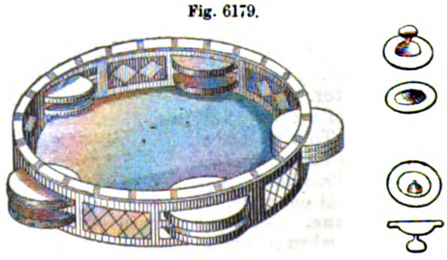
The *timbrel* of Miriam, the priestess, and sister of Moses and Aaron, was, no doubt, an Egyptian instrument. She and her attendants played on timbrels and sang the antiphone to the song of Moses and the congregation.

She "took a timbrel in her hand, and all the women went out after her with timbrels and with dances."

The ladies are now excluded from participation in Hebrew religious rites. The *tabret*, or *timbrel*, probably resembled the dasabooka of the Arabs, — a sort of *tam-tam*, or hand-drum; the *tympanon* of the Greeks.

Euripides celebrates "the skin-stretched circle of the tambourine of Phrygia, of the great mother Rhea."

Fig. 6179.



Arabian Deff and Castanets.

The modern Arabian *deff* does not differ materially from the European. It has a number of tinkling disks of metal set in slots in the rim, and is played by thrumming and shaking.

The name is derived from the Arabic *altambor*, and immediately is the diminutive of the French *tambour*, being considered a shallow drum with one head.

Tam'ine. Woolen cloth; *tammy*. Sometimes synonymous with *tawney*.

Tam'is. (*Fabric.*) *a.* A thin woolen stuff, highly glazed. *Taminy.*

b. A strainer or bolter.

Tam'my. (*Fabric.*) A glazed worsted cloth used for ladies' gaiters; also for a straining cloth.

Tamp'ing. 1. (*Smelting.*) Stopping with clay the issues of a blast-furnace.

2. (*Military Mining.*) Packing with earth, sandbags, etc., that part of the mine nearest to the charge to increase its effectiveness in a given direction.

3. (*Blasting.*) *a.* Filling up a blast-hole, above the charge, so as to direct the force of the explosion laterally and rend the rock.

b. The material used for the above purpose; it may be fragments of stone, earth, sand, or even water.

Lieutenant-General Sir John Burgoyne, of the English Engineers and Inspector of Fortifications, states that the desideratum in tamping is to obtain the greatest possible resistance over the charge of powder; if it could be made as strong as the rock itself, it would be perfection.

a. The different materials employed for tamping are: —

The chips and dust of the quarry itself. This is what is most commonly used, unless there be stone in it that strikes fire.

b. Dry sand poured in loose, or stirred up as it is poured in, to make it more compact.

General Burgoyne cites the favorable notice of sand in this connection, in the memoir of the works at Cherbourg, and also by a writer in the Journal of the Franklin Institute.

He also cites the experience of General Pasley, of the English Engineers, who condemns sand as utterly unfit.

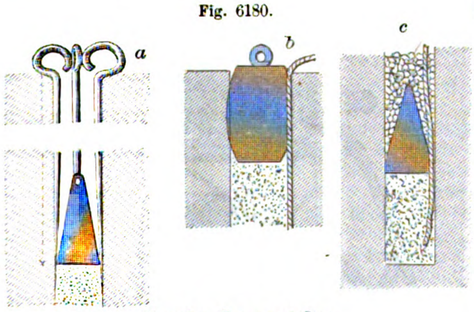
An extended series of experiments were made in the granite of Dalkey, Kingstown Harbor, Ireland, in which sands of various qualities and fineness were tried, as against the baked clay. The results of the experiments were all unfavorable to the sand.

c. Clay, well dried, either by exposure to the sun or by a fire.

d. Broken brick. It is used in small pieces and dust, and is improved by being slightly moistened with water during the ramming. It is pronounced inferior to the dried clay.

Several mechanical devices to assist in tamping have been suggested. The evident one would be a mere plug of a tapering shape, and driven into the hole. The most satisfactory of these devices has been an iron cone, with arrows around it, driven in as wedges. Another plan is a barrel-shaped plug, with a groove for the passage of the fuse. In a third instance, the iron cone was secured by tamping above it.

Fig. 6180.



Tamping Cones and Plug.

a, tamping-cone. *b*, tamping-plug. *c*, tamping-cone.

Tamp'ing-bar. (*Blasting.*) A bar of copper, brass, or wood, used in driving the *tamping* upon the charge in a blast-hole. Iron is to be avoided, as it sometimes strikes fire against a flinty or gritty piece of the tamping. See BLASTING-TOOLS.

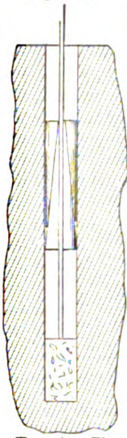
Tamp'ing-ir'on. A tool, prudently made of copper, by which the *tamping* is wadded down upon the cartridge or charge in a hole, for blasting. It is sometimes called a *driver*. A *tamping-bar*.

Tamp'ing-ma-chine'. (*Pipe-making.*) A machine for packing clay or the material for artificial stone into a mold. See STONE-PIPE MACHINE.

Tamp'ing-plug. A stopper for a hole in which a blasting-charge has been placed. It usually consists of a cone with barbs, or of a set of wedge-shaped blocks, which jam by the pressure from beneath.

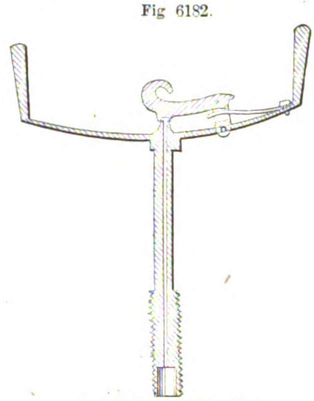
Fig 6182 is a tamping and blast plug, for splitting logs and stumps. The barrel is inserted into an auger-hole in the wood, and the contained charge exploded by drawing off the spring-hammer with a cord.

Fig. 6181



Tamping-Plug.

Fig 6182.



Tamping and Blast Plug.

Tam'pon. (*Surgical.*) A plug or stopper, of rag, sponge, etc., used in stopping hemorrhages.

Tam'-tam. *a.* The Oriental drum, consisting of a gourd covered with a lizard's skin.

b. A Chinese gong.

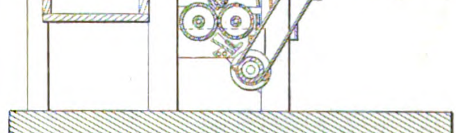
The composition, according to Klaproth, is, —

Copper	78
Tin	22 — 100

It is cast, and then tempered by being plunged, while hot, into cold water. The effect is the reverse of that with iron, as the metal is less brittle, and will bear the hammer.

The action of the hammer is to put the metal on a strain, the head having a tension like that of a drum.

Fig. 6183.



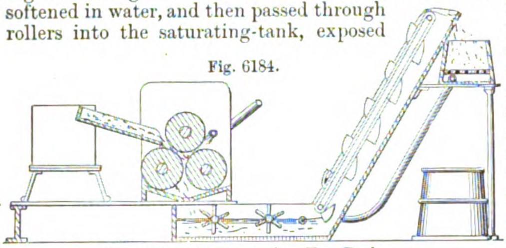
Apparatus for Desiccating Leached Tan.

Tan-bark Des'ic-ca'tor. A machine for drying leached tan-bark. It has an endless apron passing through a hopper placed over the leaching-trough, which carries the leached bark to another hopper, the latter feeding it between two hollow heated rollers which express the liquid.

Tan-ex-tract'or. A leaching device for extract-

ing the astringent matters from bark. The bark is softened in water, and then passed through rollers into the saturating-tank, exposed

Fig. 6184.

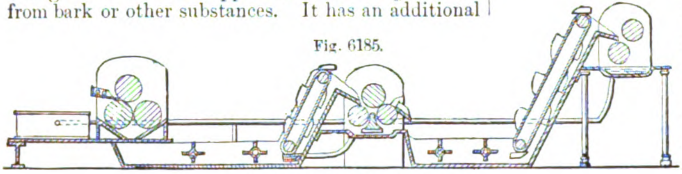


Apparatus for Extracting Tan-Bark.

in said tank to the action of beaters, elevated and passed through a series of leaches, where it is washed repeatedly until all the astringent properties contained therein are taken up by the wash.

Fig. 6185 shows an apparatus for making extracts from bark or other substances. It has an additional

Fig. 6185.



Apparatus for Making Extracts.

or secondary tank and two sets of squeezing-rollers combined with the crushing-rollers, saturating-tank, and elevator, so that the astringent qualities will be disengaged and the pulp left finally in a condition to be used as fuel.

Tang. The shank of a knife, chisel, file, etc., which is inserted in the haft.

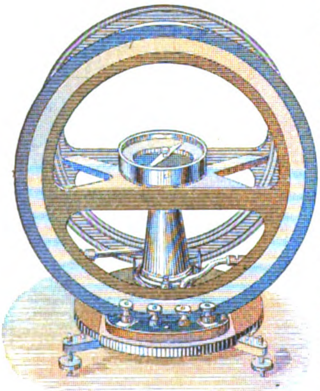
Fig. 6186.

Tang-Chisel.

Tang-chis'el. A chisel with a tang for insertion in a handle; in contradistinction to a socket-chisel, which has a hollow tang to receive the handle.

Tan'gent-gal'va-nom'e-ter. One in which the length of the astatic needle employed is so short, in comparison with the diameter of the surrounding copper ring through which the current to be measured is passed, that the intensities of currents may be regarded as proportional to the tangents of the angles of deflection of the needle. The tangents in this case serve as a direct measure of the comparative intensities.

Fig. 6187.

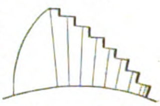


Tangent-Galvanometer.

Fig. 6187 represents Gaugan's instrument, in which two conducting rings are employed, the needle, in a case provided with a graduated circle, being supported centrally between them.

Tan'gent-scale. (*Ordnance.*) A species of breech-sight for cannon. Its base has a curvature corresponding to the circumference of the breech of the gun, and its face is cut into steps corresponding to angles of elevation. The proper hight for each step is found by multiplying the natural tangent of the elevation in degrees by the distance between the base-ring and muzzle-sight. In using the scale, the required vertical line is brought to coincide with a longitudinal line at the upper part of the breech, and the top of the front-sight is viewed over the center of the step, the breech being raised or lowered until the face of the step and top of the front-sight are in the same horizontal plane.

Fig. 6188.



Tangent-Scale.

Tan'gent-screw. An endless screw tangentially attached to the index-arm of an instrument of precision, enabling a delicate motion to be given to the arm after it has been clamped to the limb, and permitting angular measurements to be made with greater exactness than could be done were the movement entirely effected by hand.

Tan'gles. (*Nautical.*) A device used in dredging, for sweeping the sea-bed for obtaining delicate forms of marine life, too small or frangible to be obtained by ordinary dredging. The tangles, in a coarse form, has long been used in the sponge and coral fisheries.

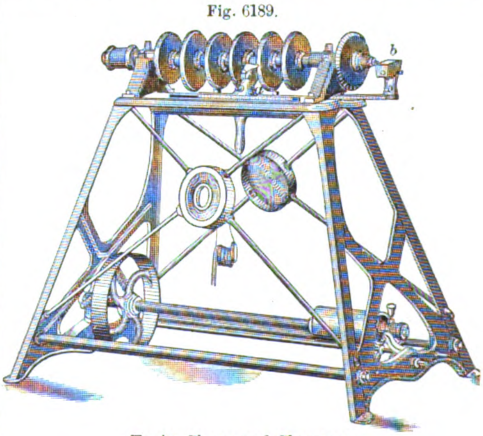
It consists of a bar 3½ feet long, supported on runners, and serving to drag after it a series of masses of hemp, each of which is a sort of mop. The fibers of the hemp entangle the smaller crustaceans and many of the more minute and delicate forms of marine life without breaking or injuring them as the dredge is apt to. Chains which are wrapped in the hempen swabs by their weight serve to keep the latter down to the work. Starfishes and sea-urchins, being prickly, are most readily caught by the tangles; in frequent instances immense masses of them are thus swept up and brought to the surface. See TRAWL.

Ta'nite. The trade name of a cement of emery and some binding material, used as a compound for grinding wheels, disks, laps, and in other forms.

Ta'nite-shap'er. A device for shaping and sharpening molding-bits, cutters, saws, and other wood-working tools.

It has a set of six emery-wheels, running between journals, and one overhung-wheel, all turning on a common spindle. The rest *a* may be fixed so as to work on either side of the table,

Fig. 6189.



Tanite Shaper and Sharpener.

or transversely thereto, and the rest *b* is adjustable to grind any desired bevel upon the overhung-wheel. The latter is specially intended for sharpening and gumming saws.

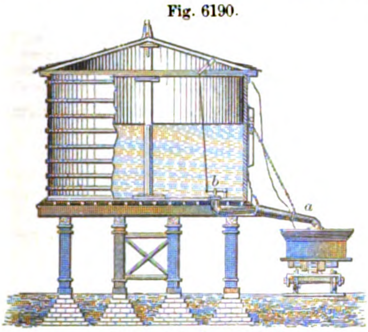
Tank. A vessel of large size to contain liquids.

1. (*Railroading.*) *a.* That part of a tender which contains the water. The tank varies in size, according to the power of the engine, and is from 500 to 1,600 gallons in capacity. See LOCOMOTIVE.

b. A reservoir from which the tank of the tender is filled.

Tanks for supplying locomotive-tenders with water are, when practicable, erected alongside of the track. They are generally made of wooden staves, like a large cask or tun, and supported

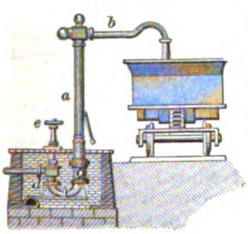
Fig. 6190.



Elevated Railway-Tank.

on a framework of wood, or upon a foundation of masonry. In Fig. 6190 the water flows into the tank from a stream or pond at a higher level, or is forced up by a pump, and is conducted by a spout *a* directly into the man-hole of the tender. The spout is usually attached to the tank by a hinged joint, so that it may be lowered to supply the water to the tender and then lifted out of the way of the engine and train. It is usually counterbalanced by a weight attached to a rope leading over a pulley at the upper part of the tank. A valve *b*, operated by a rope easy of access to the engineer, permits the water to flow when it is raised, and closes by its gravity.

Fig. 6191.



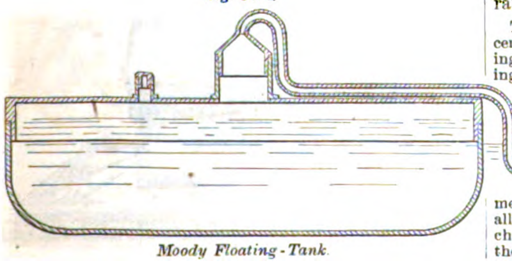
Water-Crane.

When there is no room for the tank near the track, it is placed in any convenient position at some distance from it, and the water conveyed by a pipe to a water-crane (Fig. 6191) located at the station. This consists of a vertical pipe *a*, with a horizontal branch *b* arranged to be swung around over the man-hole of the tender. It is preferable to have both pipes turn upon a joint at *c*, below the surface of the ground, as there is then less risk of freezing. The water is cut off at pleasure by a valve *d* operated by a hand-wheel *e*.

2. (*Nautical.*) Tanks for ships' use should be of galvanized sheet-iron; are usually rectangular in plan, four feet square, and from four to six feet deep. They hold from 400 to 600 gallons. A gallon is .1604 of a cubic foot. They are stowed at the bottom of the hold on a skeleton floor. Each has a man-hole in the top, and its shape is adapted to the part of the hold which it is intended to occupy.

3. (*Petroleum.*) The large development of the petroleum industry has given rise to various tanks, particularly designed for that class of oils which, in consequence of their combustible character, require particular care for their safe keeping. See OIL-TANK, page 1558.

Fig. 6192.



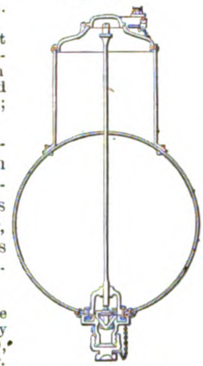
Moody Floating-Tank.

Some of the larger tanks for the storage of petroleum partake of the character of cisterns beneath the ground or floating in water. The main effort of ingenuity has been to prevent access of fire to the contents.

Moody's tank (Fig. 6192) has a dome upon its top from which extends a tube which terminates under water. By this means direct communication between the interior of the tank and the open air is avoided. See also OIL-TANK, Figs. 3386–3394.

Fig. 6193 shows the arrangement of Snyder's oil-tank for transportation; the valve-rod comes up through the dome to the level of the locked cover of the dome. See TANK-CAR; OIL-CAR.

Fig. 6193.



Snyder's Oil-Tank.

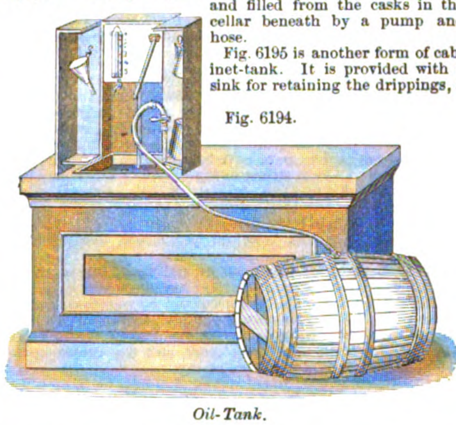
4. The term *tank* is also applied to a chamber or vessel in which a liquid is stored for dispensing or occasional use, as with oil, molasses, vinegar, wine, spirits, and other articles kept in stock, for sale in measured quantities.

Some of these are so large that the liquid may be dipped out, but usually it is drawn by a pump, as in Fig. 3370, page 1547, or by a faucet, as in Fig. 3385, page 1557. See OIL-CAN; OIL-TANK, in which three cuts occur.

Fig. 6194 illustrates the "cabinet" oil-tank, for stores, workshops, etc. It may be placed on an upper floor of a building and filled from the casks in the cellar beneath by a pump and hose.

Fig. 6195 is another form of cabinet-tank. It is provided with a sink for retaining the drippings, a pump, and a gage-rod, by which any shortage may be readily detected when the contents of a barrel or other vessel are emptied into it.

Fig. 6194.

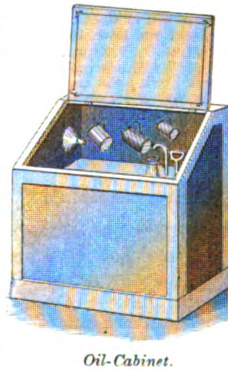


Oil-Tank.

5. (*Soda-water.*) A vessel used in measuring and dispensing sirups in soda-water apparatus.

To the glass vessel *A* is cemented a glass measuring-chamber *D*. The opening through which the vessel is charged is not seen in the drawing. When the rod is lifted by the handle *J*, the rubber *F* closes the upper opening in the measuring-chamber *D* and allows the liquid to be discharged at the opening *E*, the hollow rod *B* and its

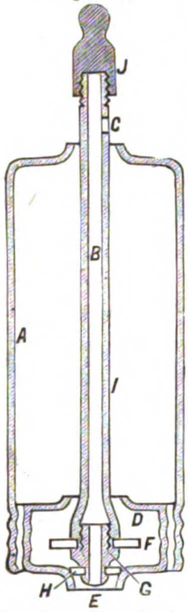
Fig. 6195.



Oil-Cabinet.

opening *C* serving as a vent for air to enter. When the rod is dropped, the washer *H* closes the opening *E*, and the chamber *D* again fills, the air in the measuring-chamber passing into *A* and collecting above the sirup. The rod *B* is of hard rubber or wood, as the sirup is not allowed to come in contact with metal.

Fig. 6196.



Matthews' Sirup-Tank.

6. (*Gas.*) The cistern of a gas-holder, in which the lower edge of the inverted chamber is beneath the water-surface, forming a *seal* for the gas. See Fig. 2178, page 951.

Tank'ard. A large drinking-cup; or a covered pitcher from which wine is poured into cups.

Properly, a large drinking-vessel, from which persons drank in succession, passing it around the table

In classical times, and during the Middle Ages, it was a mark of intimacy to drink in this way, and a mark of condescension or politeness, as the case might be, on the part of the head of a feast to offer it. Not like the equally festive but less familiar *wassail-bowl*, from which the negus, or punch, was ladled

"At wakes and wassails."

Ourselves do well remember the *loving-cup* with which the worshipful master pledged his guests and his lodge, and then, wiping the brim, laid the napkin in the handles, and passed it to the next, and so on around the table.

The *peg-tankard* seems to have been ordered by Edgar, a man of little merit, and not strong in the head any way: pins in the wooden tankard divided the drinks. "Betsy, wotever you do, drink fair."

The canons allude to it: —

"Ut presbyteri non eant ad potationes, nec *ad pinnas* bibant."

As the tankard held two quarts, and there were eight pins, the allowance was near half a pint to each, which might do if the brew were stiff. The moral was not very evident, for if any one went beyond the pin he was obliged to drink again. A fine tankard at Wardour Castle has on the lid the Virgin and St. John, one on each side of the cross, and the twelve apostles round the cup. Worshipful company.

"Of drinking-cups, divers and sundry sorts we have, some of elme, some of box, some of maple, some of holly, &c. Mazers, broad-mouthed dishes, noggins, whiskins, piggins, crinzes, ale-bowles, wassel-bowles, court-dishes, tankards, kannes, from a pottle to a pint, from a pint to a gill. Other bottles we have of leather, but they are most used amongst the shepheards and harvest people of the Country; small jacks we have in many alehouses of the citie and suburbs, tipped with silver, besides the great black-jacks and bombards of the court, which when the Frenchmen first saw they reported at their returne into their Countrey that the Englishmen used to drinke out of their bootes; we have besides cups made of hornes of beasts, of cocker nuts, of goords, of the eggs of ostriches; others made of the shells of divers fishes brought from the Indies and other places, and shining like mother of pearle. Come to plate, every taverne can afford you flat bowles, beakers; and private householders in the citie, when they make a feast to entertaine their friends, can furnish their cupboards with flaggons, tankards, beere-cups, wine-bowles, some white, some percell guilt, some guilt all over, others without of sundry shapes and qualities." — HEYWOOD'S *Philo-cathanista, or the Drunkard opened, dissected and anatomized,*" quarto, London, 1635, p. 45.

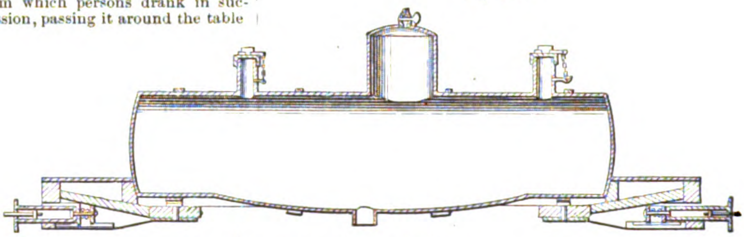
Drinking-pots of wood, with wooden hoops, are yet used in some parts of Britain.

A large drinking-glass was found in a Roman-British barrow, in Kent, England; a stained-glass one was excavated from a similar situation. Bede, Luitpraud, and Fordem record them.

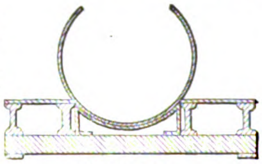
The *grace-cup* was handed round at the end of a meal.

Tank-car. (*Railway Engineering.*) A large tank

Fig. 6197.



mounted on a platform-truck, for carrying petroleum or other liquid. They are made in many forms, either of staves or of boiler-iron, usually the latter.



Oil-Tank Car.

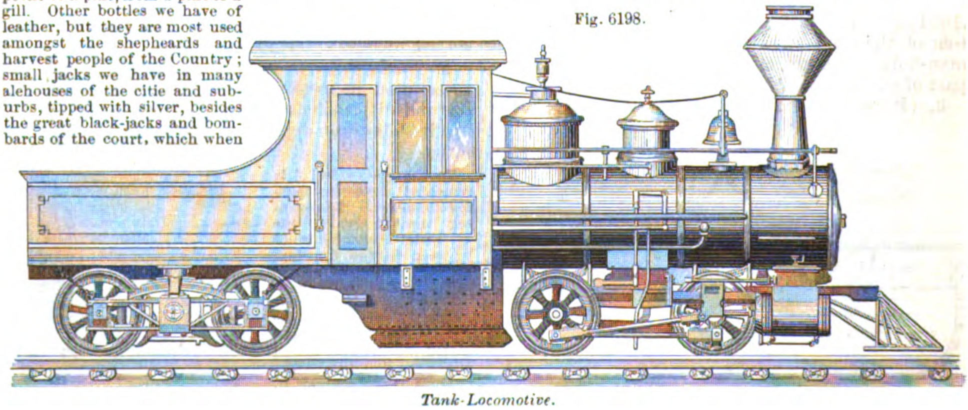
In the example, the cylindrical tube is bellied midway between its ends and on its lowest side. The tank has heads, a filling-gage, a safety-dome, and discharge-passage, which latter is at the convergent point of the bellying or lowest portion of the tank. See also OIL-TANK; TANK, 3.

Tank-en'gine. (*Railroading.*) A locomotive which carries the fuel and water it requires, thus dispensing with a tender. See TANK-LOCOMOTIVE.

Tank-lo-co-mo'tive. (*Railway Engineering.*) One having a tank or tanks enabling it to carry a supply of water sufficient for its own consumption without a tender. Such are used for yard-engines, for side-lines of limited length, and for ascending grades with moderate loads. The boiler and machinery are carried on the driving-wheels, and the variable weight of water and fuel on the tank-truck.

That illustrated is mounted on two bogie frames, the front

Fig. 6198.



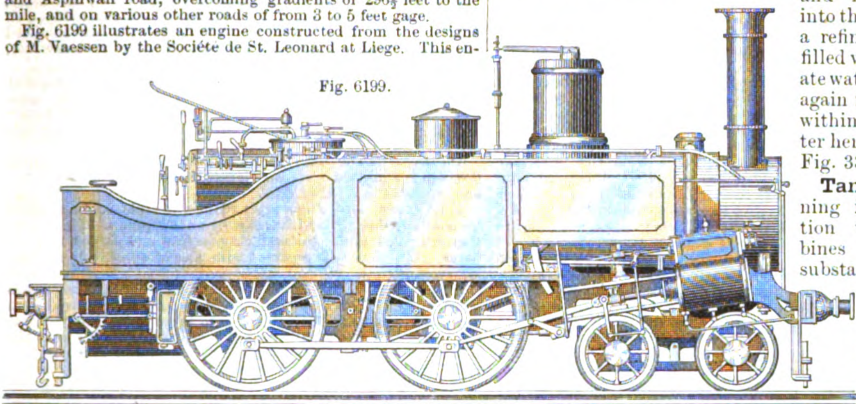
Tank-Locomotive.

one supporting the locomotive and the rear one the part in which the tank and coal-bunkers are located.

Engines of this kind have been employed on the Howland and Aspinwall road, overcoming gradients of 296½ feet to the mile, and on various other roads of from 3 to 5 feet gage.

Fig. 6199 illustrates an engine constructed from the designs of M. Vaessen by the Société de St. Leonard at Liege. This en-

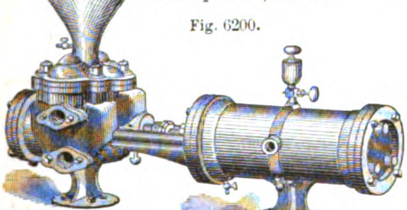
Fig. 6199.



French Tank-Locomotive.

gine is intended for the ascent of steep inclines and traversing sharp curves with a train on what M. Vaessen calls the universal system, patented by him. It was built for the Chemin de Fer Isabelle II., in Spain. The cylinders are 18.11 inches diameter and 24.16 inches stroke. The four driving-wheels are 6 feet 2 inches, and the truck-wheels 2 feet 11½ inches, diameter.

Fig. 6200.



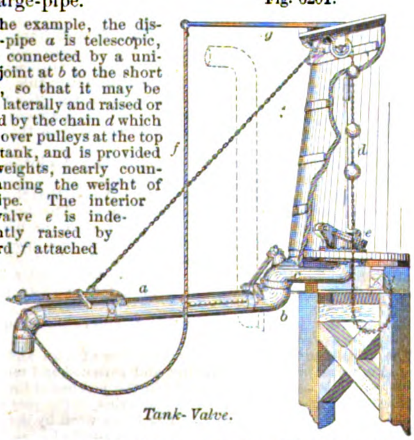
Direct-Acting Tank Steam-Pump.

Tank-pump. A form of steam-pump for the specific use.

Tank-valve. (*Railway Engineering.*) A form of valve used in locomotive water-supply tanks, for admitting water to the discharge-pipe.

Fig. 6201.

In the example, the discharge-pipe *a* is telescopic, and is connected by a universal joint at *b* to the short pipe *c*, so that it may be swung laterally and raised or lowered by the chain *d* which passes over pulleys at the top of the tank, and is provided with weights, nearly counterbalancing the weight of the pipe. The interior clack-valve *e* is independently raised by the cord *f* attached



Tank-Valve.

to the lever *g*, which has a connecting-rod leading to the valve.

Tank-ves'sel. A vessel whose hold forms a cistern for carrying molasses, oil, or other liquid. A brig constructed on this plan discharged her cargo of 88,000 gallons of molasses by means of pumps and hose leading into the reservoir of a refinery, was refilled with Cochituate water, and sailed again from Boston within 27 hours after her arrival. See Fig. 3376.

Tan'ning. Tanning is an operation which combines with the substance of the skin any other compound which has the property of rendering it imputrescible and elastic. The agent most generally employed is a soluble vegetable extract termed *tannin*, which forms insoluble compounds with the albumen, gluten, gelatine, and other components of the skin.

Tannin is yielded by the bark of oak, willow, and many other trees (see list, page 2493). The bark of oak is by far the most usual source of tannin. Catechu, valonia, and many other inspissated vegetable extracts are also used.

Another class of agents which fortify the fibrous portions of skins against the joint attack of warmth, air, and moisture are minerals which seem to act as preservative salts on the gelatino-fibrous structure of the skin. Such are alum and salt, and copperas. See TAWING.

It is difficult to determine the origin of this art, and it is somewhat confused by translating words referring to hides as if they meant *tanned* hides, that is, *leather*.

Skins and raw hides were first used and were afterward softened by means probably substantially similar to those adopted by the North American Indians. The art was reduced to a scientific basis by Sir H. Davy.

The pounding of skins, and sewing them up and inflating them, or filling them with *tanning* or *tawing* liquor, is shown in the ancient paintings of Kourna, Thebes.

Simeon of Joppa was a tanner, and dwelt by the seaside. Elijah and John Baptist wore leather girdles, perhaps *raw hide*. Strabo refers to the dresses of the Massaytan islanders as being of bark, owing to their having no cattle, and also to the skins used by other people. Pliny's statement of the materials used in treating leather shows that both the *tanning* and *tawing* operations were practiced.

Alum, sulphates of iron and copper, gall-nuts, bark of pomegranate, lotus, wild-vine roots, leaves of sumac, erythron, Rhus coriaria, and many inspissated juices.

The Saracens used alum. Du Cange mentions bark-mills and ground bark.

The art of tanning, though practiced immemorially in Europe, undoubtedly originated in the East, which, until very recent times, had almost a monopoly of the finer kinds of leather. In 1730, a man was sent from France to the Levant to learn the process of morocco manufacture, and in 1749 the first European morocco manufactory was established at St. Hippolyte, in Alsace; the art was not fairly developed in France before 1797.

This manufacture was subsequently introduced into England and Germany. In 1761, McBride of Dublin, and, in 1770, Johnson, introduced the use of dilute sulphuric acid for swelling the hides.

Sumac was used in the first half of the eighteenth century, *divi-divi*, from Caraccas in 1768. Catechu at a much later period. Steam-heating vats seem to have originated in America, but formed the subject of a French patent of 1822. The quick process was proposed by McBride in 1759, but he extracted the tanning material with lime-water. It was not until 1793-95 that the active principle requisite to the success of the process — tannic acid — was recognized by Deyeux and Seguin of Paris. It was rendered practical by Fay in England, 1790, and Seguin in France, 1795, and improved by Desmond, Brewin, Cant, and Miller. In 1839 the use of lime from gas-purifying works, previously suggested by Professor Boettger of Frankfort, was introduced into Berlin.

Half-dried sole-leather was formerly rendered compact and, to some extent, flexible, by being beaten by hand with hammers. In Switzerland, as early as 1800, water-power hammers, and, subsequently, stamps were employed. In 1842, Berendorf

of Paris invented pressing-stamps, which were supplemented by Harvey and Debergue with a roller, which effected the same purpose by its being rolled back and forth over the leather.

Fresh-slaughter hides are washed and scraped on the flesh side; salted hides are sometimes scraped, but dry hides do not require this treatment. Each of the latter kinds is soaked in water 10 or 14 days, and occasionally rubbed or beaten to supple them.

The skins are then placed in pits containing lime-water of 3 or 4 different degrees of strength; they are gradually transferred from the weaker to the stronger solutions, until, in the course of two or three weeks, the lime has dissolved the hair-sheath and, by combining with the fat, formed an insoluble soap. They are *handled*, that is, taken from the pits, and allowed to drain for an hour or two each day. When the hair is readily separable, they are removed from the pit and scraped upon the *beam*, a stand having a rounded upper surface, with the *unhairing-knife* (this is a curved, two-handled scraper, fitting the convexity of the beam); the hair comes off easily, its removal leaving a *grain*. Flesh and fat remaining on the other side are cut off with the *fleshing-knife*, which has a sharp convex edge; this process is termed *fleshing*. The hides are then washed in water, scraped, to get rid of adhering lime, the ears and projecting parts cut off, when they are ready for the tan-pit. The use of lime is objectionable, as it dissolves portions of the skin which would make good leather, makes the surface unequal, and interferes with the action of the tan. Various plans have been tried to avoid its use, among others smoking, causing an incipient fermentation which loosens the hair; piling the hides together and covering them with spent tan or litter, and allowing partial putrefaction to take place; and exposing them to air, kept constantly damp by the spray of water. In some cases weak acids are used, as very dilute sulphuric acid, sour milk, pyroligneous acid, fermented barley, rye-water, and bran; the two latter are sometimes used after liming. The effect of weak acids is to swell the pores, enabling the tanning liquor to penetrate them more readily. This process is termed *raising*: the liquid commonly employed consists of 1 part sulphuric acid to 1,000 parts water. A moderate heat is applied, and the process is completed in 24 hours.

A new English process to open the pores and render the tanning by bark more expeditious, —

1. Remove hair and particles of flesh.
2. Cleanse from the action of lime.
3. Place in a vat, flesh sides up, and cover each hide with bran, in quantity varying from 6 to 14 oz. to each hide, according to size, and cover with water.
4. Ferment. This will take two days or more, according to the weather.
5. Remove and scrape.
6. Steep in a vat, with 5 pounds ground Italian mustard and 5 pounds barley-meal to each 100 weight of hides. Here they remain from 24 to 48 hours, according to size.
7. Hang up to partially dry, and then proceed with the process of tanning by bark.

The tan-yard contains a number of wooden-lined vats, whose tops are level with the surface of the ground. Into these the hides and the ground bark, or ooze previously extracted therefrom, are put. In the old method the alternate layers of hides and of bark were placed in the pits, which were then filled up with water. When the strength of this appeared exhausted, the vat was emptied and supplied with fresh bark and water; this was repeated many times, the process occupying as much as 15 months. It, however, produced superior leather.

It is now customary to prepare the oozes and conduct them to the vats by pipes. The process consists in passing water through a stratum of the ground bark, until all its soluble matters are removed. Usually cold, but sometimes hot or tepid water is employed. Steam is conducted by a pipe beneath a pit containing the tanning material and water, and provided with a perforated false bottom, through which the extract percolates and is drawn off. In another method nearly spent bark is digested in water, at a moderate heat, and the weak ooze is transferred to a pit containing bark which is less spent, and so on until it is finally pumped into a pit filled with fresh bark.

It is common to introduce the skins into nearly spent ooze and transfer them successively to those which are stronger. Those in which the tanning is effected are called *handler-liquor*; stronger oozes, used for giving the *bloom* on the surface, are termed *layer-liquor*.

The skins are usually placed in horizontal layers, but are sometimes suspended vertically. In the process of *handling*, the hides are taken out with blunt-pointed, long-handled hooks, placed one over another, on a sloping rack over an adjacent pit, and permitted to drain for one or two hours.

When ooze instead of bark is employed, the hides are handled frequently.

By one plan, the skins are handled twice a day in the first liquor: once in two days in the second liquor; and once a month in the third liquor.

To save the trouble of handling by hooks in and out of the pit, various devices have been introduced. Several are illustrated under TANNING-APPARATUS.

1. (*Keasley*, 1845.) The hides are suspended from the bars of a frame which is periodically lowered into the liquor and raised therefrom.

2. The hides are temporarily tacked together, so as to form a chain, which is passed down into the vat and then up over a roller, by which they are kept in continuous motion.

3. (*Cagswell*.) The hides are arranged in a vat, laid flatly, except that the edges are a little raised to give the hide a dish form. The hides are packed in sawdust, and the ooze admitted above is allowed to percolate through the hides and sawdust, passing off at the bottom.

4. (*Spilsbury*, 1831.) Each hide is clamped in a rectangular frame, its edges being so nipped as to make it water-tight. Two frames are so clamped together as to make a thin water-tight box into which the ooze is admitted, to percolate through the hides, by hydrostatic pressure.

5. (*Drake*.) The hide is sewed up to form a bag, into which the ooze is admitted from an elevated cistern. The bags may be suspended in a vat of ooze.

6. (*Knowles and Duesbury*.) Hides are placed in a vessel from which the air is withdrawn by an air-pump. The ooze is then admitted under hydrostatic pressure and forced into the pores. The process is repeated with ooze of constantly increasing strength.

7. (*Herapath*, 1837.) Hides are sewed together into an endless band, and are passed between rollers, as they are removed from one pit to another. The object is to press out all of the ooze and open the pores for the reception of the ooze of the next pit.

8. (*Squire*.) Hides are placed in a horizontal cylinder, four fifths full of hides and hot ooze. The cylinder rotates at the rate of 6 or 8 revolutions per minute, and has interior ledges to tumble the hides as it rotates. The ooze is renewed from time to time, but fresh bodies of atmospheric air are excluded.

9. (*Nossiter*, 1844, *English*.) Each hide is contained in a frame which occupies a horizontal position in the pit of ooze. The frames are laid in, one over another, and circulation for the ooze is permitted all around them. The object is to keep them from contact, and the time is said to be shortened one half.

10. (*Berenger and Sterlingue, French*.) A series of 8 vats are made to communicate, so that the space between the false bottom and the bottom of No. 1 discharges, by a pipe, into the top of No. 2, No. 2 in the same manner to No. 3, and so on throughout the series, the contents of No. 8 being pumped into No. 1.

No. 1 is first charged with bark and hides and filled up with water. After a period, say from 15 to 21 days, No. 2 is similarly filled, and a quantity of strong ooze is introduced into No. 1, which displaces its former liquid contents and causes them to overflow into No. 2. After a similar interval of time (15 to 21 days), the pit No. 3 is charged with bark and hides, and strong ooze being poured into No. 1, its liquid contents are driven into No. 2, which overflow into No. 3. Again there is an interval, when No. 4 is charged, and so on until No. 8 has been charged and has laid its allotted time under the first liquid. No. 1 is by this time ready to be drawn, and is recharged with fresh bark and hides, the filling of No. 2 with ooze acting throughout the series of pits, the contents of No. 8 being pumped into No. 1, which has now become the last of the series.

11. (*Turnbull*, 1845.) The hides are tanned by endosmotic and exosmotic action, being sewed into the form of bags, filled with weak ooze and suspended in vats of strong ooze. The inequality of density causes a circulation of both liquids through the tissues. The weakness of one and the strength of the other solution must be maintained to preserve energy of action.

12. (*Schynder*.) The hide is indented by means of an instrument having 200 to 300 needles to the square inch. It is then exposed to the action of tan-liquor, which is led by the perforations to the interior portions of the hide.

13. The method employed by the Baskirs and Kirguises of Asia is a *substitute* for tanning, but may be here mentioned. The hair is detached by a knife. The skins are suspended in a pit, from parallel cords. Smoke is introduced into this pit by a tunnel from another pit, in which a fire is made. The fire is a smudge of dry and decayed wood, and both pits are covered in so far as is consistent with a draft sufficient to keep the smoke in effective action.

Two or three weeks are required to put the hides into a tough and lasting condition, impermeable to water.

14. The *Pampas Indians* stretch the hides, so that they shall not shrivel while drying in the sun's rays. The brains are also dried. At the end of the hunting season the hides are steeped, the hair shaved off; the wet hides and powdered brains being placed in an earthen pot and heated to *about* 95°. The villains have no thermometers. The cerebral matter is converted into a kind of soap, and forms a lather which renders the skin pliable.

The skins are then stretched by thongs, and rubbed frequently during the process of exsiccation.

The Esquimaux use in tanning the urine of man and beast. The skins are prepared in the fur, and softened and tanned in urine, which is usually kept in tubs in the porches of their huts for use in dressing deer, seal, and other skins, in the preparation of which they show great skill. The boots worn by the Esquimaux are generally made from seal or walrus hides, and resist water.

A number of distinguished chemists and practical tanners have attempted, and, to some degree, succeeded, in tanning leather by the application of minerals, obviating the use of the vegetable extract, *tannin*.

Of these may be cited the methods of Bordier and Cavalin, and the alum process.

1. *Bordier's Process.* The hides, being *unhaired* and *bated*, are steeped in a solution prepared as follows: —

224 pounds of bruised copperas are dissolved in 15 gallons of boiling water, in a copper kettle. This being transferred to a vat of 44 gallons capacity, 44 pounds of sulphuric acid (sp. gr. 1,848) are added, and to this gradually added 44 pounds of black oxide of manganese, in powder, the solution being constantly stirred.

The mixture is thinned with water and the hides steeped therein. The effect is to impregnate them with an insoluble sub-sulphate of peroxide of iron, and render the animal fiber imputrescible. From 3 to 8 days are required for the process.

2. *Cavalin's process* is to impregnate the cleaned and unhaired hides with a solution of

Bichromate of potassa.......	10 pounds.
Alum	20 pounds.
Water......................	180 pounds.

They are immersed 4 days, being handled and rubbed every day.

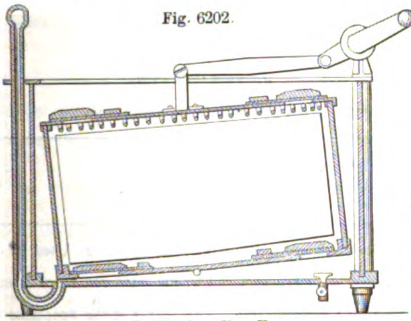
They are next steeped in a solution of

Protosulphate of iron..........	1 pound.
Water..........................	1 gallon.

The hides are not allowed to touch in the vat, but are taken out every 12 hours and drained, the process being repeated till the leather is formed.

The iron base is peroxidized in the hide by means of the chromic acid, which is itself reduced to the state of sesquioxide,

Fig. 6202.



Oscillating Tan-Vat.

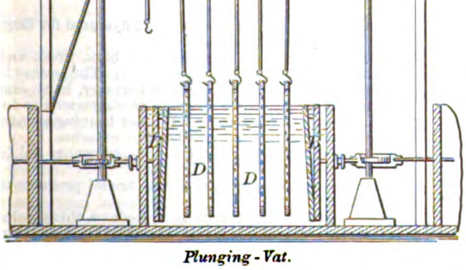
and remains with the iron and a portion of the alumina base, firmly united with the tissue.

3. The alum process consists in applying to the skins a saturated solution of alum and salt, followed by dressings of flour, yolk of eggs, oil, etc. See TAWING.

For tanning *in vacuo*, see patents: —

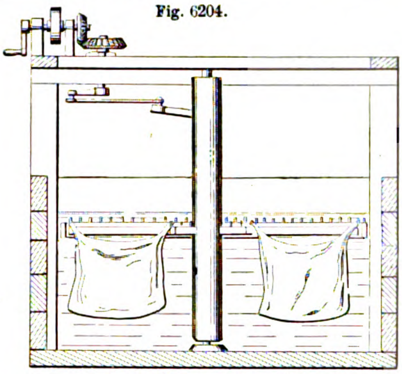
No.	Name.	Date.	No.	Name.	Date.
23,360.	Fergusson.	Mar. 29, '59	60,524.	Johnston.	Dec. 18, '66
29,656.	Aldrich ...	Aug. 21, '60	75,391.	Doty	Mar. 10, '68
48,361.	Brewer *et al.*	June 27, '65	84,190.	Hosmer...	Nov. 17, '68

Fig. 6203.



Plunging-Vat.

Fig. 6204.

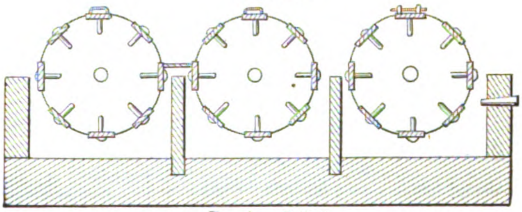


Rotary-Movement Tan-Vat.

Symonds' process for utilizing the useful matters which are not withdrawn from the bark by steeping, consists in burning the spent bark and conducting the products of combustion into a trough filled with water, where the solid and soluble portions are retained.

Tan'ning-ap'pa-ra'tus. A vat with devices for moving the hides in the liquor, or for circulating the liquid about the hides, in order to expose them to

Fig. 6205.



Tanning-Cylinders.

fresh quantities as the liquid in immediate contact with the hide parts with its tannin. Several forms of apparatus have been made, some of which are here illustrated.

1. *Oscillating Movement.* The hides are suspended in a box whose top and bottom are provided with valves opening upward; the box is oscillated upon a horizontal axis in a tank of tanning-liquor, and the motion causes a constant upward flow of the liquor, whose gravity is ascertained by an indicator attached.

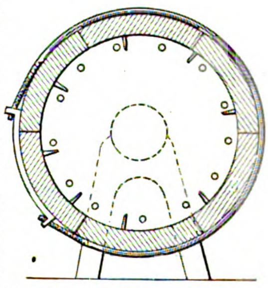
2. *Vertical Movement.* In Fig. 6203, the hides are distended upon cloths within wired frames *D D*, and, being suspended from a beam, are subjected to the action of rammers *B B* within the vat, by which they are alternately squeezed and released, causing the circulation of the liquor and the absorption of tannin by the hides.

3. *Rotary Movement within Vat.* The hides are suspended on the pins upon the rim of a horizontal wheel which has oscillation within the tank by an arm of its shaft, which is connected by a rod to a crank upon a shaft extending to the outside.

4. *Rotary Movement of Vat.* The hides are placed in open-sided rotating cylinders, which are partly submerged in vats containing tan-liquor, and have inwardly projecting pins to work the hides.

In Fig. 6206, the barrel is studded inside with pins, and has a perforated false bottom near one end, through which the tanning liquid flows in passing from the tubular induction-gudgeon to the hides within the cylinder. The liquor passes out through the other gudgeon.

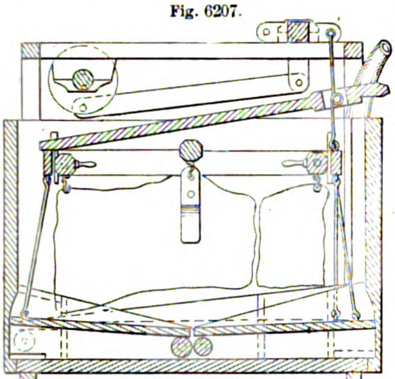
Fig. 6206.



Revolving-Cylinder for Tanning Hides.

5. *Circulation of Water by Pumps.* Fig. 6207 has a series of lifting-pumps, arranged in and operated at the bottom of the vat, for raising the heavier and stronger liquids from the bottom to the top of the vat, and thus by mixing render it of more

Fig. 6207.



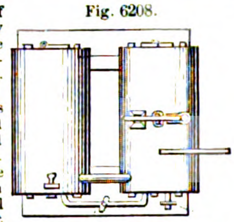
Tan-Vat with Pump.

uniform strength throughout. The tanning-liquid is thrown against the hides, suspended in the air, by a force-pump, in a column or in spray.

6. *Vacuum Process.* Air being exhausted from the tank, the liquor is allowed to enter and penetrate all the interstices between the hides and also the pores of the skins. The exhaust is by means of pumps, or, as in the example, by a pipe with stop-cocks to a separate steam-condenser.

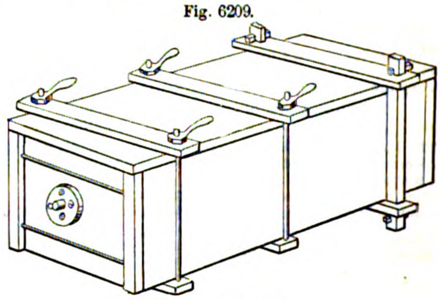
In Fig. 6209, the hides or skins are smoothly stretched or folded in an air-tight vat, and stratified with bark or matting interposed. The air being exhausted and the liquor admitted, the tank can be reversed and adjusted at will by manual power, or at set times by mechanism rotating the vat on its longitudinal axis.

Fig. 6208.



Tank for Tanning in Vacuo.

Fig. 6209.



Vacuum Tan-Vat.

TANNING-MATERIALS, DYE-STUFFS, ETC.

Common Name.	Botanical Name of the Genus or Species of the Plant used or producing the Article.	Native Place, or where chiefly grown.	Qualities, Uses, etc.
Alder bark..........	Alnus glutinosa........	Britain, etc......	The bark produces a yellow or red color. Used in dyeing and tanning.
Alkanet root........	Anchusa tinctoria.....	Shores of the Mediterranean	Used as a dye to stain woods Its red color is easily imparted to oils, etc.
Aloes...............	Aloe (various)	E. Indies........	Afford a brown dye. The leaves of the Socotrine aloe give a violet color that does not require a mordant to fix it.
Aniline	A product of coal-tar..	Discovered in 1826 by Unverdorben.	From it have been obtained mauve, magenta; also blue, green, violet, and black. See TAR.
Argol	Vitis vinifera....	Europe, etc	The coarse cream of tartar produced in casks in which wine has been stored. Used in dyeing.
Arnotto.............	Bixa orellana	S America	Red colored pulp covering seeds of the plant afford an orange or yellow dye for silks, and to color cheese, butter, and varnishes.
Barberry root, etc. ..	Berberis vulgaris, etc...	Europe, etc	The root, stems, etc., afford a yellow dye The bark is used in tanning.
Barwood............	(See Camwood)		
Bedstraw	Galium verum	Europe, etc	The flower tops afford a yellow dye with alum mordant; the roots a red dye.
Beech-bark	Fagus (various)	Europe and N. America	The tannin yielded by this bark makes a white but inferior leather, and is used only in places where oak is scarce.
Birch	Betula (various)	Europe and N. America	For tanning Russia leather, the inner bark is much used, especially on account of the brown oil which it yields, to which this leather owes its smell and durability
Brazil wood.........	Cæsalpinia brasiliensis	West Indies, Brazil, etc.	The heart-wood affords a red dye. Used also to make red ink.
Broom..............	Cytisus scoparius, or Sarothammus scoparius, and Genista tinctoria......	Europe	Used in dyeing yellow. For tanning, and for house brooms.
Buckthorn..........	Rhamnus (numerous) ..	Europe, etc......	Affords dyeing materials. Sap green from the berry, and yellow from the bark.
Campeachy wood....	(See Logwood.)		
Camwood	Baphia nitida........	W. Africa.......	Called also barwood. Affords the red dye used for English bandana handkerchiefs.
Catechu	Acacia catechu.........	E. Indies........	A resin-like extract obtained from the bark, wood, and leaves. Used in dyeing and tanning. The leather is very permeable to water, light and spongy, hard, and of a dark reddish-fawn color. The characteristic deposit, from oak bark and a few other tanning agents, known as *bloom*, is not produced by catechu.
Chica...............	Bignonia chica.........	S. America... ..	Affords a red pigment. Used to give an orange red to cotton goods.
Coal-tar colors.......	....	....	Aniline, mauve, magenta, solferino, are all products of coal-tar.
Cochineal...........	Opuntia cochinillifera ..	Mexico	The cochineal insect (*Coccus cacti*) feeds on this species of cactus, and affords a valuable scarlet and crimson dye.

Common Name.	Botanical Name of the Genus or Species of the Plant used or producing the Article.	Native Place, or where chiefly grown.	Qualities, Uses, etc.
Cork-tree	Quercus suber	Spain and Portugal	The *liber*, or inner bark, may be used for tanning.
Crottel	Parmelia omphalodes	Europe	A lichen growing on rocks and trees. Used to produce a brown color.
Cudbear	Lecanora tartarea, etc.	Sweden, etc.	A lichen growing on rocks at high elevations. Used to give a purple color — which is very fugitive — to woolen goods.
Cutch	(See Catechu.)		
Divi-divi	Cæsalpinia coriaria	S. America	The fruit-pod of the leguminous shrub is a powerful astringent. Used in tanning. Leather prepared by this substance is very porous, and sometimes tinged brown, unless the air be excluded in the process of tanning.
French berries	(See Buckthorn.)		
Fustet	(See Sumac.)		
Fustic	Maclura tinctoria, or Morus tinctoria	W. Indies, Brazil, etc.	Wood affords a yellow dye.
Galls	Quercus infectoria	Asia Minor	There are several kinds of galls, or gall-nuts; all produce gallic acid. Used in dyeing black, ink-making, tanning, and as a styptic. The gall is an excrescence produced on the species of oak named by the puncture of the insect, *Cynips quercusfolii*.
Gambir, or Terra japonica	Uncaria gambir	E. Indies, Malay Islands, etc.	Used in dyeing and tanning. Contains a principle called *catechine*. It was formerly called *terra japonica*, as it was supposed to be an earth from Japan. It is the inspissated juice of a slender-stemmed, vine-like shrub with oval leaves and clusters of pale purplish flowers. The leaves and branches are boiled to obtain the astringent extract, which is condensed by evaporation and dried in little squares. It is used by the Malays as a dye, a salve, and a masticatory with betel-nut and tobacco.
Garancine	Rubia tinctoria	S. Europe, etc.	The dye-principle of madder; obtained from it by the action of sulphuric acid.
Gum-trees	Eucalyptus (various)	Australia	Contain an astringent principle which can be used in tanning.
Heather	Calluna vulgaris	Europe	Affords a yellow dye.
Heaths	Erica (various)	Europe	Some kinds used in tanning.
Hemlock bark	Abies canadensis	N. America	In union with oak-bark, is supposed to produce the best leather. Hemlock alone produces leather inferior to that prepared with oak-bark, and, besides, imparts to it a red color. In America, it is largely used as a substitute for the bark of the oak.
Henna	Lawsonia inermis	Africa, Arabia, etc.	The powdered leaves used to dye leather, etc., a reddish yellow or orange. In Egypt, it is employed by the women to give an orange color to the nails.
Indigo	Indigofera anil, tinctoria, etc.	India	A very valuable blue dye.
Kelp	Fucus vesiculosus, etc.	Sea-shores	The ash of various kinds of sea-weed. Affords soda, etc.
Kermes	Quercus coccifera	S. Europe	The kermes (*Coccus ilicis*) feeds on the leaves of a species of oak, and affords a red dye. Its use is of very ancient date.
Kino	Pterocarpus marsupium / Pterocarpus erinaceus	E. Indies, Africa.	Used as a yellow dye for cotton in the East Indies.
Lac-dyes	Ficus religiosa, etc.	E. Indies	The *Coccus lacca*, by puncturing trees of the East Indies, produces shell and other lacs, that afford beautiful red dyes.
Larch	Larix alba	Europe, etc.	For tanning, inferior to oak.
Lichen dyes	Lecanora rocella, etc	Cool climates	Many genera and species give dyes; as cudbear, litmus, orchil, etc.
Litmus	Rocella tinctoria	Canaries, S. Europe, etc.	A lichen used to give a purple dye to silks. Used in chemistry as a test for alkalies and acids.
Logwood	Hæmatoxylon campechianum	Central America.	Used in dyeing red and black colors, shades of purple, etc. Called also campeachy wood.
Lombardy poplar	Populus dilatata		For tanning. Imparts a fragrant smell to the leather, similar to that of Russia leather.
Madder	Rubia tinctoria, etc	France	Employed to produce the celebrated Turkey red and other dyes. Affords garancine by the action of sulphuric acid.
Madder (Indian)	(See Munjeet.)		
Mangrove bark	Rhizophora mangle	Tropics	The bark is very astringent. Used for tanning.
Mimosa	Mimosa	Warm climates	The bark of an Australian species may be used in tanning.
Munjeet	Rubia cordifolia	N. India	Used for the same purposes as the European madder. Also affords garancine.
Myrobalans	Terminalia (various).	India	The fruit husk possesses an astringent principle. Used by tanners.
Nicaragua wood	(See Peach-wood.)		
Nutgalls	(See Galls.)		
Oak bark	Quercus (various).	Europe, etc.	The bark is employed in tanning and dyeing. It is stripped in spring; dried, ground, and steeped to extract the tannin.
Orchil, or Archil	(See Litmus.)	Europe	Is properly litmus in an early state of preparation, when it possesses a purple color.
Peach-wood, or Nicaragua wood	Cæsalpinia brasiliensis	S. America	Used as a material for red dyes.
Pearlash, or Potash	Various plants	Russia, America.	Procured by burning many woods and plants, and lixiviating the mass. Used for scouring wool and for cleansing generally; also in soap.

Common Name.	Botanical Name of the Genus or Species of the Plant used or producing the Article.	Native Place, or where chiefly grown	Qualities, Uses, etc.
Persian berries	(See Buckthorn.)		Afford a yellow dye.
Pomegranate bark	Punica granatum	Europe, etc.	Used in dyeing. Especially to give morocco leather a yellow dye.
Quercitron	Quercus tinctoria	N. America	A valuable yellow dye is obtained from the bark of the tree.
Safflower	Carthamus tinctorius	India, China, S. Europe, etc.	The flowers afford a yellow and red dye. Used in dyeing silks various shades of rose-pink, and in making carmine-rouge.
Saffron	Crocus sativus	S. Europe, etc	Used as a yellow coloring material. Obtained from the stigmas or tops of the flowers.
Sanders-wood (red). Santal-wood Saunders-wood	Pterocarpus santalinus	India	The wood affords a reddish-brown color, as a dye for woolen goods, also red and scarlet with certain mordants.
Sap-green	(See Buckthorn.)		
Sappan-wood	Cæsalpinia sappan	India and Ceylon	A wood much used as a red dye-stuff.
Spanish berries	(See Buckthorn.)		
Sumac, or Sumach	Rhus cortinus Rhus coriaria	S. Europe	The powdered leaves and young branches are used in tanning and dyeing orange, yellow, and black.
Tannin			A principle obtained from galls, oak-bark, etc. Used in tanning. It has the power of solidifying the gelatine of animal substances, as skins, and thus converting them into leather.
Terra japonica	Uncaria gambil	Malay Islands	Also called gambir. Used largely in tanning and dyeing.
Turkey berries	(See Buckthorn.)		
Turmeric	Curcuma longa	India, etc.	The powdered root (also called Indian saffron) affords a yellow dye. Is used in chemistry as a test for free alkalies.
Valonia	Quercus ægilops	Greece, Asia Minor	The acorns and cups of this species of oak are used in dyeing and tanning. Leather prepared by this substance is harder and less permeable to water than that made with oak-bark.
Weld	Reseda luteola	Britain, etc	The leaf and stems yield a yellow dye.
Willow bark	Salix alba	Europe, etc	Remarkable for its astringent taste. Leathers made from kid and lamb skins owe their agreeable smell to this bark, with which they are tanned.
Woad	Isatis tinctoria	Britain	Used to dye blue colors. Now superseded by indigo.
Wongshy	Gentiana (?)	Batavia	Yellow dye-stuff obtained from the seed-vessels of the plant.
Yellow berries	(See Buckthorn.)		

Tan-nom'e-ter. A hydrometer for determining the proportion of tannin in tanning liquor.

Tan-pit. A sunken vat, in which skins are steeping in tanning liquor.

Tan'ty. (*Weaving.*) The Hindoo loom, consisting of bamboo beams for the warp and cloth, a pair of heddles moved by loops, in which the big toes are inserted, a needle which answers as a shuttle, and a lay.

Tan-vat. A pit or tank in which tanning of hides is accomplished. See TANNING-APPARATUS.

Tap. 1. (*Machinery.*) A tapering, longitudinally grooved screw of hardened steel, having a square head, so that it may be turned by a wrench. It is used for cutting an internal screw, as that of a nut. See SCREW-TAP, Fig. 4754.

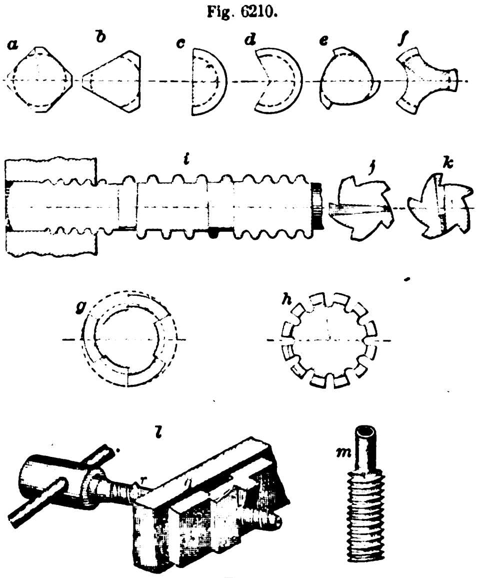
The most primitive kind of tap (Fig. 6210, *a*) is formed by filing four planes upon the screw: this gives very obtuse cutting edges. In *b*, three planes only are filed away, giving an angle more favorable for cutting. These sections are used for very small taps. The half-round tap *c* gives the most favorable cutting angle, and has been recommended as cutting a clean thread with comparatively small labor; the form *d* has also been employed. Taps with three or five cutting edges *e f* are more common; it is usual to form them with elliptical grooves, which permit the shavings to escape readily, and are easily wiped out.

In Bodmer's tap *g*, the cutting edges of the teeth are made prominent, their faces inclining backward at an angle of 3° from a true circular curve, so as to reduce the friction of the tool.

For cutting screw-dies and tools and other thin articles, the tap *h* has a larger number of grooves, and a greater proportion of its face is left standing to give it a sufficient bearing on the metal.

Taps with removable cutters have been used. *i j k* is Jones's tap. Tapering holes are made in the body of the tap to receive the cutters, which are caused to project slightly beyond the general surface by a slip of paper placed within the mortise. Sometimes they are made parallel and protruded by a set-screw. *l* shows a wood screw-cutting tap of this kind. It has a square helical groove, which fits two plates on the guide *p* through which the tap passes, and which is secured to the wood *q* to be tapped; the cutter *r* is inserted in a radial mortise. *m* is a hollow tap for the same purpose; a hole is made at the termination of the thread, and chamfered so as to form a

Fig. 6210.



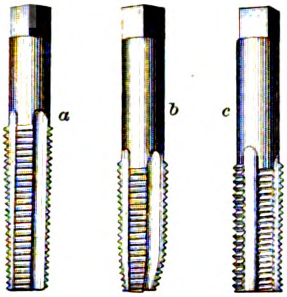
Taps.

cutting edge, the shavings passing into the central hollow of the tap.

Master taps are used for cutting the dies employed in cutting screw-threads. In some cases, for deep threads, two pairs of dies are employed, but generally one pair is cut by a tap one depth larger than the screw.

The process of screw-cutting was greatly improved by Maudslay, who introduced the practice of having three cutting edges, and using three taps, the entering taper tap, the middle tap, and the plug tap, by which shallow or *dead* holes in cast-iron can be safely tapped with full threads.

Fig. 6211.

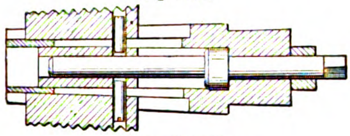


Taps.

a, taper-tap.
b, plug-tap.
c, bottoming-tap.

Fig. 6212 is an expanding-tap, the cutter being inserted in inclined dovetailed grooves in the sides of the stock. They are connected by screws to a plug sliding in a hole bored in the axis of the stock, and which serves to draw them up or down on the inclines to increase or decrease the diameter.

Fig. 6212.



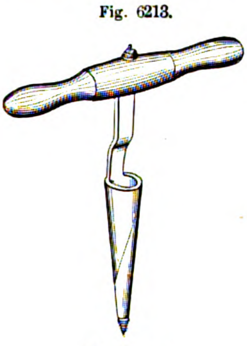
Expanding-Tap.

2. A faucet.
3. The heel of a boot, made up of *lifts*.

Tap-bor'er. A tapering boring-instrument for making spigot or bung holes in casks.

Fig. 6213 has a sharpened, salient, spiral edge, and a gimlet-point.
Fig. 6214 is the half of a hollow cone, with a sharpened edge and gimlet-point.
Fig. 6215 has a ring shank for a handle.

Fig. 6213.



Tap-Borer.

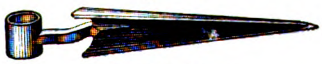
Fig. 6214.

Tap-Borer.

Tape. 1. (*Fabric.*) A narrow linen or cotton fabric, twilled or plain, white or colored.

2. (*Printing.*) *a.* One of the traveling-bands which hold and conduct the sheet of paper in a power-press. The *nippers* take the sheet from the feed-board, and the *fly*, taking it from the tapes, delivers it on to the heap.

Fig. 6215.



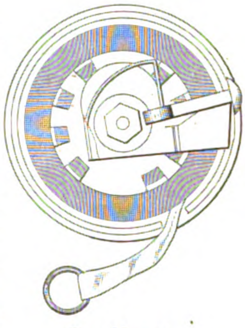
Ring Tap-Borer.

b. A similar band in a paper-folding machine.

Tape-car'ri-er. A tool-holder, like a frame-saw, in which a corundum tape is mounted to be used in cutting or filing.

Tape-fuse. A long, flexible, ribbon-shaped fuse, containing a composition which burns with great rapidity. By means of a fuse of this kind, a charge of powder may be exploded at the distance of several hundred yards, and apparently almost simultaneously with the communication of fire to the other end.

Fig. 6216.



Tape-Measure.

Tape-line. A measuring-tape winding into a case.

Tape-meas'ure. A ribbon of tape or other material winding upon an axis inside a case.

They are made of *linen* or *steel*, from 10 to 100 feet long, and divided into feet, inches, and subdivisions of an inch.

The linen tape-measures of the best quality are interwoven with fine brass wire, to prevent stretching.

The example is so arranged that pressure on the plug will hold the tape at any desired point.

Tape-pri'mer. A narrow strip of flexible material, usually paper, containing small charges of fulminating composition at short and equal intervals apart, and covered with a water-proof composition, as the Maynard primer. It was never much favored in the service, and has been superseded by the plan of placing the fulminate within the cartridge.

The tape-primer required a peculiar lock, having a recess for containing the tape and mechanism for advancing each primer successively to the nipple.

Ta'per. A small wax-candle. Usually having a long wick with such a covering of wax as to allow the taper to be coiled.

Wax tapers are made by drawing a string through a pan of melted wax at a speed regulated according to the thickness desired.

Ta'per-file. A file which is rectangular in section, and whose thickness and width gradually decrease toward the *point*.

The faces are not quite flat in the direction of their length, but are somewhat rounded; technically known as *bellied*.

A flat file, without a belly, is known as a *parallel* file.

Ta'per-vise. One whose cheeks are arranged to grasp objects whose sides are not parallel. See VISE.

Tap'es-try. (*Fabric.*) A kind of woven hangings of wool or silk, frequently raised and enriched with gold and silver, representing figures of men, animals, historical subjects, etc. The term is of somewhat indefinite meaning, and the purpose equally indeterminate. It was originally intended for hangings, to hide the wall, or make a screen or curtain. Ovid mentions human figures as worked on the curtains of theaters.

For an account of ancient tapestry, see Smith's "Dictionary of Greek and Roman Antiquities," article "Tapes."

Tapestry is described in the Book of Exodus.

"Plato, the comic poet, namesake of the philosopher, says: —

'There the well-dressed guests recline
On couches rich with ivory feet;
And on their purple cushions dine,
Which rich Sardinian carpets meet.'

For the art of weaving embroidered cloths was in great perfection in his time; Acesas and Helicon, natives of Cyprus, being exceedingly eminent for their skill in it, being weavers of very high reputation." — ATHENÆUS (A. D. 220).

The tapestry of Pollux, τάπητες, was woven shaggy: the *amphitapetia* was shaggy on both sides; the *tapetia* only on one side; the *ephestris* was shorn.

Tapestry-hangings are said to have been invented by the Pergamenians. Attalus III. bequeathed his kingdom to the Romans, and thence, it is said, hangings were introduced into Italy. The Greeks and Latins had embroidered hangings. These hid the bad carpentry or stone walls. The Anglo-Saxons had wall-hangings of silk, embroidered with needlework or plain. Tapestry was common in England to the time of Elizabeth.

Tapestry was made in France at a very early date. The oldest and most celebrated specimen in existence is the Bayeux tapestry, containing embroideries representing the conquest of England by William the Conqueror, and supposed to have been worked under the supervision of his queen, Matilda. Tapestry was first made by the loom in Flanders. The manufactory at Fontainebleau was established by Francis I. in the sixteenth century; that at Gobelin's was enlarged under Louis XIV.

The French ascribe the invention to the Saracens, and formerly called the workmen who were employed in its manufacture *sarazins*.

The manufacture was introduced into England by Sheldon, in the reign of Henry VIII. It was encouraged by his successors. Hampton Court Palace yet displays their tapestry on its walls.

These hangings were a very ornamental accession to the bare walls of the buildings of some centuries since. Arras, Brussels, Antwerp, and Valenciennes excelled in the manufacture, but the best known at the present day is the factory at the Gobelin's, near Paris. It is named after Giles Gobelin, a French dyer, of the reign of Francis I., and was established by Henry IV. about 1606, and much enlarged by the renowned Colbert in 1666. It is said to have been conducted by Flemish artists.

Hand tapestry is embroidered by the needle, woolen or silken threads being worked into the meshes of a fabric.

Basse lisse is woven upon a loom. The warp is horizontal, and is stretched above the pattern to be copied. The weft is inserted by a *flute*, which partakes of the characters of a needle and a shuttle. A treadle arrangement depresses some of the threads and forms a parted shed. The face of the work, being downward, cannot be inspected until it is removed from the loom; this inconvenience, probably, led to the substitution of the *haut lisse*, in which a vertical warp is stretched between a warp beam and a cloth beam. The pattern is placed at the back of the warp, through the threads of which it may be seen, and the outlines are copied upon the warp. The weft and pattern are then worked in with needles corresponding in number to the kinds and colors of threads used.

Tap'es-try Car'pet. 1. A two-ply carpet in which the warp is first printed and then woven.

2. The patent tapestry rugs have a velvet pile surface with a thick weft shoot of cotton, flax, or other material.

3. Tapestry Brussels carpet, called *moquette*, of a fine quality. *Wilton* carpet.

4. Mosaic tapestry; the cut wool is fixed to the ground by caoutchouc.

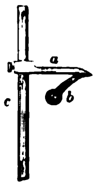
The Persian and Turkish modes of using carpet are the most ancient, the sizes being comparatively small, and placed about a room rather for individual convenience than as a general covering. The terms *tapestry* and *carpet*, or the originals thus translated, are in a little confusion. The ideas are now distinct, but when both were made by hand and in smaller pieces, the differences were rather of position than character. The rugs covered the *triclinia*, or were laid upon the floor, as appears in the representations in Pompeii, and later in the altar-cloths of the choirs in cathedrals and abbeys.

It is recorded that Sinchius, Bishop of Toledo, in 1255, covered his floor with tapestry, — an example followed by Eleanor of Castile, wife of Edward I.

Bedside carpets occur in 1301 on the Continent of Europe; and in the fifteenth century a carpet is shown around a throne, and a bedside rug with a handsome pattern, the remainder of the floor having a checkered matting of two colors.

Tap-hole. An opening at the base of a smelting-furnace for drawing off the molten metal. It is stopped by a plug of refractory clay (*bot*), which is removed in the act of tapping.

Fig. 6217.



Tappet.

Tap'lings. The whang-leather straps which connect the *souple* and *hand-staff*.

Tap'net. A rush basket in which figs are imported.

Tap'pet. (*Machinery.*) *a.* A projecting arm *a* which is touched by a cam *b*, or other moving object, in order to impart an intermittent reciprocation to the rod *c*. Specially used as a valve-motion in steam-engines.

b. A similar device on the stem of a stamp in an ore-battery. It is struck by a cam, lifting the stamp, which falls as the cam slides from under the tappet, its shoe striking the ore in the mortar.

Tap'pet-mo'tion. (*Steam Engineering.*) The apparatus for working the valves of some forms of condensing-engines. The valve-rods have levers attached, which are moved by projecting *tappets* on a rod connected to the beam.

Tap'pet-wheel. (*Machinery.*) A wheel having spurs on its periphery, adapted to trip a lever, trip-hammer, fulling-mallet, etc., or to raise the stamps of an ore-mill.

Tap'ping. 1. Screw threading a hole.

2. (*Founding.*) The jarring of a pattern in its bed in the sand to give it *clearance*. With small castings this is done by sticking a skewer into the pattern and *tapping* it with the *slicker* or *trowel*; with larger castings more energetic means are employed, but in the same way.

3. Boring a hole in a pipe, cask, etc., to insert a plug, connect a branch-pipe, or introduce a faucet, as the case may be.

4. Boring maples for *sugar-water*, as it is called in the Western, or *sap*, in the Eastern States.

Tap'ping-ap'pa-ra'tus. 1. For threading screws. See SCREW-TAP; TAP; TAPPING-MACHINE, 1.

2. For opening the flow-hole of a furnace. See TAPPING-BAR.

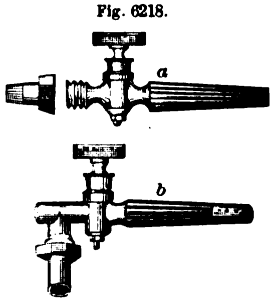
3. For cutting the bark and alburnum of the maple. See TAPPING-GOUGE; AUGER.

4. For boring holes in mains or pipes. See TAPPING-MACHINE, 2; TAPPING-DRILL.

5. For inserting a faucet in a cask. See TAP-BORER; TAP-COCK.

Tap'ping-bar. (*Founding.*) A round bar with a sharp point, used for letting out the metal from the furnace into the ladles. Two such are generally used; the first a light bar with a chisel edge to clean away the unburned clay from the tap-hole.

Fig. 6218.



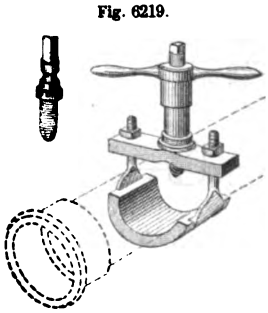
Tapping-Cocks.

Tap'ping-cock. A cock having a taper stem, enabling it to be fixed firmly in an opening by driving.

a, straight-nose tapping-cock.
b, bent-nose tapping-cock.

Tap'ping-drill. One for boring holes in water mains and pipes. A strap goes below the pipe, and has screw-bolts which hold the cross-piece, and also the tube in which the drill-stem works.

Fig. 6219.



Tapping-Drill.

Tap'ping-gouge. A gouge used in tapping the sugar-maple, and in making the spiles to conduct the sap to the buckets.

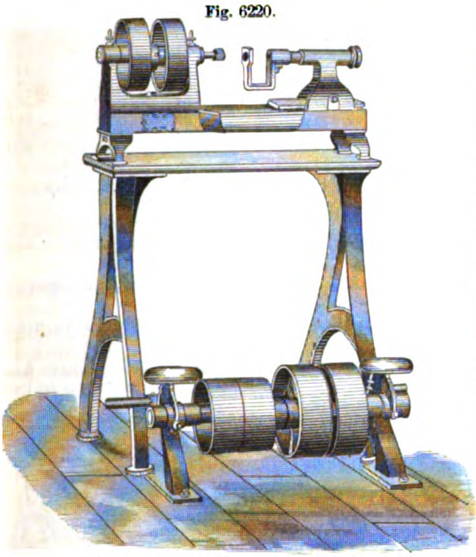
In the West the liquid is called *sugar-water*; in the East, *sap*.

Tapping with the gouge is not now so common; boring with the auger and inserting an elder or a turned spile is the usual plan.

Tap'ping-ma-chine'. 1. (*Metal-working.*) A machine for tapping out internal screw-threads.

In that illustrated, the taps are held in a chuck fixed in the rotary mandrel of the stationary head, and may project as far as desired. The work is held in a clamp on the sliding-head, which is advanced toward the tap. An arrangement is provided for gaging the penetration of the tap when the hole is not to pass through the work, and the motion is reversed in the act of drawing back the work.

Fig. 6220.

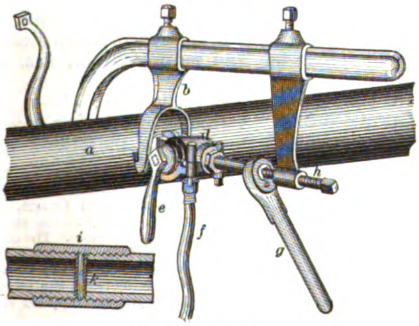


Brown and Sharpe Tapping-Machine.

2. A machine for tapping water-mains.

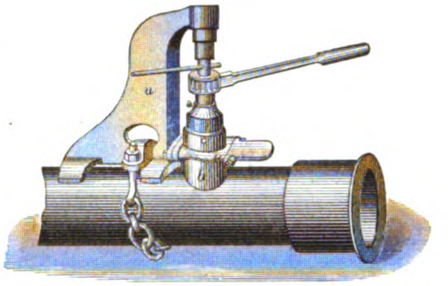
a is the main, against which the device is held by the movable arm *b*. The drill passes through the two-part drill-holder *d*. At the end nearest the pipe is a detachable washer in a socket, having a concave face, which is clamped against a packing-gasket to make a water-tight joint. The handle *e* operates a cock within, through which the drill passes, and which closes the opening when the drill is removed. The connecting-pipe is then substituted for the drill, the cock opened, and the connection made. The hose *f* conducts away the chips. The drill is operated by the ratchet-lever *g* and fed by the screw *h*. *i* is an arrangement for dispensing with the cock usually employed in making connections, and which is afterward left in the earth. A glass plate *k* is interposed between the ends of two sections of pipe, and crushed by screwing the sections together. The pieces are washed out by the flow of water.

Fig. 6221.



Tapping-Machine.

Fig. 6222.



Gas-Main Tapping-Machine.

The apparatus (Fig. 6222) is for tapping gas-mains without causing escape of gas. The curved standard *a* is lashed to the pipe, the drill-stock works through a hollow foot *b*, which is cushioned to render it gas-tight, and is provided with a sliding-valve arrangement, which is closed when the drill is lifted, and kept so until the end of the service-pipe is to be inserted.

Machines for tapping gas and water pipes and mains. Patents: —

Nos. 24,949	65,863	129,853
25,216	77,453	129,869
30,051	112,626	130.577
30,901	113,314	133,016
45,964	119,895	136,621
46,246	122,668	144,374

Tap'ping-tool. A tool for tapping maple-trees to obtain the resulting sap (New England), or sugar-water (the West), which exudes from the alburnum principally. Tapping is done by a gouge and mallet, by an axe, or by an auger.

Tap-plate. A steel plate furnished with a number of holes which are wormed and notched, to adapt it for cutting threads on blanks.

Fig. 6223.

Tap-Plate.

Tap-wrench. A two-handled lever for rotating a tap used in forming an interior screw-thread. The shank of the tap is held between a fixed and a movable die, which are approached by a screw, and are adapted to hold shanks of various sizes. See DIE-STOCK.

Fig. 6224.

Tap-Wrench.

Tar. A dark-colored resinous substance obtained by distillation from the pine or from coal.

There are many oils resulting from the distillation of coal-tar; some of the light ones being used to produce local insensibility to pain, such as the freezing of the gum in dental operations. One of these light oils, benzol, exhibits in a remarkable degree the number and value of the coal-tar productions. Fifty years ago, in 1825, Faraday discovered, while experimenting on coal-tar, the substance now known as benzol. Twenty years after, a French chemist found that when benzol was treated with nitric acid, a substance called nitro-benzol resulted, having the odor of bitter almonds, and now used for giving almond soap its odor.

About the same time a Dutch chemist discovered a beautiful blue color while experimenting on indigo, and shortly after a blue solution was obtained in alcohol from nitro-benzol. It was soon proved that the two blue colors were of exactly the same constitution, and they were called aniline. They were regarded as curiosities, but no practical use was made of them, as there were many kinds of blue dyes, and much cheaper than aniline. But in 1856 an English chemist, Perkins, while searching for a cheap method of preparing quinine, from nitro-benzol, obtained a beautiful solution of *mauve* color. This was found to be such an effective dye that numerous experiments were made on this substance, and the result is considerably over three hundred dyes of all the beautiful colors of the spectrum, red, orange,

yellow, green, blue, indigo, and violet; first came the *mauvine* and *rose aniline* in 1856, then the *aniline red* in 1859, then the *aniline blue* in 1860, then the *aniline green* in 1863; after that the violets of methylic and ethylic *rosaline*, and *aniline black*.

In 1870, *alizarine*, the coloring principle of madder, was produced from one of the coal-tar products.

Dr. Hofmann, of the University of Berlin, furnishes, in "Percy's Metallurgy," the following list of the compounds generated by the destructive distillation of coal, the new atomic weights being used.

Hydrogen	H	Sextene (caproylene)	C_6H_{12}
Water	H_2O	Septene (œnanthylene)	C_7H_{14}
Carbonic oxide	CO	Ethine (acetylene)	C_2H_2
Carbonic acid	CO_2	Benzol	C_6H_6
Sulphurous acid	SO_2	Toluol	C_7H_8
Hydrosulphuric acid (sulphuretted hydrogen)	H_2S	Xylol	C_8H_{10}
Bisulphide of carbon	CS_2	Cumol	C_9H_{12}
Hydrocyanic acid	HCN	Cymol	$C_{10}H_{14}$
Hydrosulphocyanic acid	$HCNS$	Naphthaline	$C_{10}H_8$
Acetic acid	$C_2H_4O_2$	Anthracene	$C_{14}H_{10}$
Carbolic acid (phenol)	C_6H_6O	Phenanthrene	$C_{14}H_{10}$
Cresylic acid (cresol)	C_7H_8O	Fluorene	$C_{13}H_1$
Phlorylic acid (phlorol)	$C_8H_{10}O$	Pyrene	$C_{16}H_{10}$
Rosolic acid	$C_{20}H_{10}O_3$(?)	Crysene	$C_{18}H_{12}$
Hydrocarbons.		*Basic Nitrogen Compounds.*	
Methane (marsh gas)	CH_4	Ammonia	H_3N
Sextane (propyl)	C_6H_{14}	Aniline	C_3H_7N
Octane (butyl)	C_6H_{18}	Pyrodine	C_5H_5N
Decane (amyl)	$C_{10}H_{32}$	Picoline	C_6H_7N
Duodecane (caproyl)	$C_{12}H_{26}$	Lutidine	C_7H_9N
Paraffine	$C_{10}H_{2n}+_2$(?)	Collidine	$C_8H_{11}N$
Ethene (olefiant gas)	C_2H_4	Parvoline	$C_9H_{13}N$
Tertene (propylene)	C_3H_6	Corindine	$C_{10}H_{15}N$
		Rubidine	$C_{11}H_{17}N$
		Viridine	$C_{12}H_9N$
		Chinoline / Leucoline	C_9H_7N
		Lepidine	$C_{10}H_9N$
		Cryptidine	$C_{11}H_{11}N$
		Pyrrol	C_4H_5N

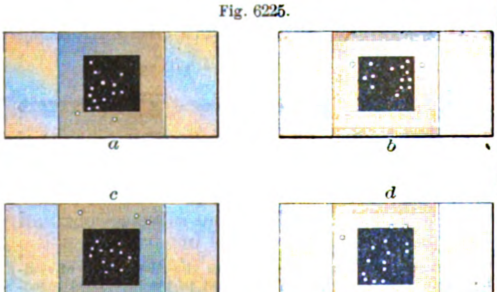
Tarring and feathering was a punishment of offending Crusaders (HOVEDON, "Temp. Richard I."). A bishop of Hulverstadt stripped, oiled, pitched, and feathered a number of monks and nuns.

Tar-board. (*Paper.*) A strong quality of mill-board made from junk and old tarred rope.

Tar′get. 1. A butt or mark in archery or rifle-shooting.

Fig. 6225 illustrates shots made by three of the contestants at the recent shooting-match at Creedmoor between the American and Irish teams; each team was composed of 6 men, and

Fig. 6225.



Target (Creedmoor).

had 15 shots at the distances of 800, 900, and 1,000 yards, making 270 in all for 6 men.

a, H. Fulton, American, 58; 800 yards.
b, J. B. Hamilton, Irish, 58; 800 yards.
c, J. K. Milner, Irish, 57; 800 yards.
d, H. Fulton, American, 57; 1,000 yards.
In a possible 60.

The sizes of the targets of the National Rifle Association at Creedmoor are as follows: —

	Up to 300 yds.	300 to 600 yds.	600 to 1,000 yds.
Size	6 × 2 feet	6 × 6 feet	6 × 12 feet.
Bull's-eye	8 × 8 inches	2 × 2 feet	3 × 3 feet.
Center	2 × 2 feet	4 × 4 feet	6 × 6 feet.

Bull's-eyes count	4.
Centers count	3.
Outers count	2.

See RIFLE.

The following is the complete score of the shooting at Dollymount, Ireland; the targets are shown in Plate LXVIII.

THE AMERICAN TEAM.

	800 yds.	900 yds.	1,000 yds.	Total.
Col. H. A. Gildersleeve	56	56	52	164
G. W. Yale	57	52	51	160
Major Henry Fulton	58	57	46	161
R. C. Coleman	56	48	52	156
Col. John Bodine	52	59	51	162
Gen. T. S. Dakin	58	55	51	164
Total	337	327	303	967

THE IRISH TEAM.

	800 yds.	900 yds.	1,000 yds.	Total.
Wilson	58	50	55	163
Hamilton	56	54	51	161
McKenna	52	44	53	149
Milner	55	37	41	133
Johnson	58	54	50	162
Pollock	59	53	49	161
Total	338	292	299	929

Total for American team	967
Total for Irish team	929
Americans over their opponents	38

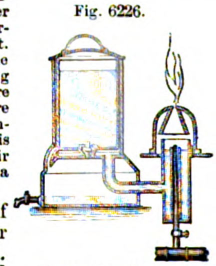
2. The *sight*, sliding on a leveling-staff. Also called a *vane*. See Fig. 2913.

Tar′la-tan. (*Fabric.*) A showy, transparent muslin dress-goods.

Tar-lamp. A lamp for burning tar for purposes of illumination.

The tar is contained in the cylindrical case, and flows from thence by a pipe to the burner, at whose summit it is ignited. The supply-apparatus is on the fountain-lamp principle, and a chamber below the reservoir catches any overflow, which is drawn off by a faucet. A jet of air is introduced through the center of the annular burner, having a pressure of $1\frac{1}{2}$ pounds to the square inch. This is admitted at pleasure by a faucet below. Without the central blast, a small lambent flame is obtained; when the compressed air is admitted, the tar burns with a vivid white light.

Fig. 6226.



Beale's Tar-Lamp.

Tar-pau′lin. A cloth of stout canvas, coated with tar or other water-proof compound. Employed on shipboard and ashore for covering hatches, boats, hammocks, etc., and protecting articles generally from the weather.

A tarpaulin, or thick unpainted canvas, sometimes called a *paulin*, forms part of the equipment for each carriage of a field-battery of artillery.

Tar′rass. A volcanic earth used in making cement. See POZZUOLANA.

Tarred Line. (*Nautical.*) Cord which has been tarred, in contradistinction to *white* line.

Tarred Links. Used for lighting up forts, trenches, etc. They are made of old rope, well beaten, to soften it, and are covered with a composition of pitch, tar, and mutton-tallow, similar to that used for pitched fascines.

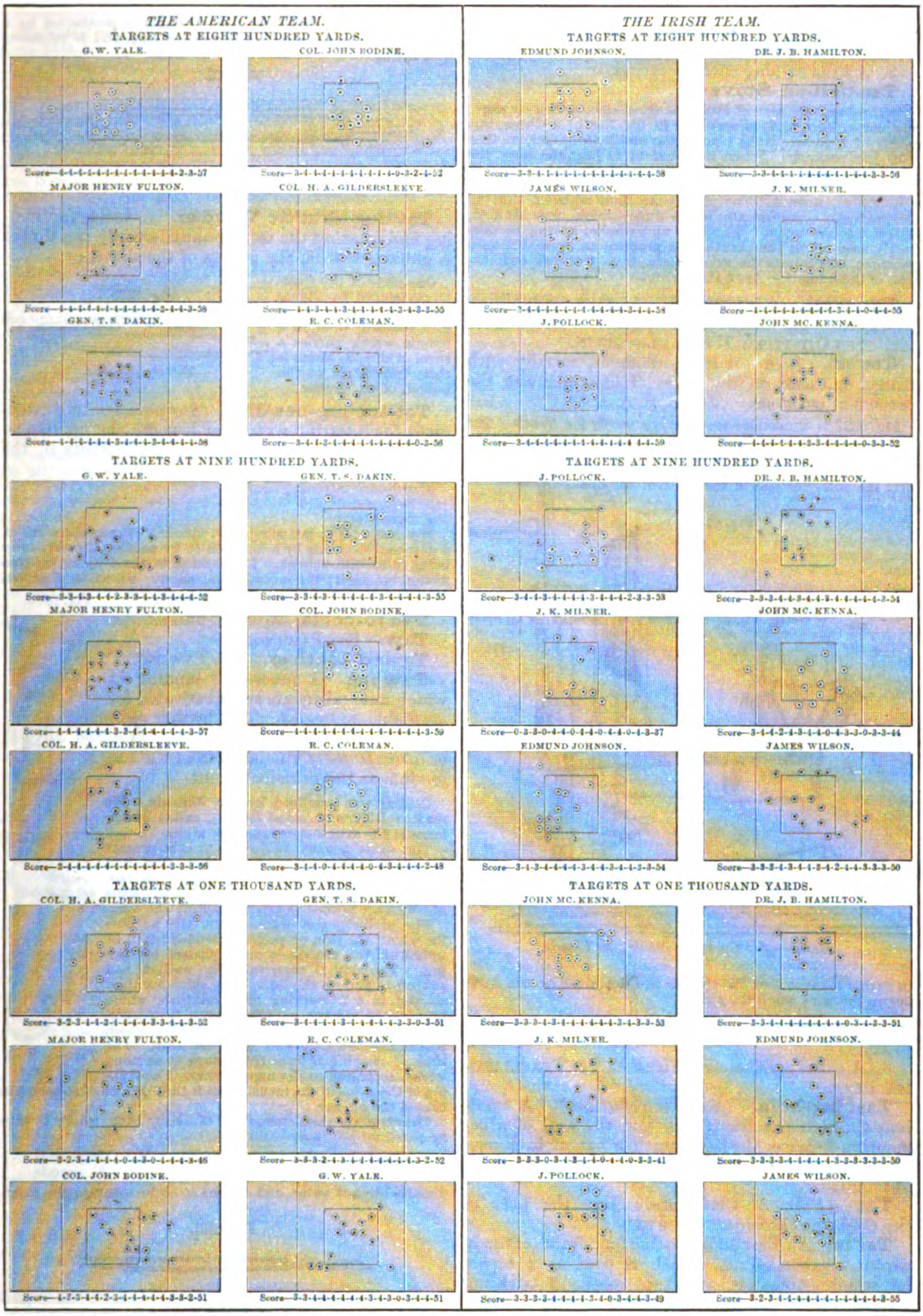
Tar′ris. POZZUOLANA (which see).

Tar′sia-work. A species of inlaying in wood, much practiced in Italy during the Middle Ages, especially for wall-paneling.

Wood in its natural colors was employed in the earlier specimens, but afterward, when more complicated figures, birds, flowers, etc., were introduced, the various pieces were stained; the colors, however, generally lacked permanence. The art was revived some years since in France, and M. Boucherie introduced a method of permanently tinting the wood to a considerable depth. Shades are produced by immersing the pieces in hot sand; the design is built up on paper, and applied in the manner of veneer.

Tar′tan. 1. (*Fabric.*) Woolen cloth, cross-barred with stripes of various colors, forming *panes*, and constituting the peculiar patterns which formerly distinguished the different Scottish Highland clans.

2. (*Nautical.*) A small vessel with one mast and



THE TARGETS AT THE INTERNATIONAL RIFLE-MATCH.

Diagrams showing the Shots made by each contestant of the American and Irish Rifle-Teams at Dollymount, Ireland, June 29, 1875.

PLATE LXVIII.

See page 2498.

a bowsprit, the mainsail being spread by a lateen yard. Used in the Mediterranean.

3. A kind of long covered carriage.

Tar-ta'ri-an Stove.

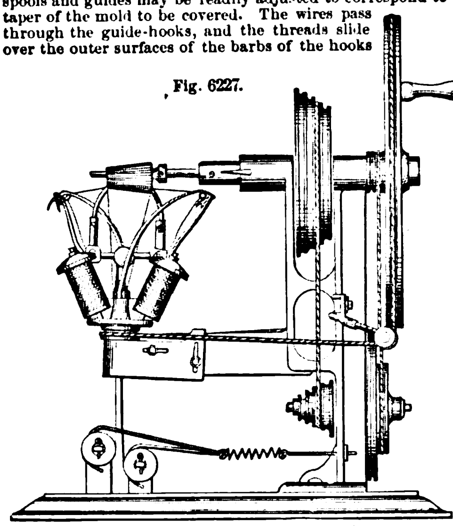
"The *kang*, the sort of large flat stove upon which we slept, was not entirely made of stone, as in the North of China, but partly of movable planks placed one beside the other, so that they join perfectly. When it is desired to heat the *kang*, the planks are taken away, and a quantity of dry and pulverized horse-dung is spread over the interior, and some lighted charcoal thrown upon it. The planks are then replaced, and the fire gradually communicates to the dung, which, once kindled, does not go out again. The heat and smoke, having no outlet [?], soon warm the planks, and produce an agreeable temperature, which lasts the whole night, from the slow combustion of the dung." — ABBÉ HUC, *Travels in Tartary*.

Tar-well. (*Gas-works.*) A tank containing water, through which gas is passed to extract the tar. See DIP-PIPE; HYDRAULIC MAIN.

Tas'sel. 1. A pendent ornament, usually with fringe, and used on the edges of hangings and the corners of cushions.

Fig. 6227 is a machine for covering molds for tassels. The spools and guides may be readily adjusted to correspond to the taper of the mold to be covered. The wires pass through the guide-hooks, and the threads slide over the outer surfaces of the barbs of the hooks

Fig. 6227.



Machine for Covering Molds for Tassels.

in such a manner that the threads are deposited on the wires before the same reach the mold.

2. (*Architecture.*) A board beneath the mantel-piece.

3. A *teasel; Dipsacus fullonum.* See TEASELING-MACHINE.

Tast'ing-hole. (*Steel-manufacture.*) A small hole through the bar-trough and the wall of a cementing-furnace, through which a bar of iron may be withdrawn to examine the condition and degree of progress.

Tat. (*Fabric.*) Cloth made from the fiber of the *Cochorus olitorius.* See JUTE.

Tat'ta. An East Indian name for a frame of finely woven bamboo-splints, which is used as a screen for window-openings, and kept moist by trickling water, so as to cool the air passing through it into the apartment. An *alcarazza.*

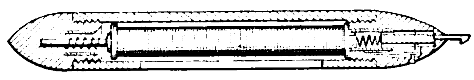
Tat'ting. A kind of lace edging, consisting of a set of loops strung upon a thread, on which they are afterward pulled up to form a loop-edging.

Tat'ting-shut'tle. A small shuttle used in *tatting.*

Fig. 6228 has a sheathed spool with a spring at each end. A tatting-hook at one end of the shuttle may be protruded or sheathed at pleasure.

The shuttle (Fig. 6229) has a pin *b* which is protracted by a thumb-piece to pass a thread through a loop, and is retracted by a spring.

Fig. 6228.

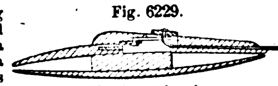


Tatting-Shuttle.

Tat'ting-shut'tle Wind'er. A device for holding and rotating the tatting-shuttle while the thread is guided between the prongs of the shuttle.

One plate of the shuttle is clamped by sliding sleeves on a bar attached to a rotating shaft in a handle which carries a spool of thread, which is thus transferred to the bobbin of the shuttle.

Fig. 6229.



Tatting-Shuttle.

Tat-too'ing-nee'dle. (*Surgical.*) An instrument for inserting a pigment beneath the epidermis. Used professionally for coloring white spots in the cornea.

a, ordinary tattooing-needle.
b, Baader's.
c, Agnew's.

Moses alludes to tattooing (Lev. xix. 28). It was the mark of a devotee, was made by a hot iron or by needles, the punctures being filled with powder. The emblem of the deity or the profession was used; the moon, cross, arrow. Branding of slaves, deserters, and even of recruits, was practiced.

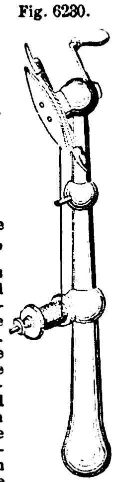
Tau'ro-col'la. Glue of bull's-hide.

Taw. See TAWING.

Tawed Leath'er. See TAWING.

Taw'ing. A process of tanning in which mineral agents are substituted for vegetable extracts. The leather produced is known as *Hungarian, white,* or *alum leather;* the latter from the use of alum as the principal agent.

Fig. 6230.



Tatting-Shuttle Winder.

Tawing was practiced by the Romans. We read in Isidore of *calcei* (shoes), called *alutæ*, because the skin was softened by alum.

The skins usually subjected to this process are those of the goat, sheep, deer, dog, and some other skins of small size, such as the raccoon, ground hog (woodchuck), fox, etc., some of which are tanned as pelts, retaining the hair.

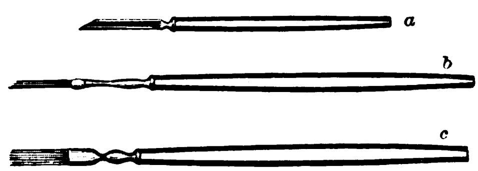
The preliminaries depend upon the purpose for which the skin or pelt is intended; if it be unhaired, the process is accomplished by liming. The skin is then carefully washed and rubbed to remove the lime. The skins are then steeped in a fermenting bran mixture, whose proportions are two pounds of bran to the gallon of water. This develops acetic acid, which neutralizes the lime and swells the skin. The time of steeping is from three days to as many weeks, according to the temperature. The sinking of the skins in the menstruum is the evidence of the completion of the process.

The skins are then steeped in the alum bath, which is thus prepared for 100 sheep-skins: —

Alum	20 pounds
Salt	4½ pounds

dissolved in hot water, and diluted so as to saturate the skins.

Fig. 6231.



Tiemann's Tattooing-Needles.

The skins are tramped in the bath, or subjected to the tumbling operation in a closed revolving cylinder with interior slats.

The skins are then put into a paste made by adding to the alum bath

Wheaten flour	20 pounds
Yolks of	50 eggs

well mixed. The skins are separately treated with this compound, and then left in it for a night. They are then drawn, suspended on poles, and left to dry, being occasionally stretched.

They are then worked on the softening iron to remove unevenness, develop whiteness, and stretch uniformly. The process is completed by stretching on hooks, rubbing with the stretching-iron occasionally, as the drying proceeds.

The skins may be surfaced with pumice, and glossed with a smoothing-iron.

When the *pelt* is to be dyed, the wool or hair is colored previous to the alum bath.

The coloring of the *skin* is by a tinctorial mixture applied to the grain side while damp, and rubbed in by an iron.

Split horse-hides are made into *tawed*, *white*, or *alum leather*, and are the material for leather aprons used by the mechanics of various arts, the pioneers of the army in full dress, for thongs of whips, and for other purposes.

In Hungary and other countries of Europe, alum-tanned leather, said to be equal to bark-tanned, is used to a considerable extent for harness. The process, it is said, may be completed in 24 hours. Heavy ox or cow hides fresh from the slaughter-house are first well washed in salt and water to remove the blood, and then laid on the beam, flesh side up, and well scraped. The hide is then placed on a smaller beam, and the hair removed with a sharp knife, after which it is placed in a tanning solution of salt and alum pulverized; the hide is well sprinkled with this and rolled up, and, as the liquid oozes out, it is heated and poured over the hide; this process is continued for 24 hours, when the leather is ready to take the grease; using a cold solution produces a firmer and less porous leather, but takes more time, — three or four days, — small quantities of alum being added to the solution each day. After scraping, the leather is colored with logwood and a small proportion of copperas: it is then rubbed with iron-black and dried. It is finally well rubbed in the direction of its length, and smeared with a mixture of equal parts of hog's lard, tallow, and train oil on the flesh side, tallow only being used on the grain side.

Taz'za. An ornamental vase with a spreading, flat top.

T-band'age. (*Surgical.*) A bandage shaped like the letter T, consisting of a strip of linen attached at right angles to another strip. When two such strips are so attached it is a double T. Used in supporting dressings in diseases of the perinæum, groin, etc.

Tea-boil'er Cock. A cock having a T-headed thumb-piece, by turning which its valve is opened or closed.

Teache. (*Sugar.*) The smallest evaporating-pan and the one nearest the furnace front. *Tache.* See TACHE.

Teach'ing-ma-chine'. A machine invented by Alfred Long of London for purposes of instruction in languages and music.

It consists of a series of cubes inclosed in a box with a glass side; on these cubes are written the words (or notes, in case of music) which it is intended the child shall learn, and then, by turning the handle of the machine, the words appear in various arrangements, and are read off each time, or translated as they appear, by the pupils.

Tea'gle. A corruption of *tackle.* A name applied in England to an apparatus for hoisting operatives and material to the upper stories of factories. See HOISTING-MACHINE; MAN-ENGINE.

Tea'ket-tle. An ordinary piece of stove furniture for boiling water for infusing tea, etc.

Team-boat. (*Vessel.*) A ferry-boat whose paddles are worked by horses on board.

Team'ing. 1. (*Steel-manufacture.*) The operation of pouring the molten cast-steel from the crucible into the ingot-mold.

2. (*Civil Engineering.*) The operation of transporting earth from the cutting to the embankment.

3. A certain mode of manufacturing work, which is given out to a boss, who hires a gang or team to do it, and is responsible to the owner of the stock.

In the shoe business, for instance, each man has his part to perform. One *lasts*, another puts on the *outer soles*, another finishes *bottoms*, and still others put on *heels* and finish *edges*, and thus the boot or shoe goes through all these different processes until it is completed, packed in boxes, and returned to the manufacturer. After reaching this point they are rigidly examined, the final "finishing-touches" put on, "cased" up, and marked.

Team-shov'el. An earth-scraper. A scoop drawn by horses or oxen, managed by means of handles, and used in removing earth. See EARTH-SCRAPER; SCRAPER.

Tea'pot. A vessel in which tea is infused.

The first notice of tea among the "Western barbarians" is perhaps the account given by Herodotus, Book IV. xxi., xxiii.: —

"Beyond the Tanais the region of Scythia terminates, and the first of the nations we meet with are the Sauromatæ, who inhabit a space of fifteen days' journey. . . Beyond these are the Budini, and beyond them a desert of eight days' journey. [Then follows an orderly account of several countries occupied by other nations, then a stony tract, and eventually a people] living at the foot of some lofty mountains [Himalaya]. They live chiefly on the *produce of a tree* which is called the *ponticus:* it is as large as a fig-tree, and has a kernel not unlike a bean. When it is ripe they press it through a cloth; it produces a *thick black liquor* which they call *aschy:* this they *drink, mixing it with milk;* the grosser parts, which remain, they form into balls [brick-tea] and eat."

The worthy chronicler was mistaken as to one point: it was a leaf and not a fruit. Even then he was much nearer to the mark than one of the large whiskey-distillers of Cincinnati, who observed to a lady in the hearing of the author, "Sponges, madam; I believe they grow on trees."

The annals of China place the use of the leaf at a very remote date. It was introduced into Japan in the ninth century A. D., but was not brought to Europe till some seven centuries later. It was about the middle of the seventeenth century (1664) that the East India Company presented to the queen of England a package of two pounds of tea, then valued at forty shillings a pound. About the same time some Russian ambassadors returned to Moscow, bringing some carefully packed green tea, which was esteemed a great delicacy. The overland tea is still the best.

An advertisement in the "Mercurius Politicus," September 30, 1658, is as follows: —

"That excellent and by all physitians approved *China* drink, called by Chineans Tcha, by other nations *tay*, alias *tee*, is sold at the 'Sultana Head' Coffee-house, London."

"I did send for a cup of tee, a China drink, of which I had never drunk before." — PEPYS, 1660.

In 1667 the British East India Company gave their agents an order for "teas of the best kind to the amount of 100 dollars." In 1678 they imported 4,713 pounds, a quantity which appears to have glutted the market for several years. In 1721 the annual import had reached 1,000,000 pounds.

Tea was used in China long before it was cultivated, several varieties of the bush growing wild.

Among the first notices by foreigners of its use — excepting the remarkable one by Herodotus, the father of history, as he has been termed, and his character for truth and veracity becomes more and more established — is the account given by two Mohammedan travelers of the ninth century, translated from the Arabic by Renaudot, "Ancient Accounts": —

"The emperor also reserves to himself the revenues which arise from the salt-mines, and from a certain herb which they drink with hot-water, and of which great quantities are sold in all the cities, to amount to great sums. They call it *sah* (or *tcha*), and it is a shrub more bushy than the pomegranate tree, and of a more taking smell, but it has a kind of bitterness with it. Their way is to boil water, which they pour over the leaf, and this drink cures all kinds of diseases." El Wahab elsewhere describes the infusion as "drunk out of beautiful cups molded of a rare earth, and made almost as transparent as glass."

"These Mohammedan travelers found a country in which letters were cultivated by high and low. There were schools in every town for teaching the poor to write and read, and the masters were paid at the public charge. There was a large literature of printed books. The governmental officers were selected from the literary graduates, and had been for three centuries" (sixth century A. D.). — PROF. SEWALL.

They had also dials, and clocks, moved by weights.

This was the era of Alfred the Great, the most versatile monarch and greatest man of history. It was also the brilliant epoch of the Moorish occupation of Spain, then the gem of Europe. About this time took place the separation of the Greek and Roman churches, and the temporal sovereignty of the latter was assuming its great proportions.

The *brick-tea* or *tile-tea* of China is used universally over Northern Asia and Chinese Tartary. Tea is used as a beverage and also as an ingredient in stews and soups.

"Brick-tea boiled with salt."

"We seated ourselves on a red carpet, and there was soon brought from a neighboring tent, which served as a kitchen, tea with milk, rolls fried in butter [doughnuts], cheese, dried grapes, and sweetmeats."

"Payments in Tartary are made in brick-tea, whether the

article be a horse, a house, or any other commodity. Five bricks of tea represent an ounce of silver." — ABBÉ HUC, Journey in Tartary, 1844-1846.

Another traveler writes: "On the Thibet side of the Himalaya mountains a tribe of wandering traders, called the Hunnias, travel over great distances, living upon brick-tea, which is brought from China, and consists of the coarsest leaves, twigs, and seeds of the tea, pressed by weights into lumps, and rendered more adhesive by a slight admixture of the serum of sheep's blood. Upon this they perform long journeys."

At Kiachta, in 1862, the imports of tea from China amounted in value to 7,748,816 silver roubles, equal in value to $ 5,812,000, as follows: —

Tea	6,851,445 roubles.
Brick-tea	897,371 roubles.

Fig. 6232, from Hooker's "Himalayan Journal," illustrates a brick of tea, two forms of teapot, and a teacup, used by the Thibetans. A tobacco-pipe, two pouches, flint and steel (which

Fig. 6232.

Teapots and Brick-Tea (Thibetan Himalaya).

might readily be mistaken for a knife), and those Oriental substitutes for the knife and fork, the chopsticks, are also shown.

A nourishing mess is prepared from this brick-tea, which is extensively used throughout the colder regions of Asia, by churning up a handful of the leaves with salt, butter, and soda, and boiling the compound, which is served up scalding hot.

Tea is produced in greater or less quantity and perfection in that part of Asia extending from westward of Nepaul to and including the Japanese islands on the east, and embracing in its greatest width more than 20° of latitude, say from 18° to 38° on the continent, and extending to beyond the 40th parallel in Japan. The great center of production, however, is an oval area in the East, lying on each side of the parallel of 30°, extending back some five hundred miles from the coast, its greatest width being somewhat less. Shanghae is on the extreme northeast boundary of this district, where it is terminated by the coast. Attempts have been made, it is said, recently, with considerable success, to introduce the culture of the plant into Ceylon. It has also been cultivated with some success in Northern India.

About 1844, Dr. Junius Smith, of South Carolina, attempted the culture of tea in that State. The plants throve, but the product could not compete in price with that grown by cheap labor in China. In Brazil, the shrub is found to thrive even more luxuriantly than in China, attaining the proportions of a small tree, but the leaf lacks the delicate aroma which distinguishes it on its native soil, becoming harsh and coarse-flavored Within a few years past it has been naturalized in California, where the climate and soil appear propitious.

Though indigenous in China, the native growth there is not much depended on for a supply. On the contrary, the plant is most carefully cultivated, and affords one chief employment to the people of that vast empire. The plant is grown in almost every variety of soil, but that best adapted to it is a light loam, more or less stony, abounding in vegetable mold, and moist but not wet. The seeds are gathered in October, and kept in sand till the following spring, when they are sown, either in rows in the field where they are to grow, or else in beds, from which they are transplanted; if the latter, they are put out the second year in rows three or four feet apart. In growing, they look not unlike a field of currant-bushes with us. They are hardy, yet if the weather is very cold they need protection; if dry, the cultivators resort to irrigation. The gathering of the leaves sometimes commences the third year, though often not till the fourth. There are three or four harvests, — the first, of leaf buds, early in April, though many prefer to forego this, and allow the leaves to grow. If gathered, these buds make the choicest variety of black tea, known as Pekoe. But new leaves soon appear, and a second gathering occurs the last of April, or early in May, which is the principal harvest, and affords a fine tea as the product. A third gathering occurs early in July, which furnishes leaves of an inferior quality; and sometimes there is a fourth gathering in August or September, which furnishes leaves still coarser and poorer. The plants rarely last more than eight or ten years, when they are dug up and replaced with a new stock. In gathering, the leaves are stripped off with much care, and carried to a building where they are assorted and dried.

The drying process varies as to the kind of tea to be produced, for our varieties of green and black tea are not so much the product of different species or regions as results from different ways of curing the same leaf.

The green teas are cured almost as soon as the leaves are brought from the field, being allowed to remain not more than an hour or two thinly spread upon trays, to dry off any superfluous moisture, before they are put into the roasting-pans. These latter have been in the mean time heated by a brisk fire, and into them are thrown a few of the leaves, which are allowed to remain four or five minutes, rapidly shaken and stirred, when they are thrown out upon a table and rolled with the hands. Afterward they are again thrown into a pan, heated by a slow, steady fire, and allowed to remain an hour or an hour and a half, being kept all the time in motion by the hands of the workmen. Sometimes they are thrown upon a table to be rolled a second time. This completes the chief part of the operation, though afterward, when a considerable quantity has thus been finished, it goes through a farther process of winnowing and sifting to separate impurities, and assorting into different varieties, and reheating also, to be sure that the drying is complete.

Teas for home consumption are never colored. Those for export to Europe and America are made more pleasing to the eye, if not to the palate, by the addition of Prussian blue, China clay, turmeric, and a white powder usually composed of kaolin, soapstone, or sulphate of lime. Black-lead and indigo are also employed for coloring and glazing. Rice or paddy husks mixed with fragments of the tea-leaf, and tea-dust mixed with sand and rice-water, known as "Lie tea," are other factitious products designed to "cheer but not inebriate" the outside barbarian.

The *maté*, or Paraguayan tea, is a holly (*Ilex paraguaiensis*), and is gathered in the woods during the whole year. It is kiln-dried, and then powdered in mortars. In use, a quantity of the leaf is placed in a bowl, steeped awhile in cold water, and then boiling water poured upon it. It is imbibed through a tube to avoid drinking the particles of leaf and stem.

The *yaupon* of the Carolinas, called by the South Carolina Indians the *cassina*, is also an *Ilex* (*I. cassine* or *vomitoria*), and has been used from time immemorial by the Southern Indians, the leaf being a valued article of exchange between the Indians of the coast — where it grows — and the tribes of the interior. It is a stimulant, and acts, according to quantity and the condition of the person, as a diuretic or emetic. It formed the "black drink" of the Indian ceremonials. See Lawton's "Travels in Carolina," London, 1709, pages 90, 91. Also Porcher's "Resources of the Southern Fields and Forests," Charleston, 1869, pages 431-433.

It is also used as a substitute for imported tea by the poorer inhabitants of North Carolina in the vicinity of the sounds, and to a small extent forms an article of domestic export.

A list of vegetable substances prepared by infusion for medicinal or stimulating purposes might be extended to an indefinite length. A few of these, in which the mouth acts the part of a teapot, the saliva serving to extract the stimulating principle, form the ordinary solace of no inconsiderable portion of the human race. To say nothing of tobacco, the chewing of which is pretty much confined to the natives of this country, though approaching cosmopolitan universality perhaps among sailors, we have the *betel* of the East Indies, the use of which is very general over a considerable part of the world's surface, and particularly among the Malayan races.

This is prepared from the leaves of several species of pepper, as *Chavica betle*, *Chavica siraboa*, plucked green and spread over with quick-lime (*chunam*), generally prepared from oyster-shells, and wrapped around scrapings of the areca nut (*Areca catechu*). Though too pungent for a European taste, and, it is said, frequently rendering its users toothless by the age of twenty-five, the Malays of all ages generally keep their betel-boxes in requisition from morning till night. It imparts a red color to the saliva and blackens the lips and teeth. Those species of plants of the genus *Chavica*, a division of the pepper family, which yield it, are extensively cultivated. They are climbers, and are trained on poles, trellises, or the stems of palms.

The coca, in general use among the Indians who inhabit the elevated plains among the Andes, is a stimulating narcotic, consisting of the dried leaves of *Erythroxylon coca*, in combination with a peculiar alkaline substance called *clipta*. Provided with a sufficient supply of this drug, an Indian will make an arduous journey of several days' duration without food. Its habitual use is said to be attended with effects analogous to those of opium. The plant is largely grown in the province of La Paz, in Bolivia, forming an important source of wealth to the inhabitants.

A German authority, Von Bibra, in his Preface to "Die narkotischen Genuss-Mittel und der Mensch" (Man and the Use of Narcotics), assumes the following: "Coffee leaves, in the form of infusions, are used by 2,000,000 of human beings; Paraguay tea is consumed by 10,000,000; coca by as many; betel is chewed by 100,000,000; chicory, either pure or mixed with coffee, by 40,000,000; cacao, either as chocolate or in some other form, by 50,000,000; 300,000,000 eat or smoke hashish; 400,000,000 use opium; Chinese tea is drunk by 500,000,000; coffee by 100,000,000. All known peoples of the earth are addicted to the use of tobacco, chiefly in the form of smoking; otherwise as snuffing or chewing."

Alcoholic stimulants are not included in his estimate.

Tear′ing-ma-chine′. A machine for disintegrating woven fabric to make fiber for reworking. It usually consists of a cylinder with sharp-pointed teeth that seize the fabric close to the feeding-rollers, and tear and deliver it into a receptacle.

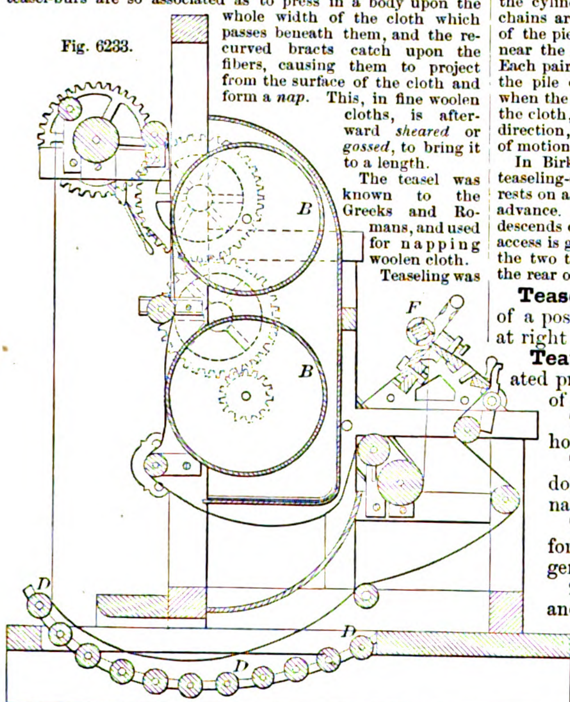
Tears. The vitreous drops from the melting of the walls of a furnace.

Teas′el-ing-ma-chine′. (*Woolen Manufacture.*) A machine in which woolen cloth is teaseled to raise a nap upon it, the ends of the fibers being exposed and laid in one direction, which forms the grain of the cloth.

The teasel (*Dipsacus fullonum*) has large burs with stiff, hooked awns, which are used in raising a nap on cloth. The teasel-burs are so associated as to press in a body upon the whole width of the cloth which passes beneath them, and the recurved bracts catch upon the fibers, causing them to project from the surface of the cloth and form a *nap*. This, in fine woolen cloths, is afterward *sheared* or *gossed*, to bring it to a length.

The teasel was known to the Greeks and Romans, and used for napping woolen cloth. Teaseling was formerly done by hand; a number of teasel-heads being fixed in a small wooden frame with cross handles. The surface of the cloth was worked first in the direction of the warp and then in that of the weft, the cloth being damped. The teasel-heads were cleaned by children with small combs, and when the teasels became damp they were laid aside to dry.

Fig. 6233.

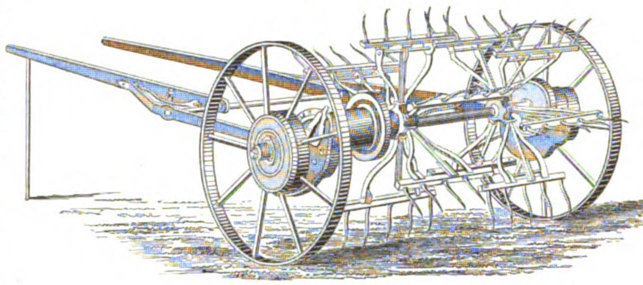


Teaseling-Machine for Finishing Woolen Cloth.

In the *gig-mill* the teasels are arranged in long frames attached to a hollow rotating cylinder, and the cloth by means of rollers is moved in a direction opposite to that of the cylinder, superseding the hand method. See GIG-MILL.

Oldland's teaseling-machine, English patent, 1830, consists of a horizontal, revolving *teasel-frame*, furnished on its under side with teasels, wire-cards, brushes, or other materials used in dressing, or raising the pile of the cloth. The revolving teasels are put in motion by a band on the spindle; and as the cloth is brought under the teasels by conducting rollers, it is pressed up against them by supporters covered with elastic material. There are two teasel-frames in the breadth of the goods, and each of these has a motion from the middle of the goods to the selvage and back again, so that the operation on the cloth is not rectilinear, but by the end motion of the cloth the lines of action continually cross each other at fine angles.

Fig. 6234.



English Hay-Tedder.

Ferrabee's teaseling-machine, English patent, 1830, employs two series of teasels, each attached to an endless chain, which passes around two cylinders, by which it is put in motion, the pile being raised from the middle sloping to the sides. Two of the cylinders which support and give motion to the teasel-chains are placed with their axes extending along the middle of the piece of cloth, and the other two cylinders are placed near the selvages of the cloth with their axes parallel thereto. Each pair of cylinders is made to turn in a direction to raise the pile of the cloth from the middle toward the selvages, when the cloth is at rest; but when an end motion is given to the cloth, the line of action of the teasels assumes an angular direction, whose obliquity is determined by the respective rates of motion of the teasels and the cloth.

In Birkenshaw's machine (Fig. 6233), the axes of the two teaseling-cylinders *B B* are in one vertical plane. The cloth rests on a series of rollers *D D D*, allowing but not forcing its advance. The cloth, after passing over the upper feed-rollers, descends on a series of rollers and goes under a bridge *F*, where access is gained to it by the attendant as it runs in contact with the two teaseling-cylinders. A shearing-cylinder is placed in the rear of the lower teaseling-cylinder.

Tease-ten′on. (*Joinery.*) One on the summit of a post, to receive two beams meeting each other at right angles.

Teat. (*Mechanics.*) A small, rounded, perforated projection, otherwise called a *nipple*, as that of a gun.

Tea-urn. A metallic, vase-shaped vessel to hold hot water for replenishing the teapot.

Teaze-hole. (*Glass.*) (Fr. *tizard*, "fire-door.") The fuel-opening in the glass-furnace.

Ted′der. 1. A rope, strap, cord, or lariat, for fastening an animal by the head to a manger, post, or stake. See TETHER.

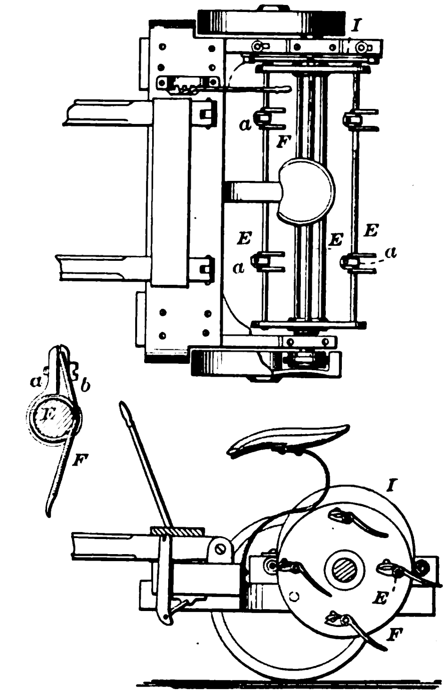
2. (*Agriculture.*) A machine for stirring and spreading hay, to expedite its being dried by the sun and air. See HAY-TEDDER.

The English hay-tedder (Fig. 6234) has two separately rotating cylinders, and is so arranged that the action of the barrels may be easily reversed, so that after the grass has been strewn in the usual way, by reversing the motion, throwing it backward, it is laid very lightly and loosely, permitting more free access of air for drying.

Tedders are classed as *Reels*, *Kickers*, and *Endless* belts, according to their mode of action.

In Fig. 6235, the bars *E* carrying the tedder teeth *F* are connected by cranks to a revolving ring *I* which is confined between two rollers, and so arranged as to cause the teeth to point in the same direction during their entire revolution with the tedder-frame. Screw-clamps *a b* secure the teeth upon the tedder-bars.

Fig. 6235.



Hay-Tedder.

Tedge. The *ingate* or aperture in a mold through which the molten metal is poured. The metal hardened therein is a *sprue*, or *waster*.

Tee. A T-shaped pipe-coupling, adapted for a stem-pipe and two branches.

Tee-ir'on. A rod with a cross-bar at the end, for withdrawing the lower valve-box of a pump.

Teem'ing-punch. One for *starting* or driving a bolt out of a hole. A *drift*.

Teest. A stake or small anvil used by sheet-iron workers. See STAKE.

Teeth. The plural of tooth.

It signifies a row of wires, prongs, or projecting pieces, which have various forms and duties in different tools, implements, and machines, as, —

The teeth of a comb, rake, saw, file, etc.

The wires of a carding-machine or curry-card.

The cog of a gear-wheel.

The tine of a fork. See TOOTH.

Specifically: The lower zone of facets of a *rose-cut* diamond, forming a truncated, pyramidal base for the *crown*, or projecting portion. See DIAMOND.

Teg'u-la. A roofing-tile.

Tein'o-scope. A name given by Sir David Brewster to the prism-telescope.

If a prism be placed horizontally with the refracting edge downward, so that the visual rays from an object enter and emerge from it at equal angles, the object will appear of its natural size; if the refracting edge be turned toward the object, this will appear to be elongated or magnified vertically. A similar prism placed vertically magnifies the object in the direction of its width; and a combination of the two gives an image enlarged in both directions, but fringed with the prismatic colors. This may be corrected by making the prisms of a glass which only transmits one color; by viewing the fringed image through a piece of glass of this kind; or, what is better for most purposes, by using a second pair of similar prisms placed in reversed directions to the first.

Professor Amici, of Modena, used a combination of four rectangular prisms, having their refracting angles different and connected in pairs; the pair nearest the edge are vertical, and the second pair horizontal, so as to produce equal refraction in each direction, the magnifying power being about three times. This plan is well adapted for ordinary glasses.

Tel-a-mo'nes. (*Architecture.*) Male figures serving as columns or pilasters. Somewhat similar are *Atlantes, Persians, Caryatides*, etc.

Tel'e-graph. In a general sense, the word *telegraph* includes all modes of communicating intelligence to a distance. The modes may be classified as, —

1. Visible.
2. Audible.
3. Tangible.

1. Of the first are: —

a. Semaphores; moving or posturing arms (*Chappe's; Pasley's; Popham's*).

b. Arrangement of disks, triangles (*Edgeworth's*), lanterns, arbitrary characters (*Hook's*).

c. Waving flags or torches (*Polybius*) by day or night.

d. Various flags disposed on signal halyards (*Marine Code*).

e. Colored lights.

f. Rockets varying in number or variety.

g. Intermittent flashes of light, from a mirror (*heliotrope*), or a lantern.

h. Puffs of smoke, according to a code.

i. A moving pointer acting by electric impulse (*Wheatstone and Cooke's telegraph*).

j. An adjustable column of liquid (*Percival's hydraulic telegraph*).

k. The printing (*House, Hughes*), dotting, and marking a traveling ribbon (*Morse*), chemical paper (*Bain*), and autographic (*Caselli, Bonelli* telegraphs, which imprint or impress visible characters on paper.

l. The electric telegraph, read by the passage of sparks to a conductor (*Bain*).

2. Of the *audible* may be enumerated: —

a. The clicking (*Morse apparatus*) and its imitations.

b. A bell actuated by electric connections (*Bell*). (*The telegraphic sounder.*)

c. Mechanical, noisy devices; horns, gongs, drums, trumpets, whistles, clappers; some actuated by machinery, as alarms, especially for marine *fog-alarms*. See SIREN.

d. Firing of guns; varied as to intervals or rapidity.

3. Among the *tangible* may be stated: —

a. The Morse instrument read by the pulsations of the armature.

b. An electric telegraph read by the shock transmitted.

The subject of telegraphs is considered under various special titles, and detailed description of each at this place would involve repetition.

See under the following heads: —

Acoustic telegraph.
Alphabet-telegraph.
Annunciator.
Astatic needle.
Autographic telegraph.
Bank-alarm.
Battery.
Beacon.
Bell-telegraph.
Chemical-printing telegraph.
Circuit.
Circuit-breaker.
Circuit-closer.
Commutator.
Copying-telegraph.
Current-regulator.
Disk-telegraph.
Duplex telegraph.
Earth-battery.
Earth-plate.
Electric bridge.
Electric cable.
Electro-chemical telegraph.
Electro-magnetic telegraph.
Field-telegraph.
Fire-alarm telegraph.
Galvanic battery.
Galvanometer.
Galvanometric multiplier.
Heliotrope.
Hydraulic telegraph.
Indicator.
Indicator-telegraph.
Insulator.
Line-wire.
Magneto-electric telegraph.
Manipulator.
Mechanical telegraph.
Needle-telegraph.
Optical telegraph.
Pantelegraph.
Paragrandine.
Paragrele.
Pneumatic telegraph.
Printing-telegraph.
Receiving-magnet.
Recording-telegraph.
Reel-telegraph.
Relay-magnet.
Repeater.
Resistance-box.
Resistance-coil.
Semaphore.
Signal.
Solar telegraph.
Sounder.
Submarine cable.
Submarine telegraph.
Switch.
Symbol-printing telegraph.
Telegraph-alarm.
Telegraph-cable.
Telegraph-clock.
Telegraph-dial.
Telegraphic keyboard.
Telegraph-indicator.
Telegraph-key.
Telegraph-pole.
Telegraph-reel.
Telegraph-register.
Telegraph tariff-indicator.
Telegraph-wire.
Terminal.
Type-setting telegraph.
Writing-telegraph.

A brief summary of the principle and general

method of operation of the electro-magnetic telegraph may not be out of place here. The parts common to all the various forms are :—

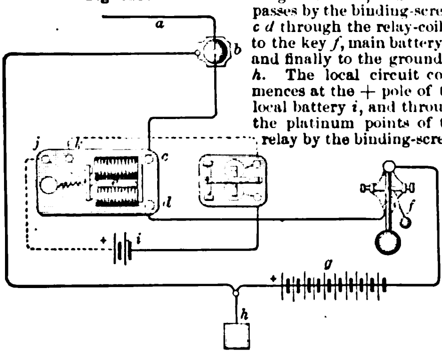
1, a *battery* for generating the electricity ; 2, a *wire* for conducting the current ; 3, a *transmitting instrument*, by which the circuit is made and broken to cause the intermittent impulses which make the signals ; 4, a *receiving instrument*, having a needle or armature which vibrates under the influence of the pulsations of the current.

Various forms of constant battery are used ; one is required at each station for transmission, a pole of each being connected by the wire with the opposite pole of the other ; the other poles are connected with the earth, which completes the circuit. When so arranged, the batteries are said to be reversed. When connection is made between the line wire and the battery at the transmitting station by means of key, lever, or other contrivance, the current flowing through the electro-magnetic coil at this station passes through the wire to another coil at the receiving station, by which it is intensified, regaining a portion of the force which it had lost by the resistance of the wire, and acquires sufficient power to operate the indicating or recording device, having done which it is conducted away to the earth. A current may thus be transmitted to any distance by having *relay* magnets at proper intervals to restore the strength of the current when it becomes enfeebled. The receiving apparatus at any or all intermediate stations may be included in the circuit, so that the dispatch will be repeated at those points, or it may be thrown out of the circuit, so that it will be received only at the extreme end of the line.

When the transmitting apparatus is out of connection with the battery, the current passing from the pole of one battery to the opposite pole of the other is conducted away to the earth. In some forms of telegraph, however, as the fire alarm, the circuit is continuous through the signaling instrument, the signals being made only when this circuit is broken.

Fig. 6236 shows the arrangement of wires, batteries, and instruments for one of the terminal stations of a line. The line-wire *a* first enters the lightning-arrester *b*, and thence passes by the binding-screws *c d* through the relay-coils *e* to the key *f*, main battery *g*, and finally to the ground at *h*. The local circuit commences at the + pole of the local battery *i*, and through the platinum points of the relay by the binding-screws

Fig. 6236.

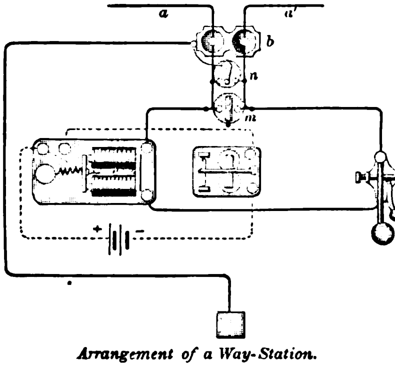


Arrangement of a Terminal Station.

j k, thence through the register or sounder coils *l*, and back to the other pole of the battery.

Fig. 6237 is a plan of the instruments and connections at a way-station. The line-wire *a* passes through the lightning-arrester *b* to the relay *e*, key *f*, back to the lightning-arrester, and thence to the next station. The local circuit is arranged similarly to the preceding. *m* is a *cut-out*, which may be turned so as to directly connect the wires leading into and out of the office, allowing the line-current to pass without going through the office. The *ground-switch n* is used to connect the line with the earth on either side of the instruments at pleasure. It is only used in case of accidents or interruptions on the lines.

Fig. 6237



Arrangement of a Way-Station.

Various as are the forms of telegraphs, and the appliances used in their working, they may be divided into a few general classes, dependent on the manner in which their indications are made.

1. The *indicator* or *needle* telegraph, in which the signals are read from the deflections of a needle to the right or left of a median line ; such is Wheatstone and Cooke's. The submarine telegraph, where the reflecting galvanometer of Thomson is employed, is a variety of this class.

2. The *disk*, *dial*, or "step-by-step" telegraph, having the letters of the alphabet arranged near the periphery of a disk, which is rotated *step* by *step* until each letter of a word is brought opposite an index. The magneto-electric telegraph of this kind is very convenient for local purposes in cities, requiring no battery and no skill in manipulation.

3. The *recording* telegraph, in which dots and dashes, representing the various letters and numbers, are marked by appropriate mechanism upon a strip of paper, as in the original Morse telegraph.

The *electro-chemical* telegraph of Bain and others belongs to this class.

4. The *printing*-telegraph, by which the letters are printed in ink upon a strip of paper, each from its appropriate key at the other end of the line. Such are those of Hughes, House, and others.

5. The *autographic* telegraph, which makes an exact facsimile of the message sent upon a prepared sheet of paper, as those of Caselli and Bonelli. This is a peculiar modification of the electro-chemical telegraph.

6. The *automatic* telegraph was invented by Wheatstone in 1858.

In the modern automatic telegraphic process, telegrams, by a device founded on the idea of the Jacquard loom, may now be committed to a roll of paper, punched with holes instead of letters, and dispatched automatically. The punched roll delivers its message to the instrument without attendance, and the message is printed at the other end of the line at the same time. The advantage claimed for this system is a gain of time, and the liberty to send messages when the line is in the most favorable condition without the assistance of the operator.

A larger number and greater variety of ideas can be conveyed with greater exactness in fewer words in the English language than in any other. Its advantage over French or German, for instance, is said to be from 25 to 33 per cent.

The telegraphs of the world are estimated (Hawkshaw) at 400,000 miles, at $500 per mile = $200,000,000.

The wire is now in all cases, except those of submarine cables, and sometimes in cities, conveyed upon poles. In this country any kind of available wood is used, and in passing through forests the wire is frequently attached to living trees. The poles seldom undergo any treatment for the purpose of preserving them. In England more pains is taken. The timber generally employed is larch treated with sulphate of copper, or red fir creosoted by the Bethel process. When not sulphated or creosoted, they are well seasoned and then painted, the but-ends being slightly charred to a foot above the ground line and tarred. Each pole is provided with an earth-wire or conductor for conveying electricity escaping from the wires in wet weather to the earth. These sometimes project above the tops of the poles, and serve as lightning-arresters.

The poles are also stayed by wire ropes connected to rods inserted in the ground, and in exposed positions double stays are employed.

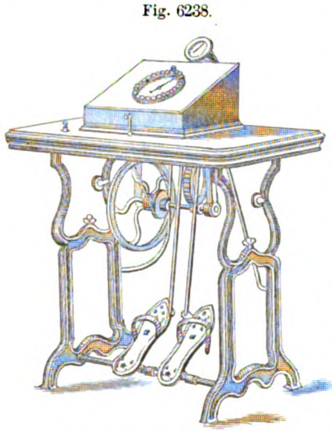
On railway lines the Varley double-cone brown-ware insulator is employed, and on canals and highways the single-cone white-ware or porcelain insulator. The wires are attached to the insulators at every post. What is known as the Britannia joint is exclusively employed for uniting the lengths of wire. This is made by bending the ends of the two wires, placing them side by side for a distance of three inches, binding them together with No. 19 wire, and soldering them.

The *domestic* or *district* telegraph is designed to connect stores, private dwellings, or other houses in cities with a central station, where there is an observer to attend to the messages received. The transmitting instrument is attached to the wall at a convenient place in the house, and connected by a wire leading to the roof, with a wire leading to the station ; it is provided with three knobs or levers, one for sounding an alarm of fire, another for summoning a policeman, and a third for indicating that a messenger is wanted. On either of these signals being transmitted, the requirement is at once indicated and attended to at the central office.

Fig. 6238 is a magneto-electric dial-telegraph adapted for railroads and private business purposes. The electricity is generated by working the treadles which rotate the armatures of the magnets. When the crank at the front of the machine is in upright position, as shown, the alarm from a distant station may be received : it is turned to the right when desired to transmit a message ; in either diagonal position the circuit is

broken, and when turned to the left the circuit is through the indicator only.

Fig. 6238.



Magneto-Electric Dial-Telegraph.

The automatic-alarm telegraph is constructed for "thieves" and for "fire." In one case, the shutters, windows, and doors are so connected with an alarm in an office or the bed-room as to spring an alarm if any of the said objects are tampered with.

In the other case, thermostats are placed at all necessary points, and when at any of these the heat of the room or passage rises a degree or two above the point for which it is set, an electric contact is made and the alarm is sprung.

The following patents of Watkins may be consulted: March 10, 1863; May 10, 1870; January 31, 1871 (six patents); March 28, 1871; October 27, 1874.

The system of *fire-alarm telegraphs*, now so general in large American cities, is referred to on page 849, and the devices on page 1913, REGISTER; page 1918, REPEATER.

One important application of the telegraph is for determining differences of longitude. For this science is largely indebted to Dr. Locke, of Cincinnati, by whom it was successfully practiced as far back as 1848. Cambridge Observatory, Mass., has thus been brought into direct communication with San Francisco by connecting the wire with the pendulum of a clock at Cambridge, so that the main circuit is broken and instantly closed at each oscillation; the moment at which the circuit is broken is noted by the observer at San Francisco, by a clock regulated to local time there, which, being compared with the local time at Cambridge, gives the difference of longitude between the two places. Many other stations, both in Europe and America, have been connected, and their longitudes determined in this way.

The moments of breaking and closing the circuit are practically the same at both places, the velocity with which the current traverses the wire being comparable only to that of light, though Professor O. M. Mitchell determined that a minute though appreciable interval of time elapsed during its passage between two widely separated stations.

The telegraph was first used for military purposes during the Crimean war, 1854-55. Its application for this purpose was greatly extended during our recent civil war, and has now become systematized in the armies of Europe.

In the French army the whole apparatus is carried in a covered carriage, divided into two compartments, one for an office, and the other containing a reel of wire. In the office is a table for supporting the instrument, two accumulators, one for the batteries, and the other for the signal-bells, and a seat for two persons. The reel is supported on its axis in the rear compartment, so that the wire unwinds as the carriage proceeds; it contains 3 kilometres (nearly 2 miles) of wire, and extra reel carriages are provided, each carrying 21 kilometres (over 13 miles) of wire on 7 reels. The wire is composed of 4 copper threads twisted together, and protected by an insulating coating of fiber and india-rubber, so that when laid on the ground it will sustain the passage of vehicles without injury. Poles are used in special cases. Each telegraph-carriage is in charge of a sergeant, two corporals, and twelve men divided into three squads, the first of which goes ahead with the sergeant, traces the line, cuts a trench for the wire, or makes the poles; the second has charge of the reels, and makes the necessary splices, and the third lays the wire or fixes it on the poles. In mountainous countries mules are substituted for the carriage; one carries a small tent, a tripod table, stake, the battery, and tools; another two reels of wire; a third draws a barrow which serves as a reel-frame, which is guided by two men, who carry it in difficult places. See TELEGRAPH-CARRIAGE.

Tel'e-graph'ic A-larm'. (*Telegraphy.*) A sounder operated by electro-telegraphic means.

There are many forms: —

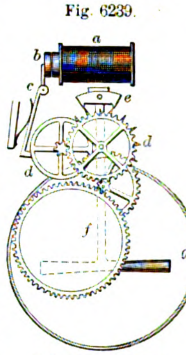
The alarm which runs down, a detent being withdrawn from the escapement. See ACOUSTIC TELEGRAPH, page 11.

The clicking-instrument, operated by successive impulses. This has grown into the ordinary telegraph, which is read by sound.

See also TELEPHONE.

Although Franklin, in 1748, fired spirits by means of a spark transmitted across the Schuylkill, the first distinct plan for a telegraphic alarm to call the attention of an operator or correspondent was by Schweigger, about 1811. He proposed a pistol, charged with a mixture of oxygen and hydrogen gases, to be fired by a spark derived from the long electric wire proceeding from the distant station.

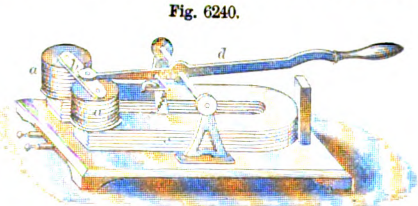
Fig. 6239.



Telegraphic Alarm.

Fig. 6239 is an alarm with an escapement. *a* is an electro-magnet; *b* an armature of soft iron, which is attracted as often and as long as the voltaic current circulates through the coil, but is prevented from coming in actual contact therewith by means of two copper studs tipped with ivory. The armature is mounted on the short arm of a lever *c*, which is normally pressed by a spring so as to engage a stop on the wheel *d*, preventing it from moving. When a current passes through the coil, the armature, being attracted, releases the lever from the stop, and clock-work mechanism operating through the scape-wheel *d* upon the pallets *e* causes the hammer *f* to vibrate, striking each side of the bell *g* alternately.

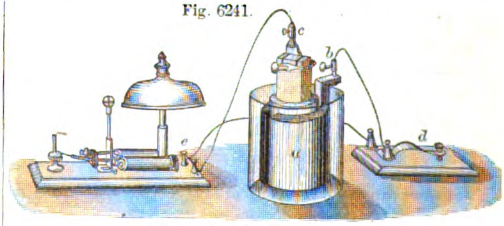
Fig. 6240.



Magneto-Electric Telegraphic Alarm.

In Fig. 6240, the hammer is rung without the intervention of an escapement, by means of a current of magneto-electricity. The cores of two coils *a a* are connected by a bar *b*, and serve as keeper to the horseshoe magnet *c*. On depressing the lever *d*, these are raised from the poles of the magnet, creating a current which passes through the coils and along the line to the bell.

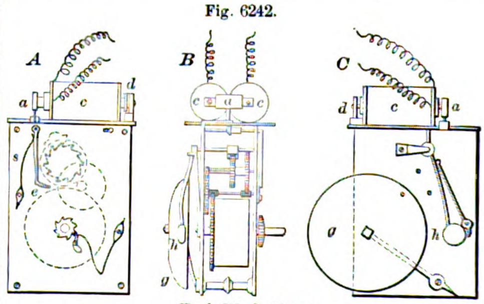
Fig. 6241.



Connection for Bell-Alarm.

Fig. 6241 exhibits the connections for a bell-alarm *a* is the battery; *b*, the zinc-pole; *c*, the carbon-pole; *d*, the key; *e f*,

Fig. 6242.



Clock-Work Alarm.

the binding screws of the bell-magnet. When the key is depressed, the battery current is thrown upon the bell. The three elements of the circuit may of course be separated by any distance within that through which the battery is able to transmit its current. A sounder or register may be substituted for the bell.

In the alarm, of which a side view is shown at *B*, and front and back views at *A C*, Fig. 6242, two electro-magnets *c c*, having their coils connected and wound in similar directions, are joined at one end by a piece *d* of soft iron. At the other end is pivoted a soft iron armature *a*, placed at such a distance as to be strongly attracted by the electro-magnet when the circuit is completed through its coils, and is connected with a detent *e*, which ordinarily engages a fly, but is released when the armature is attracted by the closing of the circuit, allowing a train of clock-work, impelled by a spring or weight to operate, and through the medium of a scape-wheel and pallets, causing the hammer *h* to strike the bell *g*. When the current ceases to flow, the armature is retracted by the spring *s*, again locking the mechanism.

Tel'e-graph–ca'ble. (*Electricity.*) The essential features of a submarine telegraph-cable are a wire or wires for conducting and a protecting compound. To these are added sheathing, to protect against abrasion or other injury, and sometimes material to increase the tensional strength of the cable. With these conditions to meet, there have been numerous patents in the United States and in England, but the patents of the latter country are in such a chaotic condition that it is almost impossible to give an intelligent idea of them. The same invention is the subject-matter of numerous patents, and the futility of many of the devices is only exceeded by the utter looseness with which they have been lapped and piled upon each other.

The inventions concern particularly, —

1. The arrangement of the coated wires in clusters with protecting envelope.
2. Wrapping or enveloping in light material to give buoyancy to the cable, and prevent the parting of the wire when laying it in deep water.
3. Modes of connecting and splicing the ends of sections or lengths of wire.
4. Machinery for constructing the cable; that is, putting on its insulating and preserving covering while the wire is paid off from a reel, or reels.
5. Materials for insulating and modes of applying the materials.
6. Coating and preservative materials over the insulated wire, or clusters of wires.
7. Means and modes of storing.
8. Machines for paying out, registering, and laying.
9. Modes of recovering, under-running, and mending.
10. Transmitting and receiving instruments.

The wires are of copper, frequently tinned, and generally coated with gutta-percha, but preferably with india-rubber. The details are very varied in different establishments, and for different kinds of cable.

In 1839, Dr O'Shaughnessy constructed a telegraph-line 21 miles long near Calcutta, embracing 7,000 feet of submerged wire; this was covered with cotton thread saturated with pitch and tar.

Professor Morse is said to have laid a wire between New York and Governor's Island in 1842.

In March, 1845, Brooman, in England, patented the method now universally employed for preparing gutta-percha; and in September of the same year Bewley patented a machine for making tubing, hose, etc., on the principle of Tatham's American machine for making lead pipe, patented in 1841.

In 1846, Mr. James Reynolds, of New York, invented a machine for covering iron wire with india-rubber, and in 1848, by the aid of this machine, covered a wire with gutta-percha, which was laid between New York and Jersey City.

Telegraphs of wire coated in this way were extensively introduced into Prussia in 1847-48, and in the latter year a gutta-percha covered wire was laid across the Rhine at Cologne by Dr. Siemens.

The first submarine cable ever laid in the open sea was laid between Dover, England, and Cape Grinez, France, in 1850. It was a single strand of wire, 27 miles in length, covered with gutta-percha, unprotected by any outside coating, and worked only one day. The next cable was also laid between Dover and Calais, in 1851. This cable was covered with iron wire, contained 4 conducting wires, was 27 miles in length and weighed 6 tons per mile. It was a permanent success. The next long cable was laid in 1853, between Dover and Ostend, a distance of 80 miles, contained 6 conducting wires, and weighed 5¼ tons per mile. In 1853 a cable of 1 conducting wire was laid between England and Holland, 120 miles, weighing 1¼ tons per mile. This cable worked for 12 years. From 1853 to 1858, 37 cables were laid down, having a total length of 3,700 miles; of which 16 are still working, 13 worked for periods varying from a week to five years, and the remaining 8 were total failures.

An unsuccessful attempt to lay a telegraph-cable between Ireland and Newfoundland was made by the "Niagara" and "Agamemnon" in 1857. In the succeeding year these vessels joined their cables in mid-ocean, and successfully completed the work. On the 16th of August, a message and reply were transmitted between Queen Victoria and President Buchanan. After 23 days, 400 messages having been transmitted, it was found to have lost its conducting power.

The name of Cyrus W. Field is indissolubly associated with the subatlantic cable enterprise.

The cable of 1858 consisted of a

Conductor. A copper strand of 7 wires, 6 laid around 1; weight, 107 lbs. per nautical mile.

Insulator. Gutta-percha laid on in 3 coverings; weight, 261 lbs. per nautical mile.

Outer Coat. 18 strands of charcoal iron wire, each strand made of 7 wires, twisted 6 around 1, laid equally around the core, which had previously been padded with a serving of tarred hemp.

Breaking Strain. 3 tons 5 cwt.; capable of bearing its own weight in a trifle less than 5 miles depth of water.

In 1865, it was attempted to lay a second cable. The operation was intrusted to the monster steamer "Great Eastern," which commenced the work of laying the cable on the 23d of July. After a considerable length had been paid out it parted, and the broken parts could not be recovered. This cable was much stronger than that of 1858, being made up as follows: —

Conductor. A copper strand of 7 wires, 6 laid around 1; weight, 300 lbs. per nautical mile; embedded in Chatterton's compound.

Insulator. Gutta-percha and Chatterton's compound; weight, 400 lbs. per nautical mile.

Outer Coat. 10 solid wires, drawn from homogeneous iron, each wire surrounded with tarred manilla rope, and the whole laid spirally around the core, which had previously been padded with a serving of tarred jute-yarn.

Breaking Strain. 7 tons 15 cwt.; capable of bearing its own weight in 11 miles depth of water.

Length. 2,300 nautical miles; actually laid, 1,896½ miles.

In 1866 a second attempt was made by the "Great Eastern," resulting in perfect success. She also succeeded in grappling the end of the cable laid the preceding year, and splicing it, so that there were now two lines of transatlantic telegraph. The cable employed on this occasion was similar to that of the year before, but of somewhat greater strength, 8 tons 2 cwt., its length 2,730 nautical miles, of which 1,868¼ miles were laid down, part of the remainder being employed in splicing the cable of 1865.

The distance in each case between the two points connected was about 1,600 nautical miles; the depth of water nowhere exceeding 2.7 miles.

The weight of the second laid (British) Atlantic cable was 2,740 cwt. In laying it while the "Great Eastern" was going at the rate of six knots an hour, the cable passes out at an angle of 6½° only, so that the inclined plane between the ship and the bottom was 17 miles long. The motion of the vessel in rolling, etc., had little effect; the greatest strain never exceeded one tenth of the breaking strength.

The paying-out mechanism consisted of six grooved wheels fitted with brakes; the cable was pressed into the grooves by six riding wheels, also provided with brakes, and kept down by levers and weights on their shafts; these served to keep the cable tight on the paying-out drum, 6 feet 1 inch in diameter, and 1 foot broad; four turns of the cable were taken around this, and it thence passed over a dynamometer wheel, which deflected it by a lever loaded with weights, and finally over a grooved wheel overhanging the stern of the ship. The apparatus subsequently used was similar to this.

The fifth Atlantic cable, between the coast of Ireland and Newfoundland, was laid by the "Great Eastern," assisted by three other steamships, each fitted with laying and picking-up machinery. The work was begun on the 16th June, 1873, and on the 27th the "Great Eastern" reached Heart's Content, Newfoundland, having payed out 1,700 miles of cable in 11 days.

This cable was made at the works of Siemens Brothers, near London, and is composed of a thick central wire, which is passed through a peculiar composition, and afterward surrounded by eleven smaller wires, the whole being cemented together by the composition. It is then coated with gutta-percha, and served with manilla fiber to the diameter of ¾ of an inch; the whole is then covered with ten iron wires spun on, each wire being previously wrapped with hemp, and afterward passed through two tanks, by which it is coated with tar, and finally coiled away in large tanks until wanted for use.

The following is a list of oceanic cables laid throughout the world up to the close of 1874. Those marked thus * are not working at the present time.

OCEAN TELEGRAPH CABLES OF THE WORLD.

Date.	From	Length in Miles.	Greatest Depth in Fathoms.
1850	*Dover, England, to Calais, France	25	30
1851	Dover, England, to Calais, France	25	30
1852	Keyhaven to Hurst Castle, England	3	20
1852	Holyhead, Wales, to Howth, Ireland	65	83
1852	Port Patrick, Scotland, to Donaghadee, Ireland	15	160
1852	Prince Edward Island to New Brunswick	12	18
1853	Denmark across the Belt	18	15
1853	Dover, England, to Ostend, Belgium	76	8
1853	Port Patrick, Scotland, to Donaghadee, Ireland	25	160
1853	*England to Holland	115	23
1854	Port Patrick, Scotland, to Whitehead, Ireland	27	150
1854	Sweden to Denmark	12	14
1854	*Corsica to Sardinia	10	20
1854	*England to Holland	120	30
1854	*Holyhead, Wales, to Howth, Ireland	65	80
1854	*Spezzia, Italy, to Corsica	110	325
1854	Holyhead, Wales, to Howth, Ireland	65	83
1855	*Sardinia to Africa	50	800
1855	*Cape Ray, Newfoundland, to Cape North, Cape Breton	74	360
1855	*Sardinia to Africa	160	1,500
1855	*Varna, Turkey, to Balaclava, Crimea	310	300
1855	*Eupatoria, Crimea, to Balaclava, Crimea	60	69
1855	*Varna, Turkey, to Kilia, Roumania	179	30
1855	*Italy to Sicily	5	27
1855	*England to Holland	123	23
1855	*England to Holland	119	23
1856	*Cape Ray, Newfoundland, to Cape North, Cape Breton	85	300
1856	Prince Edward Island to New Brunswick	12	14
1856	*Crete to Alexandria, Egypt	350	1,350
1856	Crete to Syra	170	1,020
1856	St. Petersburg to Cronstadt, Russia	10	10
1856	Across Amazon	105	—
1857	*Sardinia to Bona, Africa	150	1,500
1857	*Sardinia to Malta	500	1,000
1857	*Corfu to Malta	500	1,000
1857	*Portland, England, to Alderney	69	60
1857	*Alderney to Guernsey	17	44
1857	*Guernsey to Jersey	15	60
1857	Ceylon to Hindostan	30	45
1857	Ceylon to Hindostan	30	40
1858	*Italy to Sicily	8	40
1858	England to Holland	129	27
1858	*England to Emden, Germany	280	28
1858	*Ireland to Newfoundland	2,036	2,400
1858	*Turkey to Smyrna *via* Archipelago	565	1,100
1859	*Crete to Alexandria, Egypt	150	1,600
1859	*Singapore to Batavia	630	20
1859	Denmark to Heligoland	46	28
1859	*Cromer, England, to Heligoland	328	30
1859	Isle of Man to Whitehaven, England	36	30
1859	Sweden to Gottland	64	70
1859	Folkestone, England, to Boulogne, France	24	30
1859	Malta to Sicily	60	75
1859	Jersey to Pirou, France	21	10
1859	*Otranto, Italy, to Aviano, Turkey	50	400
1859	*Ceuta, Africa, to Algesiras, Spain	25	700
1859	*Cape Otway, Circular Head	240	60
1860	Great Belt, Denmark (2 cables)	14	18
1860	*Dacca, Hindostan, to Pegu	116	50
1860	*Port Vendres, France, to Algiers	520	1,585
1859 and 1860	*Suez, Egypt, to Cassire, Egypt	255	Shallow water.
1860	*Suakin, Red Sea, to Cassire	474	
1860	*Suakin, Red Sea, to Aden, Arabia	627	
1860	*Aden, Arabia, to Hellania, Arabia	718	
1860	*Hellania, Arabia, to Muscat, Arabia	486	
1860	*Muscat, Arabia, to Kurrachee, India	481	
1860	*Barcelona, Spain, to Mahon, Minorca	198	1,400
1860	*Minorca to Majorca	35	250
1860	*Iviza to Majorca	74	500
1860	St. Antonio to Iviza	76	450
1861	Corfu to Otranto, Italy, about	90	1,000
1861	*Malta to Tripoli, Africa	230	335
1861	*Tripoli, Africa, to Bengazi, Africa	508	420
1861	*Bengazi, Africa, to Alexandria, Egypt	593	80
1861	Dieppe, France, to Newhaven, England	80	25
1861	*Toulon, France, to Corsica	195	1,550
1862	Wexford, Ireland, to Aberman, Wales	63	50
1862	Lowestoft, Eng., to Zandvoort, Holland	125	27
1863	*Cagliari, Sardinia, to Sicily	211	1,025
1864	*Cartagena, Spain, to Oran, Africa	130	1,420
1864	Gwadur, India, to Elphinstone Inlet, India	357	437
1864	Mussendom, Persia, to Bushire, Persia	393	97
1864	Bushire, Persia, to Fao, Persia	154	19
1864	Gwadur, India, to Kurrachee, India	246	670
1864	Otranto, Italy, to Aviano, Turkey	50	347
1865	*Bona, Africa, to Sicily	270	250
1865	Trelleborg to Rugen, Germany	55	80
1865	South Foreland, England, to Cape Grinez, France	25	30
1866	Ireland to Newfoundland	1,896	2,424
1866	Ireland to Newfoundland	1,852	2,424
1866	Lyall's Bay to White's Bay	41	50
1866	Crimea to Circassia	40	..
1866	Colonia to Buenos Ayres	30	4
1866	England to Hanover	224	27
1866	Cape Ray, Newfoundland, to Aspee Bay, Cape Breton	91	200
1866	Leghorn, Italy, to Corsica	65	100
1866	Persian Gulf	160	110
1866	*Khios to Crete	200	1,200
1867	South Foreland, England, to La Panne, France	47	28
1867	Malta to Alexandria, Egypt	925	2,000
1867	Havana to Key West, Florida	125	20
1867	Key West to Punta Russia, Fla	120	20
1867	Placentia, Newfoundland, to St. Pierre	112	76
1867	St. Pierre to Sydney, Cape Breton	188	250
1867	Arendal, Norway, to Hirtshals, Denmark	66	110
1868	Italy to Sicily	5	40
1868	Havana to Key West, Florida	125	..
1869	Peterhead, Scotland, to Egersand, Norway	250	70
1869	Grisselhamm, Sweden, to Nystadt, Russia	96	47
1869	Newbiggin to Sondervig	334	48
1869	*Black Sea	300	..
1869	*Scilly Isles to Land's End, England	27	40
1869	Malta to Sicily	54	75
1869	Tasmania to Australia	176	..
1869	Scilly Isles to Land's End, England	27	42
1869	*Corfu to Santa Maura	50	160
1869	*Santa Maura to Ithaca	7	180
1869	Ithaca to Cephalonia	7	..
1869	*Cephalonia to Zante	10	60
1869	Bushire, Persia, to Jask	505	97
1869	Brest, France, to St. Pierre	2,584	2,760
1869	St. Pierre to Duxbury, U. S.	749	259
1869	Moen to Bornholm, Sweden	80	28
1869	Bornholm, Sweden, to Libau	230	62
1870	Scotland to Orkney Isles	..	37
1870	Salcombe, England, to Brignogan, France	101	59
1870	Beachy Head to Cape Antifer	70	34
1870	Suez, Egypt, to Aden, Arabia	1,460	968
1870	Aden, Arabia, to Bombay	1,818	2,060
1870	Porthcurno, England, to Lisbon	823	2,625
1870	Lisbon to Gibraltar	331	535
1870	Gibraltar to Malta	1,120	1,450
1870	*Porthcurno to Mid Channel	65	62
1870	Marseilles, France, to Bona, Africa	447	1,600
1870	Bona, Africa, to Malta	386	650
1870	Madras to Penang	1,408	1,284
1870	Penang to Singapore	400	36
1870	Singapore to Batavia	557	22
1870	Malta to Alexandria, Egypt	904	1,440
1870	Batabano, Cuba, to Santiago, Cuba	520	..
1870	Jersey to Guernsey	16	32
1870	Guernsey to Alderney	18	30
1870	Santa Maura to Ithaca	7	180
1870	Zante to Trepito	11	235
1870	Sunium to Thermia	25	160
1870	Patras, Greece, to Lepanto	2	20
1870	Dartmouth, England, to Guernsey	66	58
1870	Guernsey to Jersey	15	32
1870	Porto Rico to St. Thomas	110	22
1870	Santiago, Cuba, to Jamaica	140	..
1870	Portpatrick, Scotland, to Donaghadee, Ireland	25	160
1871	Javea to Iviza	..	430
1871	Majorca to Minorca	35	93
1871	Villa Real to Gibraltar	155	84
1871	Marseilles, France, to Algiers, Africa	447	1,625
1871	Singapore to Saigon, Cochin China	620	60

Date.	From	Length in Miles.	Greatest Depth in Fathoms.
1871	Saigon to Hong Kong	975	630
1871	Hong Kong to Shanghai	1,100	42
1871	Shanghai, China, to Nagasaki, Japan	1,200	135
1871	Nagasaki to Vladivostock, Siberia		80
1871	Rhodes to Marmarice	22	..
1871	Latakia to Cyprus	86	..
1871	Samos to Scala Nuova	11	82
1871	Myteleni to Aivali	13	33
1871	Khania to Retimo	32	200
1871	Retimo to Khandia	41	152
1871	Khandia to Rhodes	201	600
1871	Khios to Chesmeh	6	33
1871	Zante to Corfu	150	..
1871	Zante to Cephalonia	18	203
1871	Lowestoft, England, to Greitseil, Germany	223	23
1871	Anjer, Java, to Telok Betong, Sumatra	55	50
1871	Banjoewangie, Java, to Port-Darwin, Australia	1,082	1,580
1871	St. Thomas to St. Kitts	133	1,170
1871	St. Kitts to Antigua	90	130
1871	Antigua to Demerara, connecting the West India Windward Islands	1,028	
1871	Porto Rico to Jamaica	582	
1872	Lizard, England, to Bilbao, Spain	460	
1872	British Columbia to Vancouver Island.	18	
1873	Falmouth to Lisbon	850	
1873	Caithness to Orkney	8	
1873	Valentia to Newfoundland	1,900	
1873	Key West to Havana	125	
1873	Placentia, Newfoundland, to Sydney, Cape Breton	300	
1873	Heligoland to Cuxhaven, Germany	40	
1873	England to Denmark	350	
1873	France to Denmark	450	
1873	Denmark to Sweden	12	
1873	Pernambuco, Brazil, to Para, Brazil	1,080	
1873	Alexandria, Egypt, to Crete	390	
1873	Candia to Zante	240	
1873	Zante to Otranto, Italy	190	
1873	Alexandria, Egypt, to Brindisi, Italy	930	
1874	Lisbon to Madeira	633	
1874	Madeira to St. Vincent, Cape de Verd Islands	1,260	
1874	St. Vincent to Pernambuco, Brazil	1,953	
1874	Jamaica to Colon, South America	660	
1874	Pernambuco, Brazil, to Bahia, Brazil	450	
1874	Bahia, Brazil, to Rio Janeiro	1,240	
1874	Italy to Sicily	7	
1874	Jamaica to Porto Rico	582	
1874	Rio Janeiro to Rio Grande do Sul	840	
1874	Rye Beach, U. S., to Tarr Bay, Nova Scotia	550	
1874	Barcelona, Spain, to Marseilles, France	200	
1874	Shetland to Orkney	60	
1874	Valentia to Newfoundland	1,900	

United States vessels have lately been employed in taking soundings for the Pacific cable.

When this line of telegraph is laid, its length between the terminal points, namely, San Francisco and Yokohama, will be 5,573 nautical miles. The cable will, however, be divided into three sections, — from San Francisco to Honolulu, 2,093 miles; from Honolulu to Midway Island, 1,220; and from Midway Island to Yokohama, 2,260 miles.

a, Fig. 6243, is the Ohio River cable. It is composed of an interior wire of No. 10 Swedish iron, surrounded by three coats of gutta-percha and three of Osnaburg, the whole inclosed in No. 10 longitudinal wires, and lashed with one of similar size.

b is the Hudson River cable. It has three No. 10 conducting wires, each insulated by a gutta-percha covering inclosed in the same material, and is wrapped with tarred yarn.

c is an improvement on this, the wires being separated by solid gutta-percha incorporated in one mass with that which envelops all three. This is covered with tarred hempen twine.

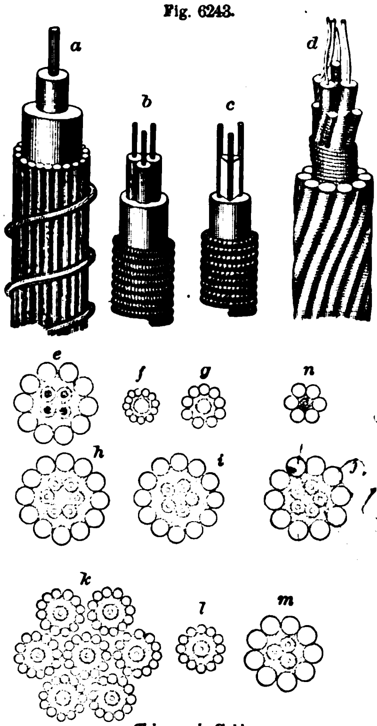
d e is the Dover and Calais cable, the first of importance laid in Europe, composed of four interior copper wires surrounded by gutta-percha covered with spun yarn. Ten galvanized wires were then twisted around the whole. Its length was 25 miles.

The next in order of time was the Holyhead and Howith cable, connecting England and Ireland. This had but one conducting wire. The shore ends were larger than those laid in deep water; *f* and *g* show the relative sizes. The distance between the two connected points is 60 miles; 10 additional miles of cable were constructed to meet contingencies.

h is the cable which it was attempted to lay down between Portpatrick and Donaghadee, Scotland and Ireland, in 1851. Owing to a gale, it was cut when 16 miles had been paid out. It was subsequently recovered in 1854, the depth of water being 150 fathoms, and found in good preservation.

i and *j* are the cables connecting Dover and Ostend, and Portpatrick and Donaghadee. These two cables are precisely similar in size and general construction, each having six wires; some improvements, however, have been introduced into the latter.

Fig. 6243.



Telegraph-Cables.

k is the shore end of the cable between Orfordness and the Hague. Each cable is composed of a single wire, the whole being brought together near the shore and twisted into one.

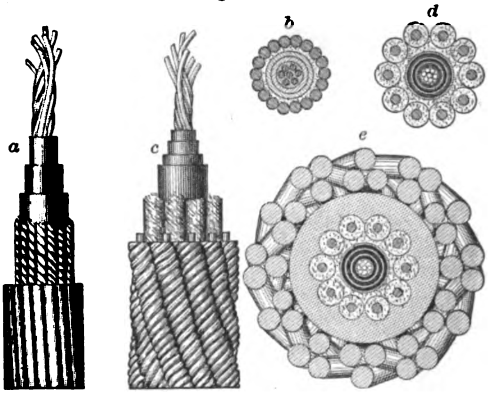
l, the cable between Prince Edward's Island and New Brunswick.

m, that across the Great Belt, in Denmark.

n, that across the Mississippi at New Orleans, on the Balise line.

The Malta and Alexandria cable (*a b*, Fig. 6244) is composed of seven copper conducting wires, over which are three layers of gutta-percha and one of tarred yarn, the whole inclosed by eighteen iron wires. The diameter of the deep-sea portion is .85 inch.

Fig. 6244.



Malta and Alexandria Cable.

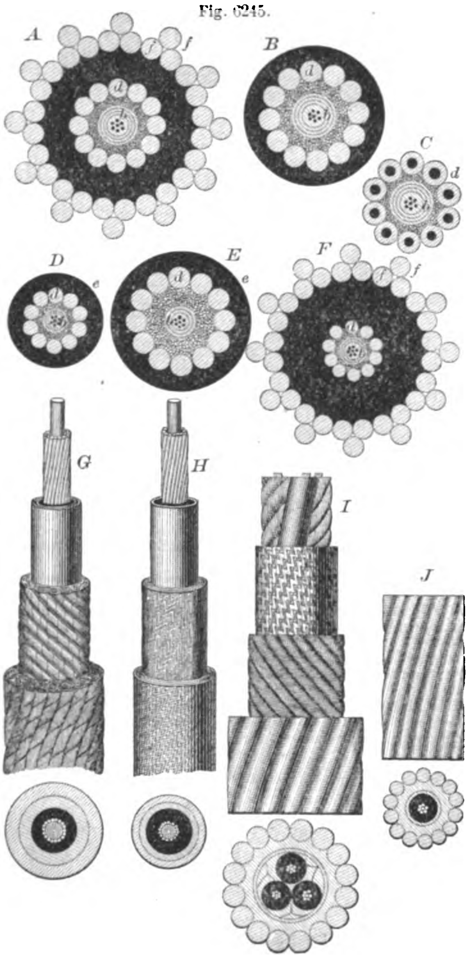
c d, the last four cables laid down between Ireland and Newfoundland. The seven wires of the core are each 0.048 of an inch in diameter, that of the whole strand being 0.144 of an inch, weighing 300 pounds to the mile.

The conductor is insulated by four layers of gutta-percha, alternating with thin layers of Chatterton's compound, the total diameter of the core being .464 inch. The sheathing consists of ten steel wires, 0.095 inch in diameter, each surrounded by five strands of tarred manilla hemp, and wrapped spirally round a covering of tarred jute yarn which surrounds the core. The weight in air is 4,000 pounds; in water, 1,568 pounds to the nautical mile.

e is a section on the same scale of the shore end of this cable.

The French Atlantic cable was laid by the "Great Eastern" in 1869. It is made in sections varying somewhat in size and mode of manufacture. The illustrations (Fig. 6245) are from "Engineering," and are one half (linear) the exact size.

Fig. 6245.



Submarine Telegraph-Cables.

A is a section of the shore ends of the cable between Brest and St. Pierre.

B, the intermediate portion connecting the shore ends to the main portion.

C, the main cable of the Brest and St. Pierre section.

D, the main cable of the St. Pierre and United States section.

E, the intermediate portion of the St. Pierre and United States section.

F, the shore end of the said western section.

The Brest and St. Pierre section weighs 400 pounds per nautical mile.

The western section 107 pounds per nautical mile.

In each case the copper conductor in the center consists of seven wires, six laid around one.

In each of them, —

b is an insulation of alternate layers of gutta-percha and Chatterton's compound, covered by a coating of tanned jute yarn of varying thicknesses in the different figures.

d, galvanized homogeneous iron wires bound with manilla hemp steeped in tar.

e, Clark's compound, consisting of mineral pitch and silica.

f, galvanized iron wire.

G H I J illustrate cables made by the Bishop Gutta-Percha Company, of New York.

In *G*, the center is an annealed steel wire surrounded by spirally laid copper wires; gutta-percha, $\frac{9}{16}$ inch thick, is laid on in three successive coatings; manilla yarn in a short spiral lay; manilla yarn in a long spiral lay. The annealed steel wire weighs 330 pounds per mile; copper wires, 475; gutta-percha insulation, 475; manilla yarn coating, 750 pounds; total, 2,012 pounds per mile.

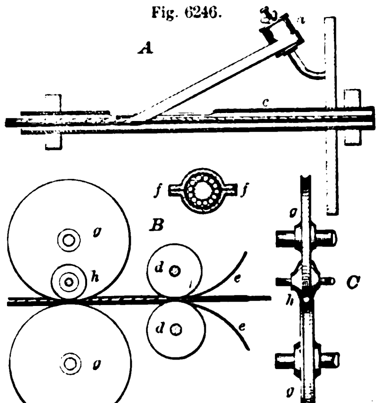
H is made in the same manner, except that instead of the manilla yarn two coatings of woven flax banding well saturated with tar are laid on spirally one over the other. Over this are put two coatings of Bishop's patent compound. This cable weighs 1,513 pounds to the mile.

I is a three-conductor cable, each strand being composed of nineteen copper wires twisted and insulated by gutta-percha $\frac{1}{8}$ inch in thickness, covered by woven banding and hemp tarred; the whole is surrounded by 16 No. 3 galvanized iron wires laid on spirally. This cable weighs 15,100 pounds to the mile.

J, a single-conductor cable, composed of nineteen copper wires similarly insulated and covered, and protected by 14 No. 7 galvanized iron wires laid on spirally. Its weight per mile is 5,850 pounds.

When rubber is employed for coating cables, an apparatus like that shown in Fig. 6246 is used. The rubber in very thin strips is wound upon a reel *a*, rotatable on a spindle. The

Fig. 6246.



Telegraph-Cable Apparatus.

wire is drawn through a slotted tube *c*, the rotation of which winds the strip upon the wire.

A second coating is put on by the apparatus *B C*. Here the wire having received the first coat is drawn by the rollers *d d* between two thin strips of rubber *e e*, the edges of which are compressed together, forming a flange on each side, as shown at *f f*. This is removed by passing it through two grooved rollers *g g*, the lower one of which acts against the two cutting edges of a disk *h*. A third coat is laid on by a similar machine.

A. F. Jaloureau of Paris has patented in the United States a method of forming telegraphic cables by the application of successive layers of bitumen, separated and maintained by spiral bands of bitumenized paper, and consolidated by coils of bitumenized twine or yarn, the whole protected, when necessary, by an outer covering of metallic wire.

In the machine for effecting this (Fig. 6247), the central wire core from the drum *A* is drawn longitudinally through the axis of a wheel carrying two bobbins *G*, by which the interior layer of wrapping-twine is applied, then over a boiler containing heated bitumen, which is applied to the twine by a roller on the longitudinal shaft of the machine; then alternately through the axes of wheels carrying bobbins *D D'*, etc., by which strips of paper are spirally wound on and over troughs of molten bitumen, which is applied by a roller as before.

A final covering of spirally laid twine is applied by bobbins on the wheel *C'*, which is coated with bitumen as the cable passes over another cistern. It is then drawn through a sand-tank *F*, and finally between pressure and tension rollers *G N O*, which extend and compact it. If desired, an outer layer of protecting wires is laid on by an additional wheel with bobbins similar to that employed in laying on the twine.

For raising a cable, grapnels with four prongs attached to a stout chain twenty or thirty fathoms long, connected to a long rope, are used for finding it and bringing it to the surface in the first instance; the end is then passed through a sheave, and conducted to a drum, rotated by the engine around which it is wound. In shallow waters, underrunning the cable is sometimes resorted to.

The drag-rope, in comparatively shallow water, is three or

four times the depth. For the Atlantic cable, the length of rope exceeded the depth by one fifth only.

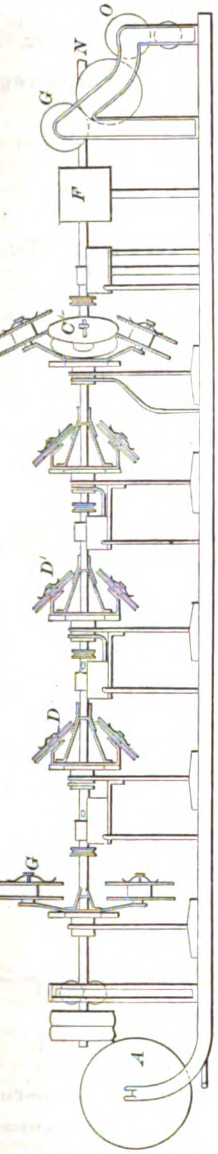


Fig. 6247.

The ship is run several miles to windward of the supposed position of the cable, and the drag being thrown out, she is allowed to drift broadside to, until by the increased strain shown by the dynamometer it is inferred that the cable has been hooked. The cable of 1865 was recovered in 1,900 fathoms of water; at this depth the strain on the dynamometer, due to the weight of the drag-rope, 2,300 fathoms in length, was $7\frac{1}{2}$ tons, increasing at times to $8\frac{1}{2}$ or 9 tons, according to the motion of the vessel; when the steady strain on the dynamometer exceeded this amount, it was assumed that the cable had been hooked; hauling

Machine for Manufacturing Telegraphic Cables.

in occupied five or six hours. When at the surface, the tension on the cable was nearly up to its breaking weight. It was grappled ten times, and several times raised a considerable distance, escaping from the grapnel, having been twice brought to the surface before the splicing was effectually accomplished.

Fig. 6248 illustrates the manner in which messages are transmitted through the Atlantic telegraph. *a* is the sending-battery; *b b'*, earth-plates; in this case, wires leading into the ocean. The current passes from the battery to the transmitting-lever *c*, and thence through the cable *d* to the point *e* at the receiving-station; here it divides, the greater portion passing through the galvanometer to the condenser *g*, an arrangement of mica plates and tin-foil acting as a Leyden jar. The remainder is conducted through the resistance-coil *h* to the earth-plate *b'*. This continues until the condenser is charged and the galvanometer-needle is no longer deflected. By depressing the lever *c*, its end is brought in contact with the earth-wire; a portion of the electricity stored up in *g* is transmitted back through the cable, taking the galvanometer in its way, and deflecting the needle, which carries a mirror, serving to indicate the letters. See REFLECTING-GALVANOMETER.

The transmission of electricity through a submarine cable is found to be a gradual rather than an instantaneous process. When a signal is made at one end of either of the Atlantic cables, no

Fig. 6248.

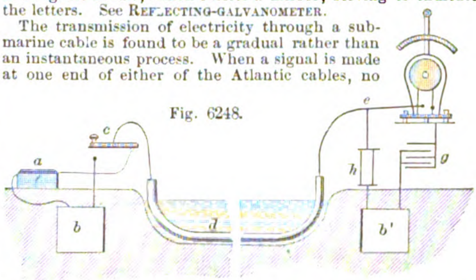


Diagram to Represent the Working of the Submarine Telegraph.

effect is experienced at the other for about .2 of a second; after .4 of a second, the current received attains about 7 per cent of its maximum intensity; in one second, about half; and not until the expiration of three seconds does it attain its full strength. To enable the operator at the receiving-station to translate the vibrations thus produced into the letters of the alphabet is the office of Sir William Thomson's REFLECTING-GALVANOMETER (which see).

Tel′e-graph-car′riage. A vehicle provided with the apparatus necessary for opening temporary communication with a permanent line. Fig. 6249 illustrates a form of carriage used by the postal department in England. This carries one of each of the different kinds of instruments employed, — six in number, — nearly 150 battery-cells, a proper quantity of telegraph-cable, and has accommodations for eight operators. It is used in military operations, at agricultural shows, races, etc., where no line of telegraph is immediately at hand.

The army-telegraph service is an important feature in most of the large European armies. A *field-telegraph*. See page 839; and notice under TELEGRAPH.

For account of a field-telegraph, see "Popular Science Review," Vol. XIII., London, 1874, pages 141 - 149.

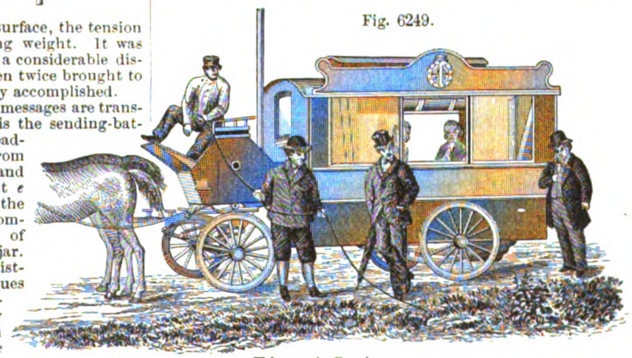
Tel′e-graph-clock. An arrangement by which time is signaled to a number of different apartments in a building or to several buildings.

This may be performed by electro-magnetic devices, or by simply mechanical means. For the former, see ELECTRO-MAGNETIC CLOCK, pages 785, 786.

Fig. 6250 is an example of the latter. A traveling pointer in each room moves over an index-path, which is the substitute for a clock-dial, being drawn by a wire connected to a weight, whose descent is controlled by a clock. Another system of wires connects the striking movement of the clock with the bell-hammer in each room, to strike the hours as they recur, in concert with the striking of the principal clock.

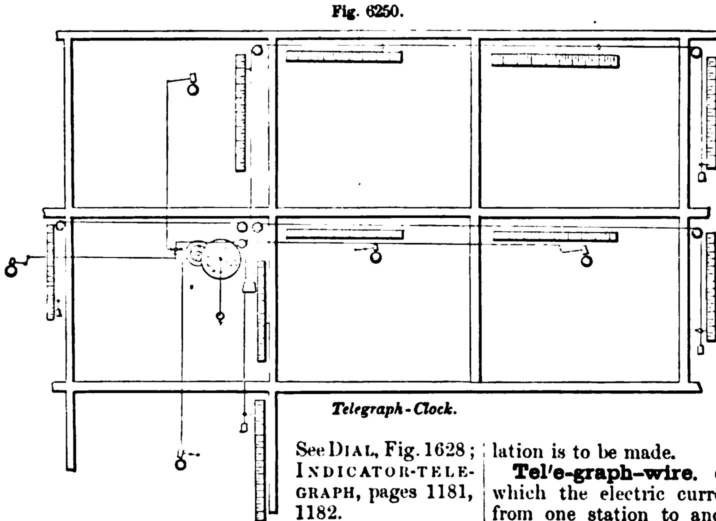
Tel′e-graph-di′al. A circle on which are arranged the letters of the alphabet, figures, etc., the hand or pointer being operated by electro-magnetic action.

Fig. 6249.



Telegraph-Carriage.

Fig. 6250.



Telegraph-Clock.

See DIAL, Fig. 1628; INDICATOR-TELEGRAPH, pages 1181, 1182.

Tel'e-graph'ic Key-board. The bank of keys of a printing-telegraph machine. See Fig. 3960, page 1802.

Tel'e-graph'ic Sig'nal. An alarm or visual indicator, usually set in motion by electro-magnetic means. See TELEGRAPHIC ALARM; SOUNDER.

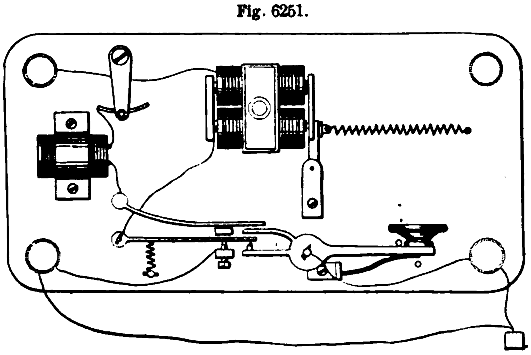
Tel'e-graph-in'di-cat'or. A pointer-telegraph. See INDICATOR, Fig. 2669, page 1181.

Tel'e-graph-in'stru-ment. A moving mechanical device used in the electric circuit. A *perforator*, *transmitter*, *receiver*, *relay*, *register*, or what not. See list under TELEGRAPH.

Tel'e-graph-key. (*Telegraph.*) The vibrating piece in a transmitting-instrument, which is touched by the finger to establish an electric circuit. See MORSE ALPHABET, *b*, Fig. 3225, page 1476.

Fig. 6251 shows a key in connection with Farmer's magnetic telegraph for sending messages simultaneously in opposite directions upon a single line of telegraph. Upon the receiving-magnet is a single set of coils, and the key makes two contacts at the down stroke, closing the branch circuit through the receiving-magnet, and the branch through the rheostat, both at once, and at the same time disconnecting the receiving-magnet from the direct ground, and connecting with the ground through the battery. The rheostat branch circuit is broken at the key at its upward stroke. See also Fig. 2744, page 1225.

Fig. 6251.



Farmer's Magnetic Telegraph.

Tel'e-graph-post. One for keeping the wires elevated above the ground and out of contact with surrounding objects, excepting the insulators on the posts.

Tel'e-graph-reel. A device on which the endless slip of paper is wound on a recording-telegraph. A common feature in telegraphs. See *i*, Fig. 3225, page 1476.

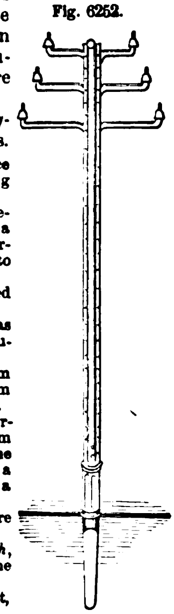
Tel'e-graph-reg'is-ter. (*Telegraphy.*) A recording-device at the receiving end of a circuit. See MORSE APPARATUS, Fig. 3225, page 1476; Figs. 4247, 4248, page 1913.

Tel'e-graph Tar'iff-in'di-cat'or. A means of ascertaining distance, approximately, by a graduated tape-line or rule sweeping from the central position, representing the office whence the calculation is to be made.

Tel'e-graph-wire. (*Telegraphy.*) The road by which the electric current passes from one station to another, the metallic communication between stations, also connecting instruments, battery, and ground. Wire and instruments form the *circuit*.

Wires are attached by *binding-screws* or *terminals* to instruments.

Fig. 6252.



Telegraph-Post.

A *loop* is a wire going out of an office and returning to the same and forming part of a main circuit.

Cross-wires is a metallic connection between two wires, owing to sagging or a blow. *Weather-cross* is a leakage of current from one wire to another, owing to defective insulation in damp weather.

A *return* wire is a *metallic circuit* used instead of the *earth*.

To *disconnect* is to take a wire off, so as to break the circuit, leaving the wire insulated.

To *loop* two wires is to disconnect them from their ordinary places and join them together, so as to form a metallic circuit.

To *cross-connect* wires is to interchange them, so that a current from one wire is shifted to another at one station and then back again at a farther station, to work around a faulty station.

To *put wires straight* is to restore the usual arrangement.

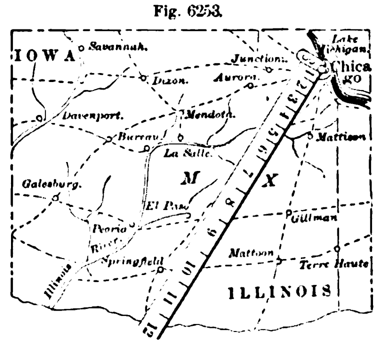
To *ground* a wire, or to *put to earth*, is to make a connection between the line-wire and the earth.

To *open* a wire is to disconnect it, so that no current can pass.

To *shackle* a wire is to cut it and place an insulator between the ends.

Bishop's process for insulating and protecting telegraph-

Fig. 6253.



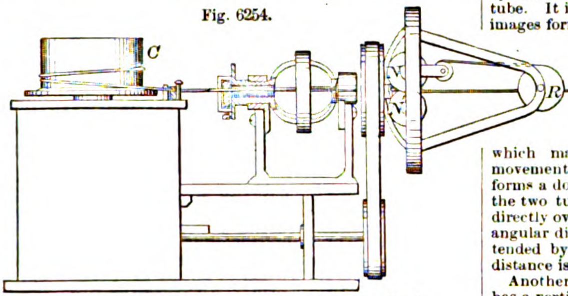
Telegraph Tariff-Indicator.

wire consists in wrapping the wire with a layer of jute, flax, or similar fiber, and applying an exterior coating, composed of asphaltum, 2½ lbs.; gutta-percha, ¼ lb; crude rosin, ¼ lb.; spirits of turpentine, ½ gall; boiled linseed oil, 1 gill; umber, 2 oz. Successive layers of the fiber and compound may be applied.

Moses G. Farmer's telegraph-wire is formed of a core of steel, which is first carefully tinned and then covered with copper, after which the compound wire is tinned, to prevent rusting. See also TELEGRAPH-CABLE.

Fig. 6254 is a machine for covering telegraph-wire with metal. The wire to be covered is drawn along by the rotation of the cylinder C to which it is attached, passing through the hollow axle of the overhung wheel K, to which motion is imparted by belt and pulley. The metallic covering ribbon is wound upon

Fig. 6254.



Machine for Covering Telegraph-Wire with Metal.

the spool R, and, being conducted over a small pulley, passes downward to the wire to which it is spirally applied by the two grooved rollers N N', connected to the wheel K, and revolving therewith. Previous to being wound upon the cylinder C, the compound wire is compelled to pass through a gage.

Tel'e-i-con'o-graph. A combination of the telescope and camera-lucida, invented by M. Revoil.

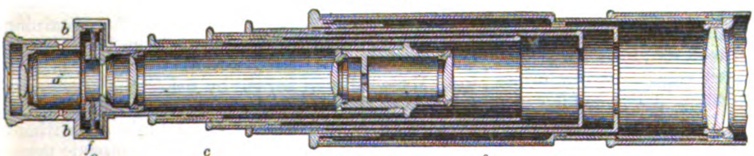
The principle involved is that of allowing the image transmitted by the object-glass of a telescope to pass through a prism connected with the eye-piece. The rays of light that would in the ordinary use of the telescope be transmitted direct to the eye are refracted by the prism, and thrown down upon a table placed below the eye-piece. The distance between the prism and the table determines the size of the image projected on the latter, and it is easy for the observer to trace on a paper placed on this sketching-table the actual outlines indicated by the refracted light. The telescope has both vertical and horizontal motion, and is so constructed that a connected drawing can be made of a larger area than can be included in the object-glass at one view; in fact, an entire panorama can be traced, if the relative positions of the axis of the telescope and the surface of the sketching-table are undisturbed.

Te-lem'e-ter. An instrument for determining the distance of an object whose linear dimensions are known, from its apparent length or hight, when viewed between two parallel wires of a telescope.

A graduated rod has long been used for this purpose in surveying; the number of divisions included between the two wires showing at once the distance in yards, feet, or other units between the rod and the telescopes.

In instruments of this kind used in military operations for ascertaining the distance of troops, the two wires are made to approach or recede from each other; standard distances, the hights of infantry and cavalry, are assumed as bases to which an indicating scale upon the telescope is graduated.

Fig. 6255.



Bardou's Telemeter.

Bardou's (Fig. 6255) consists of a telescope whose eye-tube a is surrounded by a broad flange b marked with a scale c for showing the distance in yards of infantry. An exterior ring f is graduated for showing the distance in yards of cavalry. By means of interior teeth b' on the flange b engaging pinions c c on the screw-pins d d', two wires are caused to approach or recede from each other; when these exactly coincide with the extremities of the object, the number beneath the index o, upon the scales b, indicates the distance if infantry be observed, or upon f if the object be cavalry. g g' are the field-lenses, and h is the object-glass.

Rochon's double-image telescope has within its tube a prism of Iceland spar (a mineral possessing the power of double refraction), which divides the pencil of rays into two pencils diverging from each other at a determinate angle. This prism is, by means of a rack and pinion, movable from end to end of the tube. It is moved back or forth until the edges of the two images formed by the prism are in exact contact, when an index on the slide indicates the distance according to a scale engraved on the outer surface of the tube.

The binocular marine-glass of M. Lorieux, of Paris, is designed to determine distances by the angle subtended by an object of known dimensions. It comprises two telescopes, the axes of which may be thrown out of parallelism by an angular movement around an axis joining the two eye-pieces. This forms a double image of the object, which appears single when the two tubes are parallel. One of these images will appear directly over the other; and when their edges are in contact, the angular distance between the two tubes is equal to that subtended by the object at the eye of the observer, whence the distance is readily inferred.

Another form of telemetric marine-glass by the same optician has a vertical plate on each side of the axis of the object-glass of the telescope. These are made to approach to or recede from each other by means of a right-handed screw on one side, and a left-handed screw on the other, the distance of the object being inferred from the distance apart of the two plates when their edges exactly coincide with the extremities of the object. In later constructions of this instrument, the edges of the plates are placed horizontally, as being generally more convenient.

The prism-telemeter consists of two prisms connected by a measuring-chain or tape-line, serving as a base for the triangle which determines the distance. The two observers face each other. The difference in the apparent direction of the object, as viewed by reflection in the prisms, indicates by a scale attached thereto the distance of the object.

The telemetrical telescope of Captain Gautier, of the French artillery, indicates the distance of an object by the angles formed by it at two different stations successively. The object is viewed by reflection from a prism which causes a known deviation, 3°, in its apparent direction, and from two opposite mirrors, all in the tube of the instrument.

An electric telemeter for ascertaining the distances of objects in motion has been invented by Captain Kocziczka, of the Austrian engineer corps.

Two points of observation at a known distance apart are connected by a telegraph-wire. At each station is a telescope, parallel to the axis of which, and turning with it, is a long thin needle. A second needle turns on a point representing the other station, and is connected with the wire therefrom. When an object is observed simultaneously at each station, the angle formed by the two needles — one following the motion of its own telescope, and the other that of the telescope at the other station, with which it is electrically connected — fixes the position of the object on a plat of the country placed on the table on which the instrument is mounted.

An instrument analogous to this was devised by the Archduke Leopold, to determine the proper time to explode a torpedo when an enemy's vessel passes over it. If a series of torpedoes be arranged in a straight line, one station is placed on the prolongation of this line, while the other commands a cross view of it. When a vessel passes over this line, the observer at the first station touches a key, which closes a circuit passing through both stations. The second observer, having his telescope, which is provided with a metallic arm that touches successively a series of terminals communicating with the conductors, will, at the same moment, by the movement of the telescope, bring this arm in contact with the insulated wire belonging to a torpedo, if the vessel passes directly over it, exploding the charge.

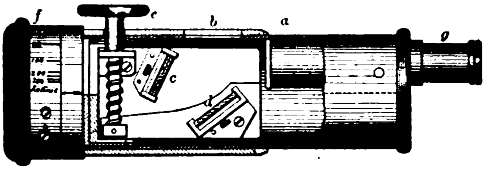
Balbreck's telemetric double-telescope consists of a square tube or box, pivoted on a ball and socket joined at the top of a tripod, and containing two mirrors turning on vertical pivots. These mirrors are partly silvered and partly transparent, and are provided with tangent screws, each carrying a divided circle with an index, by which the amount of movement may be read. Two telescopes enter

the tube at right angles from opposite directions; one at each end just beyond the mirrors. A rectangular glass prism is placed at the focus in the angle to change the direction of the rays. The distance between the centers of the mirrors is one metre. Openings are made in the sides of the box opposite the mirrors to admit light from the object to be observed.

In observing, the box is turned until the object seen by reflection is brought into coincidence with the central line of the telescope at the other end. Through the transparent part of this mirror the object will be seen by reflection, but not on the central line. It is brought into coincidence with this by means of the tangent screw. The box is now revolved 180°, and the object viewed through the other telescope, and adjustments made similar to those first described, the box being turned as before, bringing the second image again to coincide with the first. The divided circle of the first mirror will then show very nearly the true parallax; a correction is, however, necessary if very accurate results are desired.

The telemeter of Captain Gautier, of the French army (Fig. 6256), consists of a tube *a*, having an opening *b* at one side, and containing two mirrors set normally at an angle of 45°, one of

Fig. 6256.



Gautier's Telemeter.

which (*c*) is fixed, and the other (*d*) admits of slight movement by means of a thumb-screw *e*. A ring *f* turning on the axis of the instrument carries a prism, through which an object may be viewed by direct vision.

In measuring distances, the observer selects a distant and well-defined object nearly at right angles to that whose distance is to be determined, and having brought the zero or "infinity" line on the ring opposite an arrow-mark on the tube, he views the first object or "natural signal" by direct vision through the eye-tube *g*, looking over both the mirrors and through the prism. By turning the screw *e*, the image of the object whose distance is sought, and the rays from which, passing through the opening *b*, are reflected from *c* to *d*, and thence to the eye, is brought into coincidence with the natural signal. He then steps back a certain distance, say 20 yards, on the prolongation of the line passing through this first station and the natural signal. This distance, which serves as a base line, should not be less than $^1{}_{100}$ of that of the station from the object whose distance is sought. The reflected image will no longer coincide with the "natural signal" seen by direct vision through the prism. By turning the ring *f* the prism is revolved until its refraction again causes the two images to coincide. The ring is provided with a graduated scale containing a series of factors by which the length of the base must be multiplied in order to obtain the distance of the object. That factor which stands opposite the arrow on the tube is the proper multiplier.

These factors are derived by a simple calculation, from the trigonometrical properties of a triangle supposed to be right-angled at the second station. Should the first and second stations, however, not be precisely in line with the natural signal, a correction may be applied, depending on the amount of this angular variation; but this correction is so small, within the limits of angular measurement, as to be neglected in ordinary practice.

The ring may, on the same principle, by assuming one or more invariable base-lines, be so graduated as to give the distance directly in yards or metres. See also Wilson's United States patent, September 29, 1868, No. 82,669.

Tel'e-phone. An instrument for conveying signals by sound. It may consist of a steam-whistle, a fog-trumpet, or other audible alarm. The term, until lately, has been particularly applied to a signal adapted for nautical or railroad use, in which a body of compressed air is released from a narrow orifice and divided upon a sharp edge, in the manner of a steam-whistle.

The term is now acquiring a different signification.

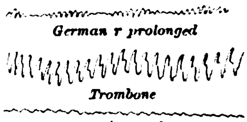
The subject of the number of vibrations per second, as constituting a given note, has been considered under MUSIC, PITCH, PIPE, etc.; and the mode of counting the vibrations under SIREN. The *vibroscope* is another instrument invented by Duhamel for the same purpose. See also METRONOME; TONOMETER.

Articulate sounds are accompanied by the expulsion of air from the mouth, which impulses vary in quantity, pressure, and in the degree of suddenness with which they commence and terminate.

An instrument which will record these impulses has been termed by its inventor, Léon Scott, a *phonautograph*, or *phonograph*, and by Mr. Barlow a *logograph;* the pressure of the air in speaking is directed against a membrane which vibrates and carries with it a delicate marker, which traces a line on a traveling ribbon. The excursions of the tracer are great or small from the base line, which represents the quiet membrane, according to the force of the impulse; and are prolonged according to the duration of the pressure, different articulate sounds varying greatly in their length as well as in intensity; farther, another great difference in them consists in the relative abruptness of the rising and falling inflections, which make curves of various shapes, of even or irregular shape. The smoothness or ruggedness of a sound has thus its own graphic character, independent both of its actual intensity and its length.

Barlow's *logograph*, described in the London "Popular Science Review," Vol. XIII. page 278, *et seq.*, consists of a small speaking-trumpet, having an ordinary mouth-piece connected to a tube, the other end of which is widened out and covered with a thin membrane of gold-beater's skin or gutta-percha. A spring presses slightly against the membrane, and has a light arm of aluminium, which carries the marker, consisting of a small sable brush inserted in a glass tube containing a colored liquid. An endless strip of paper is caused to traverse beneath the pencil, and is marked with an irregular curved line, the elevations and depressions of which correspond to the force, duration, and other characteristics of the vocal impulse. The lines thus traced exhibit remarkable uniformity when the same phrases are successively pronounced.

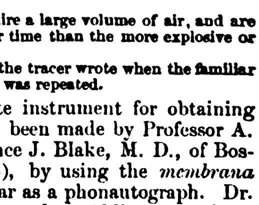
Fig. 6257.



Lines obtained by the Phonautograph.

Fig. 6257 shows curves obtained by Mr. Charles A. Morey by the interposition of a light lever between the membrane and the smoked glass, which is drawn along beneath the style, whose excursions are much magnified by the lever. The curves show respectively the tongue trill or German *r* prolonged, the mark produced by the sound of a trombone, and by the sound of *oo* in mood. See "American Journal of Science and Arts," August, 1874, pages 130, 131.

Fig. 6258.



Logographic Curves.

Fig. 6258 shows a tracing from the utterance of the word "incomprehensibility," with different degrees of effort. It will be noticed that while a certain variation occurs due to the energy, each sound preserves a specific character.

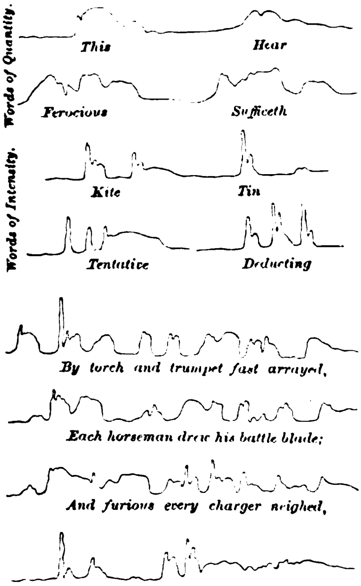
Fig. 6259 shows in the upper portion the effect of words of quantity which require a large volume of air, and are maintained a relatively longer time than the more explosive or intense kind.

The lower diagram is what the tracer wrote when the familiar stanza from "Hohenlinden" was repeated.

A much more delicate instrument for obtaining sonorous vibrations has been made by Professor A. Graham Bell and Clarence J. Blake, M. D., of Boston, Mass. (June, 1874), by using the *membrana tympani* of the human ear as a phonautograph. Dr. Blake's mode of exposing the middle ear without injuring the ossiculæ or the delicate tympanic membrane is described at length in the "Boston Medical and Surgical Journal," February 4, 1875, pages 121 – 123.

The *stapes* was removed, and a short style of hay substituted of about the same weight, so as to increase the amplitude of the vibrations and afford means of obtaining tracings upon smoked glass, as in the phonautograph experiments. The membrane is kept moist by a mixture of glycerine and water, and the speci-

Fig. 6259.



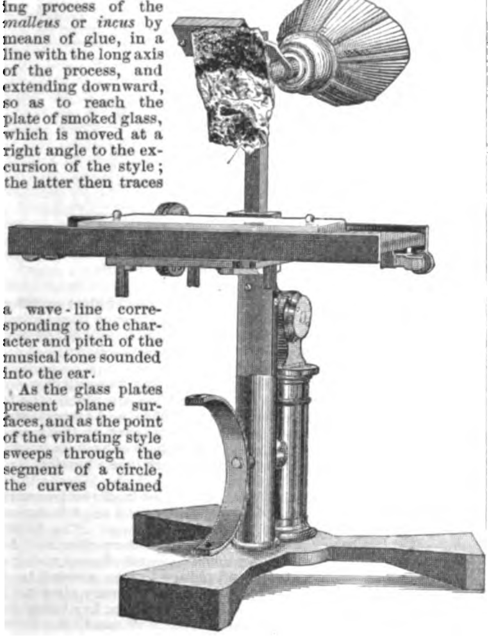
Logographic Curves.

men attached to a perpendicular bar sliding in an upright post, and moved by a ratchet-wheel. To the upright is attached, horizontally, a metallic stage six inches in length, upon which slides a carriage with a glass plate, and having a regular movement given to it by wheel and cord. A bell-shaped mouth-piece is inserted in the external auditory meatus and luted in position.

The vibrations of the membrane due to a musical tone sounded in the bell may be observed by means of a ray of light thrown upon small specula of foil attached to the *malleus*, *incus*, or to different portions of the *membrana tympani*, or may be recorded on smoked glass by a style fastened to the descending process of the *malleus* or *incus* by means of glue, in a line with the long axis of the process, and extending downward, so as to reach the plate of smoked glass, which is moved at a right angle to the excursion of the style; the latter then traces a wave-line corresponding to the character and pitch of the musical tone sounded into the ear.

As the glass plates present plane surfaces, and as the point of the vibrating style sweeps through the segment of a circle, the curves obtained are apt to be discontinuous, especially when the amplitude is great. To obviate this difficulty, a sheet of glass is employed having a *curved* surface, the concavity being presented to the style. The sheet of glass is a section of a cylinder whose semi-diameter is equivalent to the length of the style. In this way the point of the style never leaves the surface of the glass, and the curve resulting from its vibration is continuous. The carbon film is preserved by pouring collodion upon it; as soon as this is dry, the film may be floated off with water and placed upon a plane sheet of glass, or upon paper, and varnished in the ordinary way.

Fig. 6260.



The Membrane of the Tympanum used as a Phonautograph.

See the following works: "Use of the Membrana Tympani as a Phonautograph and Logograph, with Plates," Archive for Ophthalmology and Otology, 1876. "Use of the Membrana Tympani as a Phonautograph and Logograph," Boston Med. and Surg. Journal, Feb., 1875. "Mechanical Value of the Distribution of Weight in the Ossicula," Trans. Am. Otological Society, 1874.

Another step in the direction of the conveyance of sound consists in connecting a membrane in a mouth-trumpet by means of a fine cord with a similar membrane in a trumpet applied to the ear of a person at a considerable distance, say in another room. The sounds are audible, not merely as to pitch, but are recognizable as articulate sounds. The writer knew an officer who was with Nelson at Copenhagen, who was wounded so that his hearing was destroyed. He was in the habit of placing a music-box against his teeth, or holding in his teeth a string whose other end was shut tightly between the lid and the box. He said he *heard* very well.

The experiment of connecting distant sounding-boards, so that one is made to vibrate in unison with the other, is familiar; indeed, the synchronous vibration may be obtained even by the vibrations of the atmosphere, as when the sounds of a piano are repeated by those of a guitar which has been tuned in unison and stood up in the corner of the room. This is even more palpable when the guitar is laid upon the piano top.

"There is an experiment, first made by Wheatstone, where the music of a piano is transferred from its sound-board, through a thin wooden rod, across several silent rooms in succession, and poured out at a distance from the instrument. The strings of the piano vibrate, not singly, but ten at a time. Every string subdivides, yielding not one note, but a dozen. All these vibrations and subvibrations are crowded together into a bit of deal not more than a quarter of a square inch in cross section. Yet no note is lost. Each vibration asserts its individual rights; and all are, at last, shaken forth into the air by a second sound-board, against which the distant end of the rod presses. Thought ends in amazement when it seeks to realize the motions of that rod as the music flows through it." — Prof. Tyndall, in "Martineau and Materialism."

From the mechanical transmission of sounds by the air, string, or wooden rod, we pass by a decided step to devices by which vibrations are made to produce rapid contacts and breaks of an electric circuit, and thus become means of transmitting tones; and, conversely, to means of making rapid contacts, so as to set matter vibrating, and causing it to generate musical tones.

The knowledge that the pitch of tone depended upon the rapidity of vibration was well known to Pythagoras; the generation of sound by motion is familiar in the vibration of strings and wires in the Æolian harp, and the sound of the wind in a tube. The tuning-fork is so proportioned that it produces sounds of but one *pitch*, while its *timbre* depends on the quality of its material, and its *intensity* upon the amplitude of its vibrations.

Besides the tone generated by the agitation of the atmosphere, it was observed as long ago as 1785, by the Canon Gottoin de Coma, that an iron wire of at least 10 yards in length, when stretched in the open air, spontaneously gives forth a sound under the influence of certain variations in the state of the atmosphere, the effect being due to the transmission of atmospheric electricity. This transmission does not in fact occur in a continuous manner like that of a current, but rather by a series of discharges.

Mr. Beatson has proved that the discharge of a Leyden jar through an iron wire causes this wire to produce a sound if the discharge is first passed through a moist conductor, such as a wet string or animal tissue.

Professor Page in America, De la Rive in France, Gassiot in London, and Marrian in Birmingham, discovered that rods of iron placed in the interior of a helix through which a current of electricity is passed give out decided sounds at the moment when the circuit is made or broken.

Reis applied this discovery in his telephone. By causing the circuit to be made and broken very rapidly, a musical note was emitted by a rod placed in a helix traversed by the current.

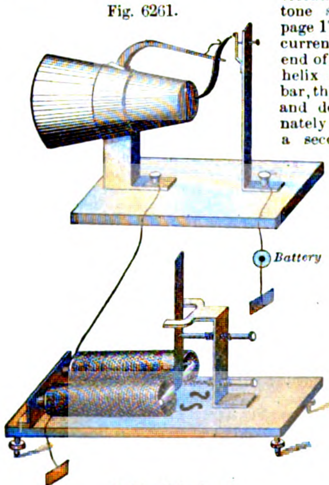
De la Rive found that exactly similar sounds were produced where the intermittent current was passed through the iron rod itself; and Professor Bell has produced similar effects by passing the current through retort carbon, plumbago, German-silver wire, and platinum wire.

In fact, the intermittent current occasions a molecular vibra-

tion in the conductor through which it is passed, whatever may be the material of which it is made, and this vibration may be rendered audible by coiling up the conducting-wire and applying it to the ear; as, for instance, an empty helix of copper wire, through which a discontinuous current is passed.

In the electro-magnetic telephone of Kirpath, the telephone sending-instrument consists of an open funnel in which the tone is sounded, and a diaphragm of thin elastic membrane, which is set in vibration by the tone, and which by its vibrations continually makes and breaks the electric circuit. The number of breaks in a second corresponds with the number of vibrations belonging to the tone sounded (see PIPE, page 1708); and since the current passes at the other end of the line through a helix around a soft iron bar, this bar is magnetized and demagnetized, alternately, as many times in a second as there are vibrations in the tone sounded at the sending-instrument At each demagnetization, a longitudinal shrinkage of the bar occurs, and a resulting sound; this is rendered more audible by placing the bar on a delicate sounding-board, which partakes of the vibrations synchronously with those of the original membrane, and reproduces the same sound.

Fig. 6261.

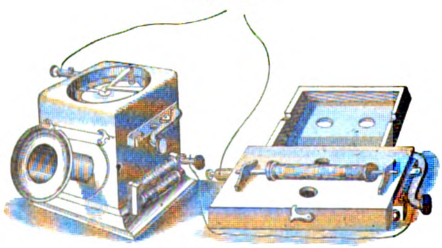


Reis's Telephone.

Fig 6261 shows one of Reis's telephones, used by Legat in his experiments upon *Telephonie*. The discontinuous current, produced by the oscillating lever which vibrates in concert with the membrane on the end of the trumpet, is passed through an electro-magnet (shown beneath), so as to occasion vibration in its armature, which is attached to a sounding-board.

Fig. 6262 principally differs from the other in its receiving-instrument. The intermittent current traverses a coil surround-

Fig. 6262.



Reis's Telephone.

ing a rod of iron, occasioning a molecular vibration in the iron. The resulting sound is rendered more intense by placing the rod and helix upon a sounding-board.

Another form of receiving-instrument is thus described by De la Rive: —

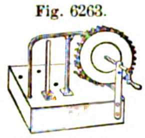
"The most brilliant sound is that which is obtained by stretching upon a sounding-board well-annealed wires, $^1/_{20}$ or $^2/_{20}$ of an inch in diameter and from 3 to 6 feet in length. They are placed in the axis of one or several bobbins, the wires of which are traversed by electric currents, and they produce an assemblage of sounds, the effect of which is surprising, and which greatly resembles that to which several church-bells give rise when vibrating harmonically in the distance"

De la Rive mentions one or two *rheotomes* or *circuit-breakers*, forms of apparatus employed by him in his experiments upon the production of sound telegraphically, for the purpose of making and breaking the circuit very rapidly.

Fig. 6263 is simply a toothed wheel so arranged as to make and break contact with a spring resting against the edge. By giving the wheel a movement upon its axis, we cause the plate to leap from one tooth to another; each leap produces a rupture in the circuit, which is closed again immediately afterward. The musical tone given out by the plate, when we have no other means of measuring it, gives us exactly the number of times that the circuit has been opened and closed, that is to say, interrupted, in a second.

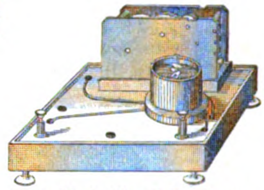
Fig. 6264 is another form of rheotome used by De la Rive, consisting of four needles arranged upon a horizontal rod, so as to dip into mercury alternately when the axis is caused to revolve.

Fig. 6263.



De la Rive's Rheotome.

Fig. 6264.



De la Rive's Circuit-Breaker or Rheotome.

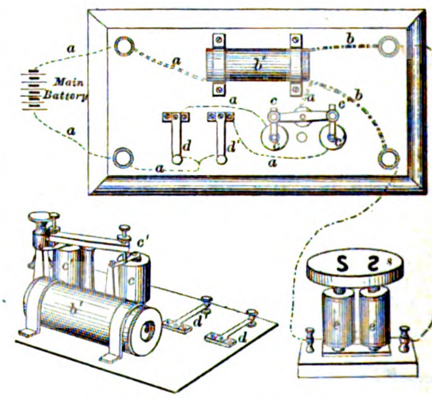
The two needles are inserted perpendicularly and parallel with each other, and so arranged that when they are immersed simutaneously in two capsules filled with mercury, and insulated from each other, the circuit is closed; and when they are not immersed, it is open A clock-work movement, or simply a winch moved by the hand, gives a rotatory movement to the axis; whence it follows that in a given time — a second, for example — the circuit may be closed or interrupted a great number of times.

Attention has long since been directed to the utilization for telegraphic purposes of the means afforded and effects elicited by the numerous observers and experimenters in this branch of acoustics.

It is well known that many distinct sounds pass through the air simultaneously without interference, and that the ear is capable of receiving several impressions at the same time, or is capable of directing its attention to one set alone, as when one listens to an alto alone of a quartette, oblivious at the time of the other voices, though not perhaps of the words of a friend seated by one's side.

Gray's electro-harmonic telegraph is founded upon the principle before stated, that an electro-magnet elongates under the action of the electric current, and contracts again when the cur-

Fig. 6265.



Gray's Electro-Harmonic Telegraph.

rent ceases. Consequently, a succession of impulses or interruptions will cause the magnet to vibrate, and if these vibrations be of sufficient frequency a musical tone will be produced, the pitch of which will depend upon the rapidity of the vibrations.

By interrupting an electric current at the transmitting end of a line with sufficient frequency to produce a musical tone by an instrument vibrated by said interruptions, and transmitting the impulses thus induced to an electro-magnet at the receiving end of the line, the latter will vibrate synchronously with the transmitting-instrument, and thus produce a musical tone or note of a corresponding pitch.

The instrument shown in Fig. 6265 consists of the transmitting-apparatus mounted on a base board, and a receiving-apparatus, shown in a position beneath the former The induction-coil b' has the usual primary and secondary circuits. An ordinary automatic electrotome c has a circuit-closing spring c' so adjusted as when in action to produce a given musical tone. A common telegraph-key d is placed in the primary circuit a a to make or break the battery connection. The key being depressed, and the electrotome consequently vibrated, the interruptions of the current will simultaneously produce in the

secondary circuit $b\,b$ of the induction-coil a series of induced currents or impulses corresponding in number with the vibrations of the electrotome; and as the receiving electro-magnet *e* is connected with this circuit, it will be caused to vibrate by successive elongations and contractions, thus producing a tone of corresponding pitch, the sound of which may be intensified by the use of a hollow cylinder *s* of metal, placed on the poles of the magnet.

When a single electrotome *c* is thrown into action, its corresponding tone will be reproduced on the sounder by the magnet When electrotomes $c\,c'$ of different pitch are successively operated by their respective keys $d\,d'$, their tones will be correspondingly reproduced by the receiver; and when two or more electrotomes are simultaneously sounded, the tone of each will still be reproduced without confusion on the sounder, so that by these means melodies or tunes may be transmitted.

Another system is founded upon the alternate making and breaking of a telegraphic circuit by means of the vibration of tuning-forks or musical reeds, as in Helmholtz's apparatus for the production and transmission of vocal sounds. If a given fork be made to interrupt an electric circuit by its vibrations, and the intermittent current thus produced be passed through a series of electro-magnets, each in connection with a fork of different pitch, and consequently different rate of vibration, only that fork will be thrown into vibration which is in unison with the first one. Practically the time required to do this is a small fraction of a second. The advantages of this method are numerous. Not only may many receiving-instruments at one station be operated, each by its own key, through a single wire, but many different stations in the same circuit may be operated, that one alone receiving the message which has an instrument with the requisite pitch, so as to vibrate in synchronism. Many signals may in this way be transmitted over the same wire at the same time, and many dispatches sent simultaneously to as many stations. All this may be done, too, without affecting the line for its ordinary use.

Three inventors have been and are working at this form of apparatus, — Elisha Gray and A G Bell of the United States, and La Cour of Denmark. See English patents Nos 1,740 and 2,646 of 1874; 947 and 974 of 1874 La Cour, 2,999 of 1874. Gray's United States patents, 166,094, 166,095, 166,096, of 1875; 175,971 of 1876 Bell's patents, 161,739 of 1875; 174,465 of 1876.

In Gray's electric telegraph for transmitting musical tones, the transmitting apparatus consists of a keyboard having a number of electro-magnets corresponding with the number of keys on the board, to which are attached vibrating tongues or reeds, tuned to a musical scale Any one of these tongues can be separately set in motion by depressing the key corresponding to it.

The closing of either of the keys completes the primary circuit from the battery through the electrotome connected with the key depressed, and the circuit-closing spring of said electrotome will immediately be thrown into rapid vibration, and a musical tone of a certain pitch will be given forth, while at each vibration the current in the primary circuit of the induction apparatus will be interrupted. By the usual intermediate means secondary induced currents are transmitted to the receiving station. Thus, for example, if the circuit-breaking spring of the electrotome vibrates one hundred and twenty-eight times per second, the tone given forth is that known as the *fundamental C*, while one hundred and twenty-eight terminal secondary currents will be induced in the secondary circuit of the induction apparatus, and transmitted through the animal tissue, — which may be the human body, — forming part of said circuit, to the resonant receiver, and will, from some cause not understood or explicable in the present stage of the art, vibrate the same synchronously with the transmitting electrotome, and thus give forth a musical tone of the same pitch.

This animal membrane must possess the specific characteristics of being a conductor of electricity; of being yielding and elastic; and of having a surface of greater electric resisting capacity than its interior.

These characteristics are found in the skin of the human body, as shown in Fig. 6268.

The operation of the key and its corresponding electrotome may be more readily understood by referring to Fig. 6266. In this, *a* is a steel reed tuned to vibrate at a definite rate corresponding to its position in the scale. One end is rigidly fixed to the post *b*, while the other end is left free, and is actuated by a local battery. The magnets *e* and *f* are arranged in the same local circuit, magnet *f* having a resistance of about thirty *ohms*, and magnet *e* about four *ohms*. When the reed *a* is not in vibration, the point *c* is in electrical contact with it, which throws a shunt wire entirely around the magnet *f*; thus, practically, the whole of the local current passes through magnet *e* at the instant of closing the key *c*. It is well known that when two electro-magnets are placed in the same circuit, the one which has the higher resistance (other things being equal) will develop the stronger magnetism, and that if the magnet of higher resistance be taken out of the circuit, the force of the other will be increased. When the key *c*, being depressed, closes the local circuit at *d*, the operation of the reed is as follows: The whole of the current from battery *l* passes through the magnet *e*, which attracts the reed say with a power of four. When the reed has moved toward *i* far enough to leave the point *g*, the shunt circuit is broken, and the current flows through both the magnets. Immediately, the power in *f* rises from zero to five, and that of *e* drops from four to one, and the reed is attracted toward *f* with an effective force of four, until contact is again established with the point *g*. The operation is repeated at a rate determined by the size and length of the reed which corresponds with the fundamental of the note it represents.

The main battery is connected as follows: One pole is connected to the ground; the other runs to the instrument, and, entering at binding-screw 4, runs to point *h* of key *c*; from key *c* to point *i*, which makes contact with the reed *a*; from reed *a* to binding-screw 1, and thence to line. It will be seen that when the key is at rest the batteries are open at the points *d* and *h*.

Fig. 6266.

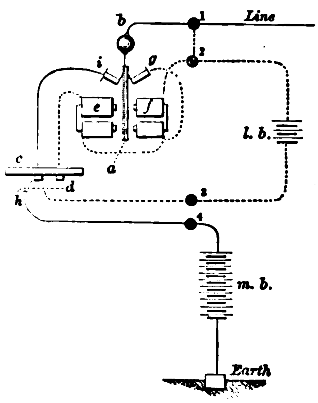
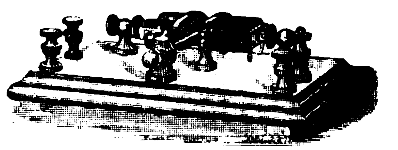


Diagram of Gray's Telephonic Transmitter and Circuits.

The diagram, Fig. 6266, shows but one key and connections, but all the keys in the instrument, whether one or more octaves, have corresponding reeds and actuating-magnets, the only difference being in the tuning of the reeds. There is but one main and one local battery used, and the connections to each key are run in branch circuits from the binding-screws, as shown in Fig 6266. But since all these branches are open at the key-points, neither of the batteries is closed unless a key is depressed.

If now the keys are manipulated, a tune may be played which is audible to the player. When any key is depressed, the local battery sets in vibration its corresponding reed, which sounds its own fundamental note according to the law of acoustics. So far, the instrument is an electrical organ with steel tongues, the motive power being electricity instead of air. The main battery has had no part whatever in its operation.

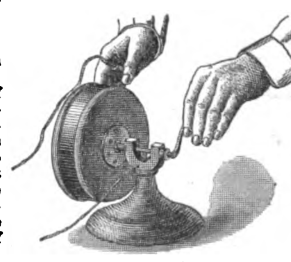
Fig. 6267.



Gray's Telephonic Transmitter, for Composite Tones.

If, however, the main circuit is closed by connecting the distant end to ground, and the point *i* is properly adjusted so that it makes and breaks contact with the reed at each vibration, a series of electrical impulses, or waves, will be sent through the line, corresponding in number per second to the fundamental of the reed, and corresponding synchronous electrical waves can be converted into audible vibrations at the distant end of the line, the note produced being of the same pitch as that of the sending reed.

Fig. 6268.



Gray's Telephonic Receiver.

There are various ways by which these electrical waves may be converted into audible material vibrations. One of them, shown in Fig. 6268, is a thin cylindrical sounding-box, made of wood, the face of which is covered with a cap made of thin metal, electrically connected to the metal stand by means of a wire.

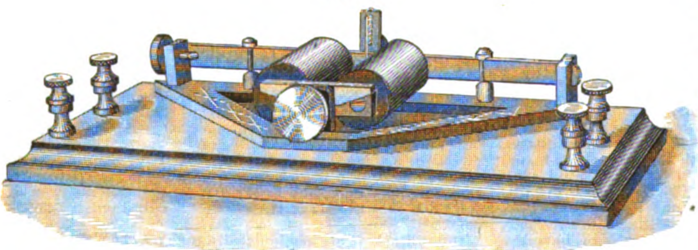
If the operator connects the cap, through the stand, to the ground, and, taking hold of the end of the line with one hand, presses his fingers against the cap, which he revolves by means

of the crank with the other hand, the tune that is being played at the other end of the line becomes distinctly audible, the intensity of the sound being determined by the rate of revolution of the plate. When the motion stops, the sound entirely ceases.

The animal tissue plays a prominent part, as previously stated. If, instead of the revolving plate and the animal tissue, an electro-magnet be placed in the circuit, or a number of them, and a tune be played at the transmitting end, the tune will be heard from all these receiving electro-magnets. These may be on the principle of that shown in Fig. 6265, consisting of a common electro-magnet having a bar of iron rigidly fixed at one pole, which extends across the other pole, but does not touch it by about 1/64 of an inch. In the middle of this armature a short post is fastened, and the whole mounted on a box made of thin pine, with openings for acoustic effects.

So far, consideration has been given to simple tones, but, as in the case of the string and rod referred to previously, a single wire has been found adequate to convey composite tones; a considerable number of tones of different pitch, either in harmony or discord, and the metallic plate or battery of magnets is adequate to translate them. In adapting this principle to a rapid telegraphic system, it becomes necessary to analyze the tones at the receiving end, so that the various messages in the different tones from as many transmitters worked by distinct operators, and all sent to line without any regard to each other, may be sorted at the receiving end by a corresponding number of receiving instruments, each of which shall sound its appropriate message in its own tone, ignoring all the others. The messages, say eight in number, and of as many varying tones, having been simultaneously sent to line, may be said — for the convenience of statement — to be carried as a composite tone to the receiving end, where they pass through a series of receivers, each one of which is in harmony with one of the transmitters. Each receiver sorts out its own message, and among them they may be said to absorb the whole of the vast number of complicated vibrations which have been sent pell-mell through the wire in the form of so many successive magnetizations and demagnetizations.

Fig. 6269.



Gray's Analyzer, or Receiving-Instrument.

Fig. 6269 is a perspective view of one form of a receiving instrument called an *analyzer*. It consists of an electro-magnet adapted to the resistance of the circuit where it is intended to be used, and of a steel ribbon strung in front of this magnet in a solid metal frame, and provided with a tuning-screw at one end, so as to readily give it the proper tension. The length and size of the ribbon depend upon the tone required. If this ribbon be tuned so that it will give a certain note when made to vibrate mechanically, and the note which corresponds to its fundamental is then transmitted through its magnet, it will respond and vibrate in unison with its transmitted note; but if another note be sent which varies at all from its fundamental, it will not respond. If a composite tone is sent, the ribbon will respond when its own note is being sent as a part of the composite tone, but as soon as its own tone is left out it will immediately stop. Thus it *analyzes* the tones which are passing over the line, and selects its own, allowing the others to pass to other instruments with which they are in accord.

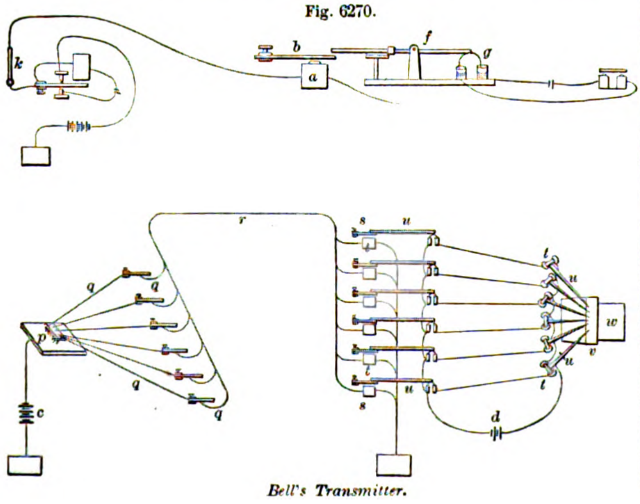
A successful experiment with this system was made at Milwaukee, Wis., on January 8, 1876. A loop was arranged by way of Horicon to Portage and back by way of Watertown, a distance of 200 miles. Over this single wire eight operators sent messages and signals in the same direction at the same time, without any one interfering with another. See for fuller description "Journal of the American Electrical Society," Vol. I. 1875. See also Gray's patent, No. 175,971, dated April 11, 1876.

The same principle has been applied to the transmitting and receiving apparatus of sounding, recording, and printing telegraphs. Bell's patent, No. 161,739, April 6, 1875, comprises a transmitter consisting of a local circuit containing an electro-magnet, with a steel spring armature tuned to a pitch corresponding with a similar armature *b* in the receiver *a*, and vibrating between two platinum points, one communicating with the main line, and the other with the local. The impulses are produced by a key *k*, and are transmitted through the main line to the receiving magnet *a*, the spring armature *b* of which tilts a light, pivoted, non-conducting lever, having at its other end a platinum bow *g* that dips into two cups of mercury and closes the circuit. The wooden lever *f* is balanced so as to vibrate much more slowly than the spring armature by which it is operated, and does not resume its normal position in contact with the latter until this has ceased to vibrate; that is, until the key *k* has been raised.

An autographic telegraph on this principle is composed of a number of these transmitters, the armature of each being connected by a wire with a metallic or conducting bristle mounted in a non-conducting base placed over a metallic plate *p*, with which the bristles are in contact.

The plate is in communication with the main battery *c*. The bristles are insulated from each other, and are placed as near together as possible. From the platinum point with which each transmitter comes in contact in making the circuit, wires *q q* lead to the line wire *r*. At the other end of the line is a series of receiving-instruments *s s* corresponding in number to and having armatures vibrating in consonance with those of the transmitters. Branch wires connect the receivers with the main line wire *r*. In connection with each receiver is a local circuit comprising an electro-magnet *t* and a vibratory lever *u*, one arm of which constitutes the armature of the magnet, and the other arm terminates in a stylus which normally rests upon an ink-ribbon *v* over the bed of the receiving-table *w*. The stylus-armed ends of the levers converge, so as to be in the same relative position, and about as near together as the metallic bristles at the transmitting end of the line. The message to be copied at the receiving end of the line is written or impressed with non-metallic ink on a sheet of metallic foil, and this sheet is placed on the metal plate under the bristles at the transmitting end.

Fig. 6270.



Bell's Transmitter.

The sheet of paper or other material on which the message is to be delivered is placed on the receiving-table *u*, under the stylus-armed levers, and both sheets are simultaneously drawn over their respective tables. So long as the bristles have metallic contact, intermittent electrical impulses from their respective transmitters pass along the line wire and operate the receivers, whose armatures *s s* are attracted, and dip into the mercurial cups, which are in a circuit worked by the battery *d*, lifting the recording ends of the levers away from the ink-ribbon. When, however, the writing comes under the bristles, each, as the metallic contact is interrupted by the interposition of the non-metallic ink, ceases to transmit the electrical impulses, and the circuit-

breaker of the corresponding receiver is raised out of contact with the mercury, the stylus end of the lever comes in contact with the ink-ribbon and causes a mark to be impressed upon the paper underneath. Springs may be employed to give this downward impulse to the levers when the circuit is thus broken. The effect of the alternate elevation and depression of the levers acting upon the ink-ribbon is to reproduce on the receiving-sheet a fac-simile of the writing or object drawn upon the metallic foil at the transmitting end.

Bell's patent, No 174,465, March 7, 1876, describes a method of operating telephonic apparatus by means of undulatory currents of electricity. Instead of making and breaking the circuit, he throws it into waves. He distinguishes three kinds of vibratory currents by which telephonic effects may be produced. 1. *Intermittent;* by making and breaking the circuit. 2. *Pulsatory;* by occasioning *sudden* changes in the intensity of a continuous current. 3. *Undulatory;* by causing *gradual* changes in the intensity of a continuous current. The specification describes the effect upon the current of transmitting a number of musical notes simultaneously by intermittent or pulsatory impulses, and by undulatory currents respectively, and also instances several modes of throwing the current into waves either with or without a battery.

Tel'e-scope. An instrument for magnifying distant objects, so as to make them appear comparatively near.

Gerbert of Auvergne, who taught astronomy in his school at Rheims, observed the stars through a tube, A. D. 1000 He derived it from his tutors at Cordova, and they, no doubt, from the Alexandrian savans. In both places, celestial observations were made through long tubes with object and ocular diopters at the respective ends. No lenses as yet.

Who was the first discoverer of the telescope cannot now be determined. Spectacles were known in the thirteenth century. Roger Bacon employs some expressions indicative of a knowledge of the effect of the combination of lenses. Dr. Dee mentions (1570) that "perspective-glasses" will enable a commander to ascertain the strength of an enemy's forces, referring apparently to an optical instrument then in use.

Baptista Porta said: "If you properly combine a concave and a convex lens, you will see distant and near objects larger and clearer."

Digges states that by an arrangement of mirrors and transparent glasses the image of a small object at a distance may be so augmented as to be brought apparently near to the observer. The matter is restated in a second edition of his works, published in 1591.

Toward the middle of the seventeenth century, Borelli, a Dutch mathematician, interested himself in determining the question of inventorship, and decided in favor of Jansen and Lippersheim, spectacle-makers of Middelburg, Holland, about 1590. Galileo, hearing of the principle of the new wonder, constructed one in 1609, magnifying four times, a second magnifying seven times, and then one magnifying thirty-two times.

It is only fair to give another account, for which we are indebted to Descartes, who lived at about the time when the invention was made public, and had a right to know whereof he affirmed. He says it was made by James Metius, and was due to a fortunate accident. James was a glass-cutter, and had a brother who was a professor of mathematics and a maker of mirrors and burning-glasses. James, it appears, was amusing himself by trying the effect of looking through two glasses, held in line and at a distance, by the respective hands. Fortunately he tried the experiment with a concave and convex glass, which gave the wonderful effect now so familiar. They were fitted in a wooden tube, and made the first telescope ever used in the world, says Descartes. The inventor was a suspicious character, and tried to keep the invention secret even on his death-bed. But his brother and some few others had seen it, and were able to follow the track, which they opened to the world, and which was followed by Galileo. Humboldt says: —

"The accidental discovery of the space-penetrating power of the telescope was first made in Holland, probably as early as the close of the year 1608. According to the latest documentary investigations, this great invention may be claimed by Hans Lippershey (or Laprey), a native of Wesel, and spectacle-maker at Middelburg; Jacob Adriansz, also called Metius, who is said to have made burning-glasses of ice; and Zacharias Jansen.

"Lippershey, on the 2d of October, 1608, offered to the States-General 'three instruments with which one can see to a distance.' On the 17th of the same month, Metius, in his offer to the States-General, states that 'through meditation and industry he had constructed such instruments for two years.' Zacharias Jansen, who, like Lippershey, was a spectacle-maker at Middelburg, together with his father, Hans Jansen, invented the compound microscope having a concave lens for its eye-glass, toward the end of the sixteenth century (probably about 1590), but discovered the telescope only in 1610

"When the news of the recent Dutch invention reached Venice, Galileo was accidentally present; he at once divined what were the essential conditions of the construction, and immediately completed a telescope at Padua for his own use He directed it first to the mountains of the moon, and showed the method of measuring their hights; attributing, like Leonardo da Vinci and Möstlin, the ashy-colored light of the moon to the light of the sun reflected back upon her from the earth. He examined with small magnifying powers the group of the Pleiades, the cluster of stars in Cancer, the Milky Way, and the group of stars in the head of Orion Then followed in quick succession the great discoveries of the four satellites of Jupiter, the two 'handles' of Saturn, — or his surrounding ring imperfectly seen, so that its true character was not at first recognized, — the solar spots, and the crescent form of Venus.

"As early as November, 1610, Galileo wrote to Kepler that 'Saturn consists of three heavenly bodies in contact with each other.' In this observation there was the germ of the discovery of Saturn's ring. Hevelius described, in 1656, the variations in the form of Saturn, the unequal opening of the 'handles,' and their occasional entire disappearance. But the merit of having explained scientifically all the phenomena of the ring of Saturn taken as one belongs to Huyghens (1655). Dominic Cassini first saw the black stripes in the ring (1684), and recognized its division into at least two concentric rings.

"The spots on the sun were first observed through telescopes by John Fabricius of East Friesland, and by Galileo either at Padua or Venice. Fabricius published his discovery in June, 1611, while Galileo did not make his generally known until May, 1612. Galileo noticed that the same spots sometimes returned, and was persuaded that they belonged to the sun itself. The difference in their dimensions when near the center of the sun's disk and on approaching his margin attracted his attention; though it does not appear, from his second letter to Welser, in August, 1612, that he had observed the inequality of the ashy-colored border at the two sides of the black nucleus, when approaching the limb of the sun. Fabricius, like Galileo, recognized the fact that the spots belonged to the sun itself, and also noticed that spots which he had observed disappeared and returned again, and these phenomena taught him the rotation of the sun, which had been conjectured by Kepler before the discovery of the spots. The cycle of admirable discoveries, which scarcely occupied two years, was completed by the observation of the phases of Venus. As early as 1610, Galileo noticed the sickle or crescent form of the planet, and, according to a practice much in vogue in those days, concealed the important discovery in an anagram.

"Huyghens, with an object-glass polished by himself, first discovered one of Saturn's satellites (the sixth) in March, 1655; and from a superstitious notion, entertained by some astronomers of the period, that the number of satellites could not exceed that of the primary planets, did not seek to discover any more of them. Four other of Saturn's moons were discovered by Dominic Cassini: the seventh, or outermost, which has great alternations of brightness, in 1671, the fifth in 1672, and the third and fourth in 1684, with an object-glass of Campani's having a focal length of 100 - 136 feet. The two innermost, or the first and second, were discovered in 1788 and 1789 by Herschel, with his colossal reflector. The second satellite offers the remarkable phenomenon of performing its revolution around the principal planet in less than one of our days.

"The telescopes which Galileo constructed himself, and others which he used for observing Jupiter's satellites, the phases of Venus, and the solar spots, magnified four, seven, and thirty-two times in linear dimensions, — never more.

"The 'Arenarius' of Archimedes says very distinctly that 'Aristarchus had confuted the astronomers who imagined the earth to be immovable in the center of the universe; that this center was occupied by the sun, which was immovable, like the other stars, while the earth revolved around it.'"

Turning the invention to immediate account, Galileo discovered the spots on the sun. On January 7, 1610, he discovered three of the moons of Jupiter, and the fourth shortly after. His discovery of the phases of Venus furnished another proof of the truth of the heliocentric theory. The papal persecution which followed Bruno, who was burnt in 1600, and Galileo, who was denounced in 1616, are familiar to readers. Galileo was visited by Milton while in prison, became blind, then deaf, and died a prisoner of the Inquisition, which followed him after death, denied his right to make a will, to be buried in consecrated ground, or to have a monument. The nineteenth century has attended to the latter duty.

The eye-glasses of the Galilean telescope were double-concave. Kepler first pointed out the possibility of making telescopes with two convex lenses. Scheiner, in 1650, reduced it to practice. De Rheita made one with three lenses; he also made a binocular telescope. The focal length of some of these telescopes was immense. Campani, in 1672, made one for Louis XIV., the focal length of whose object-lens was 136 feet. Auzont had one of 600 feet. Huyghens had one of 123 feet, which is still preserved by the Royal Society of London.

These were used without tubes. Huyghens adopted the plan of placing his object-glass in a short tube, having a ball-and-socket joint, at the top of a tall pole. To this tube was connected a string, so that the observer could bring its axis in line with that of another short tube containing the eye-glass. The great difficulty of managing these cumbrous instruments led to the invention of the reflecting-telescope.

The difficulty of the problem is thus stated by Whewell, in his "History of the Inductive Sciences": —

"If we endeavor to augment the optical power of this instrument, we run, according to the path we take, into various inconveniences, — distortion, confusion, want of light, or colored

images. Distortion and confusion are produced if we increase the magnifying power, retaining the length and the aperture of the object-glass. If we diminish the aperture, we suffer from loss of light. What remains, then, is to increase the focal length."

"Comes Mr Reeve with a twelve-foot glasse. Up to the top of the house, and then we endeavoured to see the moon, and Saturn, and Jupiter, but the heavens proved cloudy."—PEPYS'S *Diary*, 1668.

"The May-pole which stood close to the site of the church of St. Mary-le-strand was begged in 1717 by Sir Isaac Newton, and removed to Wanstead, where it was used in raising the largest telescope then known."—PENNANT'S *London*.

Telescopes are of two kinds, reflecting (or catoptric) and refracting (or dioptric). In the former, an image of the object to be viewed is produced by a concave reflector; in the latter, by a converging lens.

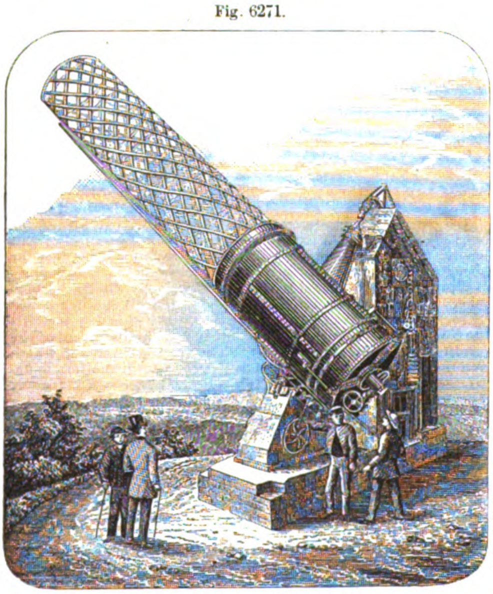
Reflecting telescopes are of four kinds.

The Gregorian telescope (*A*, Fig. 6272) was invented by James Gregory of Aberdeen in 1663. It has an annular metallic speculum and a smaller concave speculum placed in the axis of the tube, at a distance from the larger speculum greater than its focal length. The eye-piece is placed in a smaller tube at the extremity of the longer tube.

The Cassegrainian telescope (*B*, Fig. 6272), was invented by Cassegrain in 1672. It is similar to the Gregorian, except that the smaller speculum is convex instead of concave, and that it is placed in the tube at a distance from the larger speculum less than its focal length. A telescope of this kind, having a speculum of 4 feet diameter and 30 feet 6 inches focal length, was sent from England to Melbourne in 1868. The speculum weighed 3,500 pounds, and was composed of 32 parts copper and 14.77 tin.

Fig 6271 is a representation of the Melbourne telescope, which is really a very fine instrument. The tube is of open work, in order to avoid the air-currents, which with such powerful and delicate instruments are sometimes very annoying in large closed tubes. The mirror in this telescope is placed at the bottom of the tube, and a hole is pierced in the center, in which is placed the *ocular*, in this respect like the Gregorian and Cassegrainian. The hole does not make any practical difference in

Fig. 6271.

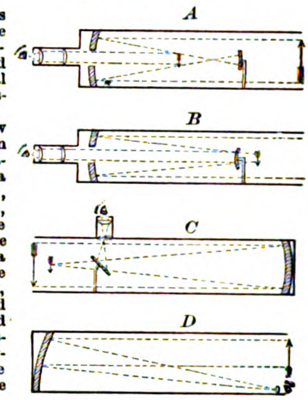


The Melbourne, Australia, Telescope.

the working of the mirror. The clock-work for driving the instrument is seen attached to it. The astronomer directs his *ocular* to a little plane mirror at the upper part of the tube, where the star image is reflected from the parabola.

The Newtonian telescope (*C*, Fig. 6272) was invented by Sir Isaac Newton in 1669. A large concave reflector is placed at one end of the tube. At a distance from the larger mirror less than its focal length is placed, at an angle of 45° to the optic axis of the telescope, a plane reflector, by which the rays proceeding from the object are turned to the side of the tube and viewed by an eye-piece whose axis is at right angles to the axis of the large tube. Foucault used a prism, which was an improvement, especially in making solar observations.

Fig. 6272.



Reflecting- Telescopes.

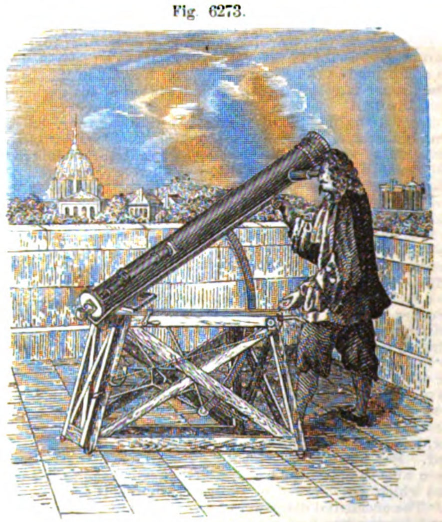
Fig 6273 represents the reflecting-telescope made by Sir Isaac Newton's own hands, and presented to the Royal Society, in whose possession it remains.

Fig. 6274 is the new reflecting-telescope in the national observatory of Paris. It has a parabolic glass mirror, weighing 1,300 pounds, at the bottom of the tube, from which the rays are reflected to a plane mirror in the head of the telescope, the image there formed being examined through a system of magnifying-glasses known as the *ocular*. The telescope is suspended on a movable axis, and has all the usual adjustments in altitude and azimuth with the automatic clock-work motion.

The platform on which the observer stands travels on the rails shown on the floor, and is omitted from the engraving. The weight of the movable portion of the telescope is 9 tons; its cost, $ 40,000.

In the Gregorian, Cassegrainian, and Newtonian instruments the central rays are lost. In the telescope (*D*, Fig. 6272) of Sir William Herschel, invented in the latter part of the last century, the large speculum is inclined to the axis of the tube, and

Fig. 6273.



Telescope of Sir Isaac Newton.

the image of the object observed is brought to the interior edge of the tube, where it is examined by the eye-piece instead of through the medium of the second reflector. By this instrument Sir William Herschel made his numerous and important discoveries.

Herschel's 7, 10, and 20 foot reflectors were made about 1779. He discovered Uranus, March 21, 1781. In 1779, he completed his 40 foot telescope, which was taken down in 1822.

The largest instrument of this class ever made was erected by Lord Rosse on his estate at Parsonstown, Ireland, in 1842.

The diameter of the speculum is 6 feet, having a reflecting surface of 4,071 square inches,—more than double that of Herschel's 40-foot telescope, with which he discovered the moons of Saturn and Uranus, and which had a polished surface of but 1,811 square inches.

A foundry was constructed for the special purpose of casting the speculum, which is composed of copper and tin combined in very nearly their atomic proportions, or 126.4 copper to 58.9 parts tin.

The metal was molten in cast-iron crucibles 2 feet in diame-

ter and 2½ feet deep; these were allowed to heat ten hours previous to the introduction of the metal, which required ten more hours to acquire sufficient fluidity for pouring. The bottom of the mold was formed of layers of hoop-iron turned to the required shape, and its sides of sand. When sufficiently cooled, the cast was removed to the annealing-oven, where it was allowed to remain for sixteen weeks previous to undergoing the grinding process. This was effected under water, by means of a cast-iron grinder having grooves cut lengthwise, transversely, and circularly in its face, emery being used to abrade the surface of the speculum and wear it to a truly circular form; this operation required six weeks.

The tube of this huge telescope, including the speculum-box, is 56 feet long, and is made of 1-inch deal boards hooped with iron. On the inside, at distances of 8 feet, are also iron rings 3 inches deep and 1 inch broad, for strengthening the sides. The diameter of the tube is 7 feet, and it is fixed to masonry in the ground by a universal joint, to allow it free movement in any required direction. At 12 feet distance on each side, walls are built 72 feet long and 56 feet high at their highest parts, the walls being 24 feet distant from each other, and lying exactly in the direction of the meridian. These allow the telescope a motion of but about 15 degrees on either side of the meridian, in an east and west direction; but in the opposite direction, that of the meridian, it may be lowered until nearly parallel with the horizon, when directed south, and so as to point to the north pole of the heavens in the other direction. Elevation or depression is effected by means of a chain and windlass, and the telescope being counterpoised in every direction, two men can perform these operations with great facility, though the total weight is about 15 tons, the speculum alone weighing 3 tons. The total cost of the instrument was not less than £12,000.

Specula for reflecting-telescopes are now made of silvered glass. Its use was first suggested by M. Foucault. Dr. Henry Draper of New York has been very successful in constructing specula of this kind; his process is described in the fourteenth volume of the "Smithsonian Contributions to Knowledge."

M. Secretan of Paris has constructed one for the observatory of Marseilles exceeding 2½ feet in diameter.

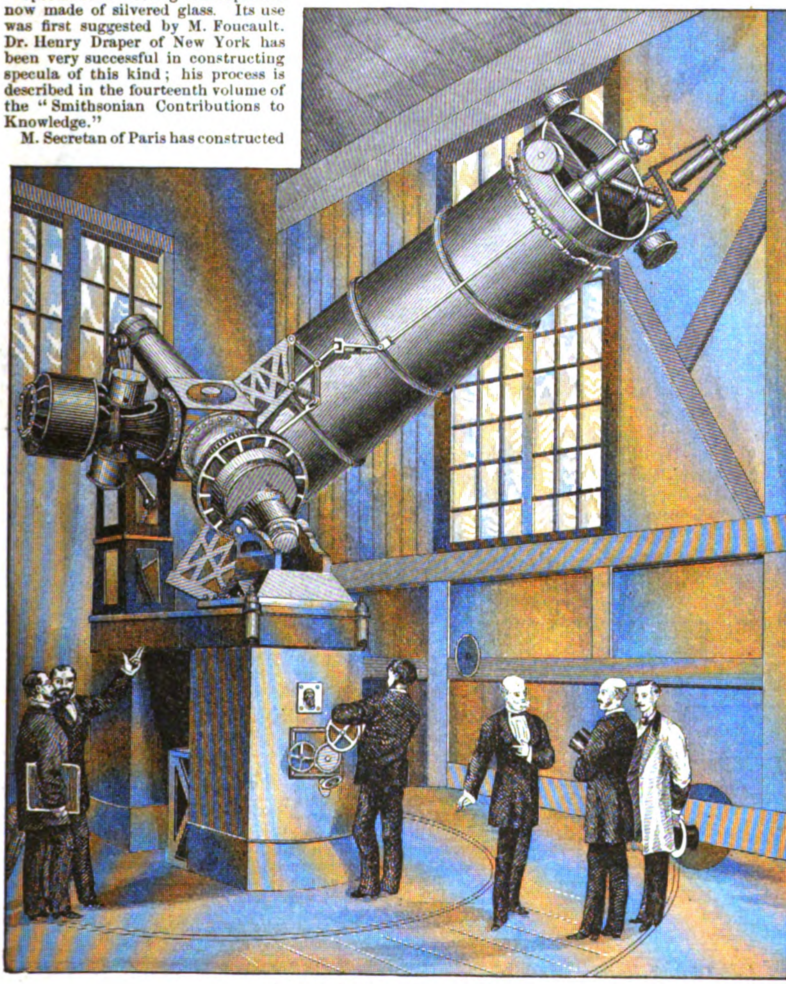
The advantages possessed by glass are that it weighs but from one half to one third as much as speculum metal, that it can be made much thinner, it is more easily wrought, and the loss of light by reflection from the silvered surface is comparatively trifling, while that from a metallic mirror amounts to from one third to one half; besides, should the silvering become tarnished, it can be removed by solution, and replaced without the necessity of regrinding the speculum.

The following remarks on the *apertures* and *powers* of telescopes, by Mr. Tomlinson, will be interesting:—

"The largest achromatic telescopes, such as those at Dorpat and Kensington, have each a clear opening of 13 inches, while that of Lord Rosse's reflector is 6 feet. Taking the diameter of the pupil of the eye at ⅛ inch, the former instruments admit 10,816 times and the latter 331,776 times the quantity of light which is received from any object by the unassisted eye. But as every speculum absorbs about half the light that it receives, the latter number must be reduced to 165,888. These numbers, then, show how much the area of any object may be magnified by these telescopes without rendering it less bright than it appears to be to the naked eye; and their square roots, 104 and 407, show their magnifying powers in such a case.

"We may also, from the size of the aperture of any other telescope, estimate what is called its absolute or penetrating power, which is independent of its length or internal arrangements, and depends solely on the size of the object-glass. The number obtained by the above rule shows how many times farther any object may be seen with the telescope than without it, supposing its brightness to remain the same at all distances as it does *in vacuo*.

Fig 6274.



Great Reflecting-Telescope of Paris.

"The *magnifying power* is totally independent of this, and can be made as great as we please, however small the telescope; but it is obvious that as long as the quantity of light admitted is the same, the more the image is enlarged the fainter it will be, its brightness being always proportional to the quotient of the absolute power divided by the magnifying power. If the latter exceed the former, as it does in astronomical telescopes, the object will be less bright than to the naked eye; but if the absolute exceed the magnifying power, the object will be seen brighter with the telescope than without it."

The telescope at the Washington Observatory, having double the aperture of either of the refractors referred to above, of course admits four times the quantity of light. In this respect it is, however, surpassed in a nearly fourfold ratio by the great reflector of Lord Rosse.

A refracting-telescope in its simplest form consists merely of a double convex lens (the object-glass), which forms an image of the object to be viewed, and a second and smaller double convex lens, called the

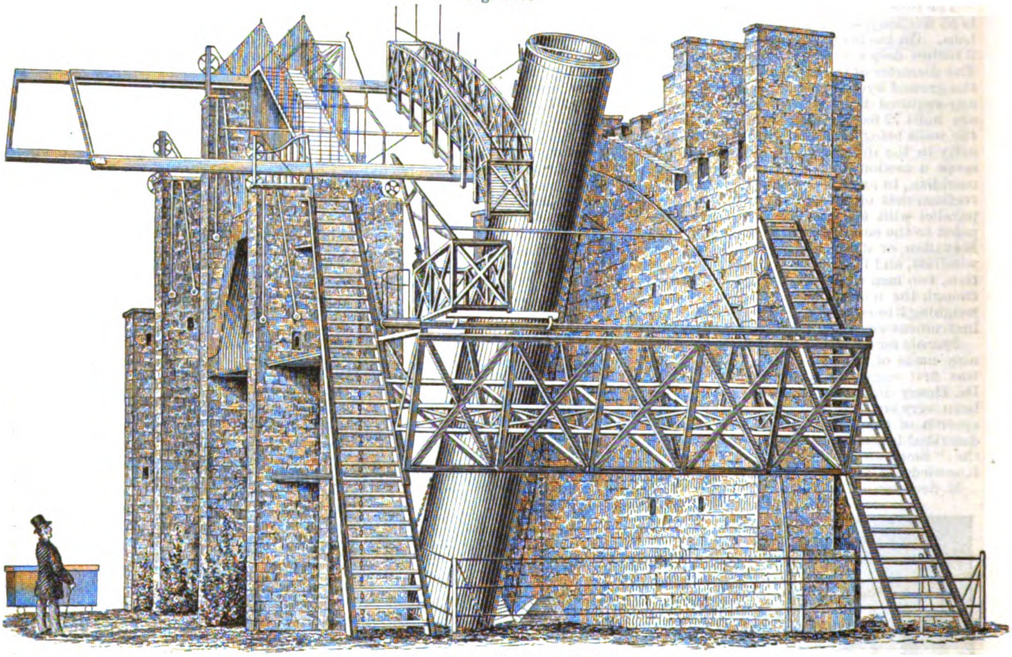
eye-piece, used as a simple microscope to examine the object formed by the first. For perfection of result, the object-glass is made double or triple, to neutralize certain optical inconveniences, called spherical and chromatic aberration, and the eye-glass is generally composed of two lenses suitably combined.

The telescope of Galileo (*A*, Fig. 6276) has a double convex object-glass and a double concave eye-glass. The common opera-glass is made on this principle. The eye-pieces of telescopes are the Ramsden, or *positive*, and the Huyghen, or *negative*.

The positive (*B*, Fig. 6276) has two plano-convex lenses, with the convex sides toward each other. The inner one is the field-glass, and the outer the eye-glass. Their focal lengths are equal. It is suited for micrometers and other instruments having wires in the focus of the object-glass.

The negative eye-piece (*C*, Fig. 6276) has two plano-concave lenses, the convex sides of both being turned toward the object-glass. The ratio of the focal lengths is usually 3 to 1, the latter representing the eye-glass. — G. Chambers. See Lens; Achromatic Lens.

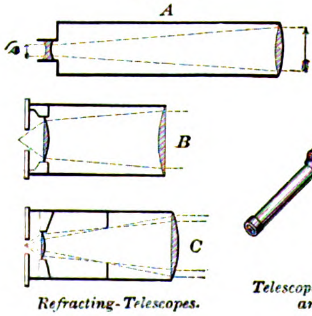
Fig. 6275.



Earl of Rosse's 6-foot Reflector.

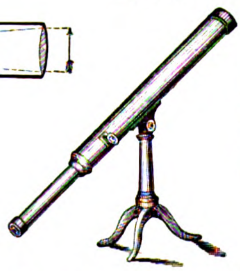
The equatorial telescope is so mounted that its vertical axis points toward the pole, having an inclination corresponding to the latitude, so that a single motion, one of rotation around that inclined axis, will cause the line of sight, the optical axis, to trace upon the sphere a circle corresponding to that in which any heavenly body appears to move. The circles increase or diminish as the telescope is moved upon its horizontal pivot, changing the angle between the line of sight and the inclined axis, just as the circles apparently described by the heavenly bodies increase or diminish according to their polar distance.

Fig. 6276.



Refracting-Telescopes.

Fig. 6277.

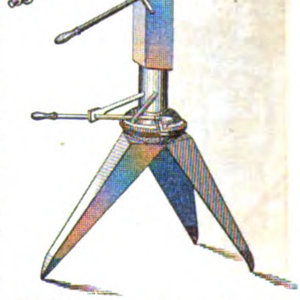


Telescope Mounted on a Pillar and Claw-Stand.

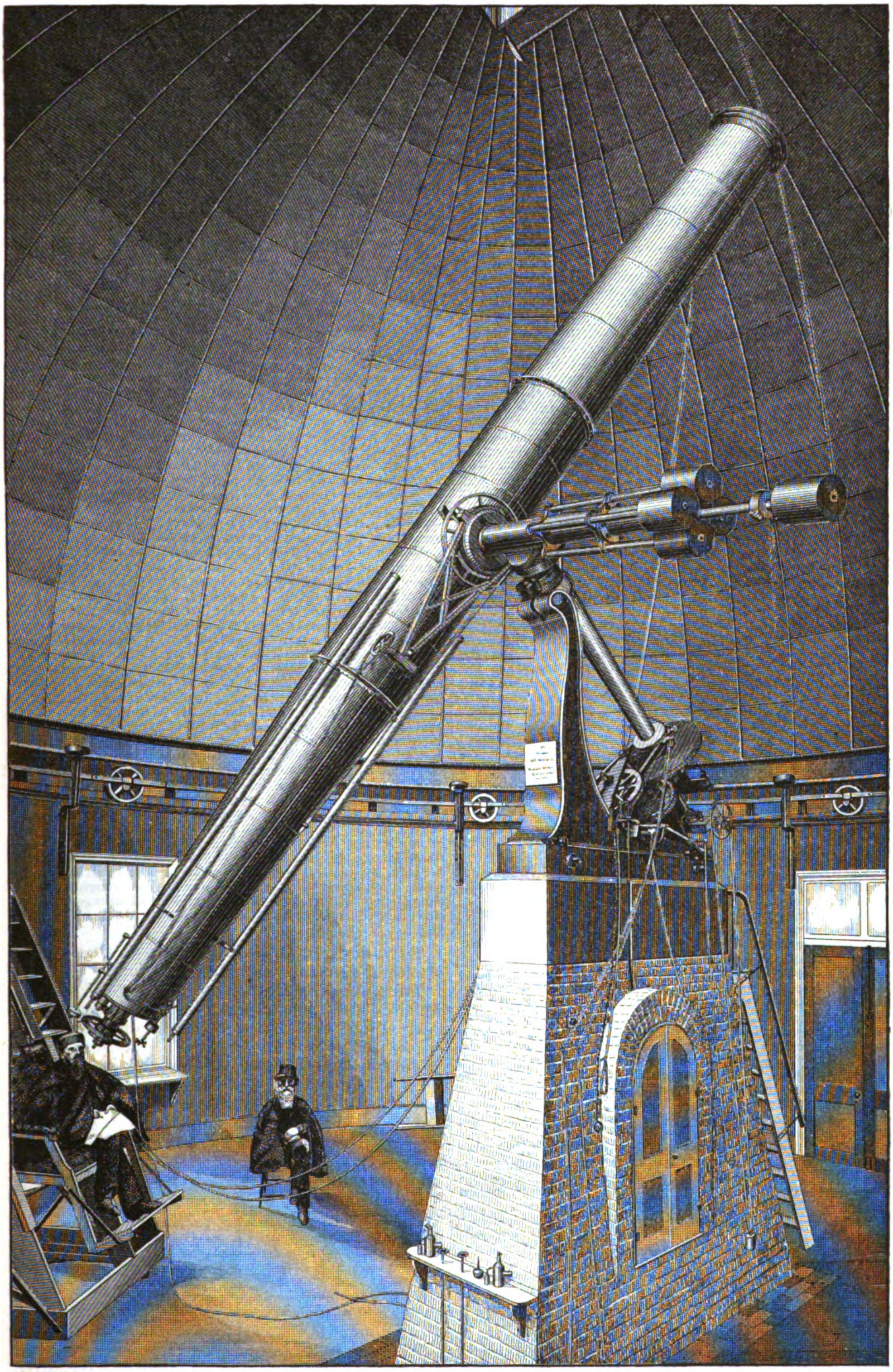
The equatorial of the Cincinnati Observatory was purchased in Munich by Professor O. M. Mitchell, the originator and director of the observatory. The object-glass has a diameter of nearly 12 inches. The death of this talented and Christian gentleman in the service of his country has been a great loss to science and to the social circle, where he was highly esteemed for his modesty and merit.

Large refractors are now universally mounted equatorially, and are made of dimensions which but a few years ago were deemed impracticable. The improvement in this respect is in a large degree due to the exertions of Mr. Alvan Clark, of Cambridgeport, Mass., who, like most other great improvers of the telescope, is a self-taught artist. It would seem that opticians, like poets, are born, not made. Mr. Clark's first object-glasses, strange to say, were made for England, but in 1862 he completed one having a clear aperture of 18½ inches for the Chicago Astronomical Society. This was followed by the great telescope of 26 inches aperture for the United States Naval Observatory

Fig. 6278.



Telescope with Motion in Altitude and Azimuth.



EQUATORIAL REFRACTING TELESCOPE AT WASHINGTON, D. C.

PLATE LXIX.

See page 2524.

at Washington, completed in November, 1873. Mr. Clark is confident of being able to produce an object-glass of 5 feet 6 inches clear aperture and 75 feet focal length.

The largest that had previously been made were those at the observatories of Cambridge, Mass., and Pulkowa, Russia, each having a clear aperture of 15 inches. These were large in comparison with the instruments that had previously been used, those at Dorpat and Kensington having but 13 inches aperture. In the United States, at that time, among the largest were those at

Cincinnati........12 inches aperture; 17 feet focal length.
West Point....... 9⅜ inches aperture; 14 feet focal length.
Washington...... 9⅝ inches aperture; 14 ft. 4½ in. focal length
Alleghany City...13 inches aperture.

The disks for Clark's lenses are made by Chance & Co., of Birmingham, England.

The crucibles are of clay, and are built up gradually in rings of about 2 inches in hight, the process requiring a whole year for its completion.

Optical glass of the best quality is then selected and crushed, and the fragments separated according to their specific gravity by a hydraulic separator, in the manner employed for treating ores. Those of uniform quality and size are selected and melted by the most intense heat of a Siemen's gas-furnace; the mass is then cooled very slowly, and the central portion sawn out. This may be reheated until sufficiently fluid, and molded to approximately the desired shape.

The disks are then tested, to ascertain if the glass is homogeneous and free from flaws. This is effected by throwing the light from a lamp through a lens on one side of the disk, and placing the eye in the focus of the lens at the other side. Any imperfections thus appear greatly magnified, and if not removable by grinding, cause the rejection of the piece, at least for a lens of the size for which it was intended. Polarized light also affords a very delicate test as to whether or not it has been equally annealed. The disk is ground upon concave plates of cast-iron of the proper curvature by pushing it back and forth, at the same time giving a slow rotary movement. Emery, with water, is used as an abradant, finer sizes being successively used.

The polishing is effected by coating the tool with a thin layer of pitch, which is pressed into the proper shape; this is covered with rouge and water, and the disk manipulated as in the grinding process. The pieces forming the lens are, when finished, put together and set on edge, facing a luminous point placed at a distance equal to twelve or fifteen times the focal distance of the lens; the appearance of this point through the lens is examined with an eye-piece of high power, or by the eye placed in the focus; the optician thus judges what parts have an excess or a deficiency of curvature. The polishing process is then repeated upon such portions as are too prominent; the lens is re-examined, and this process repeated until no departure from the proper curve at any point can be detected. This in the case of large lenses is a long and tedious operation, requiring many trials and repetitions of the process. The object-glass has but two pieces,—a plano-concave lens of flint and a double convex lens of crown glass.

The Washington equatorial (shown in Plate LXIX.) has a clear aperture of 26 inches and a focal length of 31 feet 6 inches, its total length being 32 feet 6 inches. The rough glass for the object-lens was received by Messrs. Clark in December, 1871, and was ground, polished, and finished in November, 1872. Another year was required to finish the tube and complete the other parts of the instrument.

The tube is of thin steel, in three pieces, and is mounted upon a pillar of brick supported by an arched foundation of bluestone, and capped by a block of sandstone weighing about two tons. The dome inclosing the instrument is 41 feet in diameter and 25 feet high. It rests upon a tower of equal diameter and 21 feet in hight. For lightness, and in order that the temperature may be maintained at that of the air outside, it is made of pine, covered with galvanized iron. It rests upon thirty-two iron rollers, running upon a circular track, and is rotated by a reaction-wheel driven by water from a main of the Washington aqueduct, and operating also the clock-work mechanism and the conical pendulum of the instrument.

The circles are each read by two microscopes reaching from the eye end of the telescope along its sides to the right-ascension circle, which is divided to seconds, the declination circle being divided to tenths of a minute of arc. The instrument has the usual number of eye-pieces and ring micrometer, a filar micrometer, an Airey double-image micrometer, a mica-scale micrometer, and a spectroscope. The disks for the object-glass cost $7,000; the whole instrument, about $48,000; and the building for its accommodation, about $14,000.

Next in size to this is a telescope constructed by Messrs. T. Cooke and Sons of York, England, for Mr. R. S. Newall, the contractor for the first Atlantic cable. This has an object-glass of 25 inches aperture and 29 feet focal length, and is represented as being a superior instrument.

Another English telescope, constructed by Rev. Mr. Craig in connection with Mr. Cravatt, F. R. S., has a 24-inch object-glass, with a focal length of 76 feet, the length of the tube being 85 feet. This was mounted on Wandsworth Common. The great focal length of this appears remarkable, the tendency of late having been to reduce this as far as possible in proportion to the aperture of the lens.

A telescope is now in course of construction in Dublin for the Austro-Hungarian government. Its object-glass will have an aperture of 27 inches, and its total length will be about 32 feet.

The ratio of focal lengths, mode of construction, powers, proportions, adjustments, and mounting are fully explained in many treatises on the subject. See Pearson, Loomis, Heather, Simms, etc., etc.

See under the following heads: —

Astronomical telescope.	Newtonian telescope.
Binocular telescope.	Object-glass.
Cassegrainian telescope.	Opera-glass.
Comet-seeker.	Perspective-glass.
Equatorial telescope.	Reflecting-telescope.
Eye-glass.	Refracting-telescope.
Field-glass.	Submarine telescope.
Finder.	Teinoscope.
Galilean telescope.	Telemeter.
Gregorian telescope.	Terrestrial telescope.
Herschelian telescope.	Transit-instrument.

One of the most important applications of the telescope is to instruments for making observations upon the heavenly bodies, both to determine their positions and for ascertaining the latitude and longitude. By means of a very small telescope of low power attached to his sextant, the navigator is enabled to observe with far greater accuracy the contact of the sun's disk with the horizon, or the contact of the limbs of the sun and moon, than he could with the plain sight tube. In fact, the lunar method of finding the longitude would be of little value without the telescope, and the nicety and precision now attained in observations on land, both in astronomical observations and in triangulations for surveys, would be utterly impracticable.

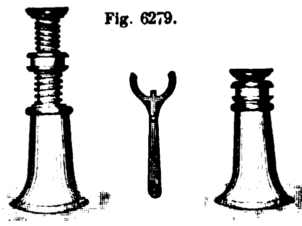
Sir John Herschel says: "The honor of this capital improvement" (the application of the telescope to the measurement of astronomical angles) "has been successfully vindicated by Derham to our young, talented, and unfortunate countryman, Gascoigne, from his correspondence with Crabtree and Horrockes, in his, Derham's, possession. The passages cited by Derham from these letters leave no doubt that, so early as 1640, Gascoigne had applied telescopes to his quadrants and sextants, *with threads in the common focus of the glasses*"; and had even carried the invention so far as to illuminate the field of views by artificial light, which he found "*very helpful when the moon appeareth not, or it is not otherwise light enough*." These inventions were freely communicated by him to Crabtree, and through him to his friend Horrockes, the pride and boast of British astronomy, both of whom expressed their unbounded admiration of this and many other of his delicate and admirable improvements in the art of observation. Gascoigne, however, perished at the age of twenty-three at the battle of Marston Moor; and the premature and sudden death of Horrockes, at a yet earlier age, will account for the temporary oblivion of the invention. It was revived or reinvented in 1667 by Picard and Auzout (Lalande, Astron.), after which its use became universal. Morin, even earlier than Gascoigne (in 1635), had proposed to substitute the telescope for plain sights; but it is the thread or wire stretched in the focus, with which the image of a star can be brought to exact coincidence, which gives the telescope its advantage in practice; and the idea of this does not seem to have occurred to Morin.

Tel'e-scop'ic Boil'er. (*Steam.*) One formed of several concentric cylindrical portions.

Tel'e-scop'ic Chim'ney. (*Nautical.*) One which is in sections slipping into each other, to be lowered in time of action, or, in certain river-steamers, in passing beneath bridges.

Tel'e-scop'ic Jack. A screw-jack in which the lifting head is raised by the action of two screws having reversed threads, one working within the other, and both sinking or telescoping within the base. By this differential arrangement greater power is obtained.

Fig. 6279.



Telescopic Jack.

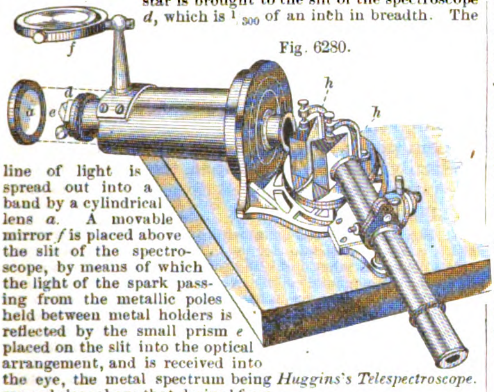
Tel'e-scop'ic Lens. A compound lens suited for the *eye* or *object-glass* of a telescope. Terrestrial telescopes, or spy-glasses, have two additional lenses, enabling an object to be seen in its natural instead

of an inverted position. See LENS; EYE-GLASS; OBJECT-GLASS; TELESCOPE; etc.

Tel′e-spec′tro-scope. An instrument for observing the light from the planets and fixed stars, for ascertaining their physical condition and the composition of their atmospheres.

At the end of the telescope is placed the spectroscope (Fig. 6280), which contains two prisms *h h*, while the image of the star is brought to the slit of the spectroscope *d*, which is $\frac{1}{300}$ of an inch in breadth. The

Fig. 6280.



line of light is spread out into a band by a cylindrical lens *a*. A movable mirror *f* is placed above the slit of the spectroscope, by means of which the light of the spark passing from the metallic poles held between metal holders is reflected by the small prism *e* placed on the slit into the optical arrangement, and is received into the eye, the metal spectrum being ranged close above that derived from the star, so that the coincidence or otherwise of the two sets of lines can be accurately observed.

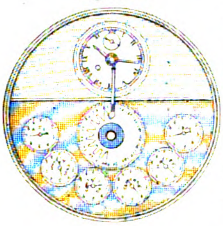
Huggins's Telespectroscope.

Tel′e-ster′e-o-scope. An instrument described by Helmholtz, 1857, for producing an appearance of relief in the objects of a landscape at moderate distances.

It consists of a frame on which are set at a convenient distance — say 4½ feet — apart two plane mirrors at an angle of 45°, which receive the rays of light from the objects; these are reflected to two central mirrors, forming an angle of 45° with the first, in which they are viewed by the eye. The effect produced is the same as if the eyes of the observer were at the same distance apart as the two larger mirrors. When objects at a great distance are viewed, they do not appear in strong relief, but rather as if detached from the general landscape. — *Annales de Chemie*, 3d series, Vol. LII. p. 118.

Tell′tale. 1. A device for counting, indicating, detecting, or verifying.

Fig. 6281.



Telltale.

2. (*Nautical.*) *a.* See TELLTALE-COMPASS.

b. An index in front of the wheel, or in the cabin, to show the position of the tiller.

3. (*Music.*) A movable piece attached to an organ to indicate when the wind is nearly exhausted.

4. (*Gas-making.*) A device attached to a station-meter to point out any irregularity in the production of gas.

It consists of a circular plate placed centrally in the dial-field and carrying a paper disk, and connected by gearing with the wheel which turns the hand belonging to one of the dials of the meter. Above it is a clock, to whose minute-hand is attached an arm carrying a pencil pushed against the paper disk by a spring. If the paper disk were stationary, the pencil would thus be caused to make a vertical stroke up and down each hour, but as the disk slowly turns with the dial-wheel, to which it is connected, the pencil traces a series of curves which are closer together or farther apart in proportion to the quantity of gas passing through the meter. If the quantity of gas produced has been uniform, the apexes of the curves will be equidistant from each other at the margin of the disk; if otherwise, their distances will vary, being nearer together when less than the usual quantity passes through the meter, and farther apart when the normal amount is exceeded.

5. (*Horology.*) A clock attachment for the purpose of causing a record to be made of the presence of a watchman at certain intervals. Arésa's is provided with a rotating paper dial, showing the hour and minute at which the watchman touched a projecting button having a point which punctures the paper dial.

Smith's has a rotating circular frame, fitted with springs and pins; the operative mechanism must be touched at certain definite intervals in order that these shall appear in their proper places when inspected in the morning.

A *telltale* clock is described in English patent No. 1,502 of 1856. See also WATCHMAN'S TIME-DETECTOR.

6. A turnstile having mechanism which indicates the number of passengers.

Tell′tale-com′pass. (*Nautical.*) A compass is suspended overhead in the cabin. The face of the card is downward, so that it is visible from below, and enables the captain to detect any error or irregularity in steering. See HANGING-COMPASS.

Tel-lu′ri-an. *Tellurion.* See TELLURIUM.

Tel-lu′ri-um. The preferable spelling, in consonance with *planetarium, lunarium. Encyc. Brit.*, XVII. 753.

An apparatus for the purpose of illustrating to the eye the real and apparent movements of the earth; exhibiting the ellipticity of the earth's orbit; the position of the sun (represented by a lamp in one of the foci of that ellipse); the inclination of the pole to the plane of the ecliptic, and the constancy of the pole during the entire yearly revolution; the apparent movement through the constellations of the zodiac; the phenomena of eclipses, day and night, sunrise and sunset, and the seasons; the varying declination of the sun; the equation of time; the motions and phases of the moon; and affording a model whereon to illustrate the theory of the tides, lunar disturbances, etc.

See No. 66,791, Campbell, July 26, 1867.

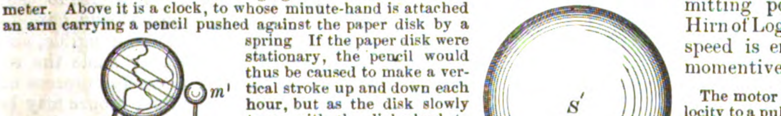
In Davis's tellurium (Fig 6282), a ball *S′* representing the sun is attached to an upright shaft rotated by a crank through the medium of intermediate gearing, and passing through a sleeve rotated by gearing driven by the same crank, and carrying a toothed disk *k* engaging a rod passing through a horizontal tubular arm attached to and at right angles to the sleeve. The rod has a series of wheels at its outer end, which impart a rotary motion to the ball representing the earth, placed on an arm inclined at an angle of 23° 28′ therewith, to the beveled disk *B′*, and to the moon *m′*; the bent stem on which the latter is mounted is connected with an eccentric ring, causing it to move in an elliptic orbit around the earth; it has also a friction-wheel, which, traveling around the inclined edge of the disk *B′*, produces an alternate ascent and descent of the moon, illustrating its changes of declination; the parts by which the moon is revolved are also so adjusted as to exhibit the retrogression of their nodes.

See also ORRERY, pages 1577, 1578; PLANETARIUM, page 1727.

Tel-o-dy-nam′ic Ca′ble. A means for transmitting power, originated by Hirn of Logelbach, in which high speed is employed to give the momentive effect of great mass.

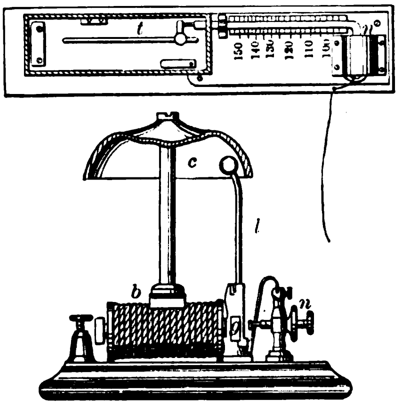
The motor is made to give a high velocity to a pulley-wheel, and this wheel is employed to carry a cable which passes over another pulley at the point where the power is to be applied for use. The cable may be lighter in proportion as the velocity with which it travels is greater. Theoretically, there is no limit to the reduction in size, if sufficient velocity be imparted to give the

Fig. 6282.



Tellurium.

Fig. 6283



Electro-Magnetic Temperature-Alarm.

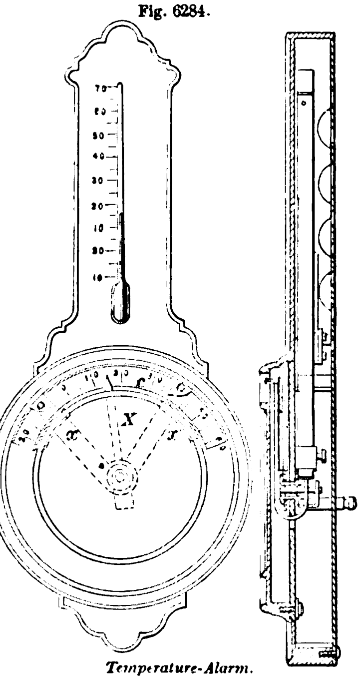
requisite momentum, but in practice this is governed by the velocity with which the pulleys may be safely run, and the strength required by the cable for overcoming the inertia of the pulleys, the friction on their axes, and the resistance of the air, and also the friction of the smaller pulleys on which it must be supported when the distance is considerable. The cable used is of wire, generally about .4 inch in diameter, and is supported at intervals of about 150 yards in grooved pulleys protected by gutta-percha The large transmitting and receiving pulleys at the ends are about 4 meters (13¼ feet) in diameter, making from 150 to 200 revolutions per minute; the cable consequently travels at the rate of 50 to 75 miles an hour. See WIRE-ROPE; WIRE-WAY.

This mode of transmitting power was first successfully employed about 1852, and has since been somewhat extensively introduced into France and other countries.

In the government powder-mills at Okhta, Russia, 274 horse-power, derived from turbines, is thus carried over 4,600 feet; at the mines of Fahlun, Sweden, over 100 horse-power is transmitted nearly 3½ miles. Some have been put up in this country. One at Lockport, N. Y., transmits 25 horse-power 700 feet over pulleys 5 feet in diameter.

The power lost by friction of the two great pulleys has been ascertained to be 2¼ per cent, by the smaller pulleys and rigidity

Fig. 6284.



Temperature-Alarm.

of the cable 1 per cent, for each 1,000 meters; to this must be added the resistance of the air. It was calculated by the inventor that all these together would entail a loss of 25 per cent in a length of six miles, leaving 75 horse-power available at that distance out of 100 originally applied; this is, however, thought to be an overestimate.

Tel'o-type. (*Telegraphy.*) A printed telegram.

Tem'o-in. (*Engineering.*) A pillar of earth left in an excavation to show how much earth has been removed.

Tem'per. 1. An alloy used by pewterers: tin, 2; copper, 1. See ALLOY.

2. The particular condition, as to hardness, of steel. See TEMPERING.

3. Milk of lime, or its equivalent, added to boiling sirup to clarify it.

Tem'per-a-ture-a-larm'. A device which automatically makes a signal when the temperature of the place where it is located exceeds or falls below a determinate point.

In Fig. 6283, one end of a wire, attached to a slider on the rod *t*, is set to a certain degree in the tube of the bent thermometer *n*, the other end being connected with one of the poles of an electro-magnetic coil *b*. A second wire, inserted into the bulb of the thermometer, leads to the other pole. When the mercury rises so as to touch the other end of the first wire, the circuit is completed, and the armature *g* of the electro-magnet, which turns on a spring axis, operates the rod *l*, sounding the bell *c*.

In Fig. 6284, the expansion and contraction of a metallic thermometer, through the medium of a segment rack and pinion, operate an index *X*, which, on coming in contact with a projection upon either of two arms x x', closes an electric circuit and operates an alarm. These arms are independently adjustable toward and from the central point of the index *c*, so as to permit various maxima and minima. See also THERMOSCOPE; THERMOSTAT; THERMOSTATIC ALARM; etc.

Tem'per-er. A machine in which articles are ground together, with the addition of a proper quantity of water, to intimately commingle them and develop the plasticity. Sand and lime thus tempered form mortar; clay thus tempered becomes fit for the potter's use. The machine used by Coignet in compounding his *béton* is called a *malaxator*.

Machines for compounding flour and water into dough are substantially similar, and are called *kneading-machines*. See pages 1230, 1231.

Tem'per-ing. (*Metal-working.*) The process of producing in a metal, particularly steel, that peculiar degree of hardness and elasticity which adapts it for any of the purposes to which it is to be applied.

The malleable metals generally increase in hardness by being hammered or rolled, and *hammer-hardening*, that is, hammering without the application of heat, is frequently employed for hardening some kinds of steel springs.

Steel, however, is for most purposes hardened by plunging it while hot into water, oil, or other liquid, to cool it suddenly.

One of the earliest notices of this art is a simile in the Odyssey, "As some smith plunges into cold water a loudly hissing axe, tempering it."

The notices of the early use of *bright iron* are given under the caption STEEL.

Bronze is tempered by a process reverse to that adopted with steel. Cooling bronze slowly hardens it. The sudden cooling makes it less frangible, and is adopted with gongs. Dr. Faraday made the remark many years since. By a careful process of alloying, tempering, and hammering, bronze may be made as hard as steel, and make excellent springs.

Pliny (A. D. 701) recommends *oil* for tempering steel; he states that *water* makes it brittle.

Metals, in general, suffer no apparent change when heated to redness and suddenly cooled. Pure malleable iron remains entirely unaffected, but when combined with proportions of carbon variable within certain limits, forming steel, it possesses this property of being hardened when suddenly cooled, and being again softened by reheating and slowly cooling to an eminent degree, giving it that pre-eminence which it enjoys over

all other metals for forming weapons, tools, and many other articles. This quality, which appears to be due to molecular changes in the metal caused by great changes of temperature, is to a certain extent participated in by cast-iron, which contains a much larger proportion of carbon, and may be superficially hardened by chilling: without, however, again being softened by a second application of heat.

Thin plates of steel may be hardened by placing them between two good conductors of heat, as a hammer and anvil. Thicker pieces become moderately hard when exposed to the air upon the anvil. If laid on cold cinders or other poor conductor, they become softer, and still more so if placed in hot cinders, or are otherwise very gradually cooled. By heating in closed boxes with charcoal, and very slowly cooling, the metal is reduced to its softest state; by using iron turnings or fine scale from the forge, lime, or other matter which will combine with the carbon, its surface may be reconverted into malleable iron, as is done in Perkins's process for transferring steel engravings. See BANK-NOTE ENGRAVING, page 228; ANNEALING, pages 111-114; STEEL-PLATE ENGRAVING.

Great diversity exists in opinion and in practice as to the best method to be adopted in each particular case. The following principles are, however, generally agreed on: —

The lowest available temperature should be employed in forging and tempering steel; the hammering should be applied equally throughout, and for cutting tools should be continued until they are nearly cold.

Coke or charcoal is much better for fuel than coal, the sulphur in which is apt to be injurious.

The scale should be removed from the face of the work to expose it more uniformly to the cooling medium.

Hardening a second time without rehammering should be avoided, and the less frequently the steel passes through the fire the better.

The smallest works are heated with the flame of the blowpipe, and are occasionally supported on charcoal. Larger works, which are yet too small to be conveniently exposed to the open fire, are protected by an iron tube or box, which is placed in the fire. A crucible or iron pot filled with lead and heated to redness is excellent for long, thin tools, such as artist's gravers. Sometimes a pan filled with charcoal dust and heated to redness on the fire is used.

Many articles are heated in the ordinary forge-fire. The bellows should be used sparingly, and the work should be allowed ample time to get hot, or *soak*, as it is termed. The piece should be uniformly heated by moving it about to expose all parts to the fire, and it is better that it should be rather underheated than over-heated, as the latter involves the risk of burning the metal, while in the former case the defect may be corrected by a second beating. Too little heat fails to produce hardness, and in the opinion of some has an opposite effect. It is consequently resorted to for lowering the temper, the steel in this case being dipped into water, suddenly withdrawn, held a few moments in the steam, again dipped, and similarly treated, and so on until cool.

Various liquids and compounds have been recommended for hardening. Plain water is that generally used, and that which has been long in use is preferred. The common opinion is that mercury gives the greatest degree of hardness: then cold salt water, or water mixed with astringent or acidifying matters; then plain water; and lastly, oily mixtures.

These last are generally used for springs and thin articles, and in some cases water covered with a film of oil is employed. A very high degree of hardness is said to be imparted to gravers, watchmaker's drills, and like small tools by plunging them while hot into a stick of sealing-wax, withdrawing them, and repeating the operation until they become too cool to penetrate. Steel pens are hardened in an oily mixture, and generally tempered in oil or an oily mixture, the boiling point of which is of the proper temperature to let the temper down, or in a dry oven, where a lesser heat may be imparted. Saws and springs are generally hardened in various compositions of oil, suet, wax, and other ingredients, which are partially wiped and afterward burnt or *blazed* off. Gunlock springs are sometimes fired in oil over a fire in an iron tray to let down the temper. Watch-springs are hardened in oil and *blazed* off; they are then stretched in a frame and polished, which appears to have destroyed the elasticity; this is, however, afterward restored by hammering. It is said that Damascus sword-blades are hardened by heating to a certain temperature, and then waving them in a draft of cold air.

Files, previous to being hardened, are drawn through beer-grounds, yeast, or other sticky matter, and then through common salt, mixed with cows' hoof previously roasted and pounded, which serves to protect the teeth against the direct action of the fire. This lessens the tendency to crank, and the fusion of the salt also indicates the proper heat for hardening. The temper of the tang is afterward *drawn* to render it less brittle.

Needles are tempered by exposure to heat on an iron plate over a fire. They are kept in motion by an iron shovel till the blue color appears, when they are instantly removed.

A convenient method of tempering small articles is by a flat bar of iron heated to redness at one end; these are placed on a part of the bar which is at the required heat until they assume the proper color. A number may thus be operated on at once, being gradually pushed forward from the cooler to the hotter parts of the bar.

The heat required for letting down the temper is judged of by the color of the film of oxide which forms upon the surface of the steel when it is reheated after hardening. For this purpose a portion at least of the metal must have a bright surface. This, as the metal becomes heated, assumes the following colors: 1, pale yellow, deepening into a straw yellow; 2, full yellow; 3, the color deepens to purple, copper, brownish purple; 4, deepens into violet; 5, indigo blue to dark blue; 6, lighter blue to sky blue; 7, the blue becomes greenish, producing shades of gray and sea green; 8, the steel reddens.

These colors form a sure guide for the workman, who has only to remove the article from the fire, when it assumes the desired color, and immerse it in cold water; this, however, is sometimes dispensed with.

The following tabular statement shows the colors and degrees of heat proper for tempering various articles of steel: —

1.	Very pale straw yellow	430°	Tools for metal.
2.	A shade darker of yellow	450°	
3.	Darker straw yellow	470°	Tools for wood, screw-taps, etc.
4	Still darker straw yellow	490°	
5.	Brown yellow	500°	Hatchets, chipping-chisels, and other percussive tools, saws, etc.
6.	Yellow, tinged slightly with purple	520°	
7.	Light purple	530°	
8.	Dark purple	550°	Springs.
9.	Dark blue	570°	
10.	Paler blue	590°	Too soft for the above purposes.
11.	Still paler blue	610°	
12.	Still paler blue, tinged with green	630°	

It has been proposed to employ in tempering, alloys composed of lead and tin in such proportions that the fusing-point of each alloy should correspond to the letting-down temperature proper to each class of articles to be tempered.

Garman and Seigfried's process of working and tempering steel consists in heating it to a cherry red in the forge, then covering it with salt; salt is also thrown into the fire, and the steel is worked until it is nearly brought to the finished form. The steel is then covered with a mixture of one part each by weight of salt, sulphate of copper, sal ammoniac, and sal soda, with ½ part of nitrate of potash, heated and hammered; being thus alternately treated with the composition, and heated and hammered until it assumes its finished form. It is then slowly heated to a cherry red and plunged into a bath composed of rain water, 1 gallon; alum, 1½ ounces; sulphate of copper, 1½ ounces; sal soda, 1½ ounces; nitrate of potash, 1½ ounces; salt, 6 ounces. These proportions may be slightly varied.

Large articles are very liable to crack if removed from the hardening bath before becoming cool, owing to the unequal contraction of the interior and exterior portions.

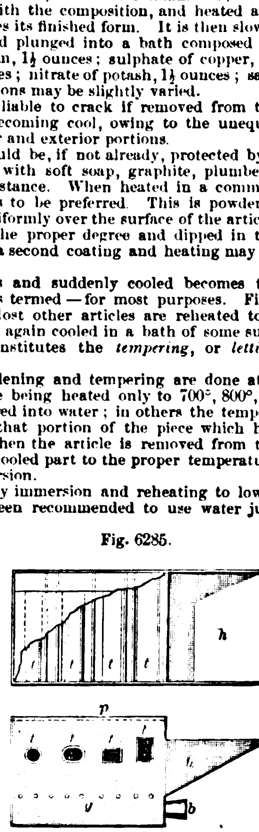
To avoid this they should be, if not already, protected by a coating of scale covered with soft soap, graphite, plumbers' size, or other suitable substance. When heated in a common fire, prussiate of potash is to be preferred. This is powdered and sprinkled or sifted uniformly over the surface of the article, which is then heated to the proper degree and dipped in the water; when extra large, a second coating and heating may be advisable.

Steel heated to redness and suddenly cooled becomes too hard — *glass hard*, as it is termed — for most purposes. Files are left in this state. Most other articles are reheated to a greater or less degree, and again cooled in a bath of some suitable substance. This constitutes the *tempering*, or *letting down* the temper.

In some cases the hardening and tempering are done at a single operation, the piece being heated only to 700°, 800°, or 900° Fah., and then plunged into water; in others the tempering heat is derived from that portion of the piece which has not been cooled, which, when the article is removed from the bath again, heats up the cooled part to the proper temperature for tempering by re-immersion.

Instead of hardening by immersion and reheating to lower the temper, it has also been recommended to use water just sufficiently hot to produce the desired temper at once. The proper heat varies according to the kind of steel and the size of the articles. For springs for the needle-gun a temperature of about 130° Fah. has been employed. For some kinds of steel, boiling water is used. Cooling in hot water is said to increase the tenacity and elasticity of steel containing 0.2 to 0.4 per cent carbon, without much affecting its hardness.

Fig. 6285.



Fellows's Tempering-Furnace.

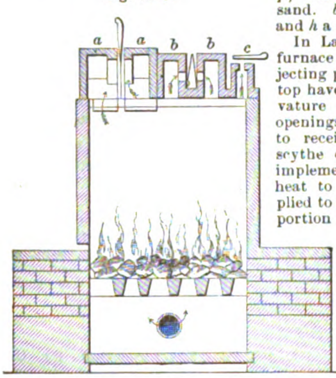
Tem'per-ing-fur'-nace. (*Metal-working.*) One specially

contrived for imparting an equal heat to the articles to be tempered.

Fellows's has a series of tubes *t* over the grate *g*, in which the articles are placed to heat for hardening. To lower the temper, they are placed on a plate *p*, which is covered with sand. *b* is the blast-pipe, and *h* a coal-receptacle.

In Layton's tempering-furnace (Fig. 6286), projecting portions *a a* of the top have a downward curvature and longitudinal openings, adapting them to receive the edge of a scythe or similar curved implement, enabling the heat to be uniformly applied to the blade; another portion *b b* has openings to which the heat is admitted through side apertures, and applied at particular spots in the blade, to rectify irregularities in the temper; at a third opening *c* the heat may be applied to the flat of the blade.

Fig. 6286.



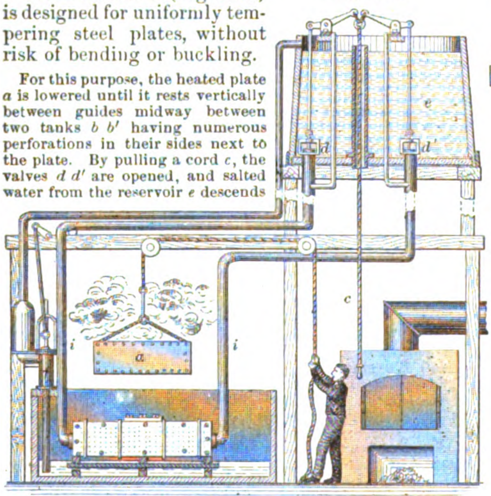
Layton's Tempering-Furnace.

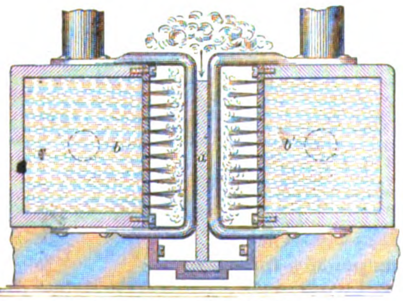
Tem′per-ing-ma-chine′. One for handling heavy steel plates during the operations in tempering.

Urban's machine (Fig. 6287) is designed for uniformly tempering steel plates, without risk of bending or buckling.

For this purpose, the heated plate *a* is lowered until it rests vertically between guides midway between two tanks *b b′* having numerous perforations in their sides next to the plate. By pulling a cord *c*, the valves *d d′* are opened, and salted water from the reservoir *e* descends through the pipes *i i* into the tanks, playing in jets against both sides of the plate; a pump *f* returns the water from the lower reservoir to the upper one, in order that it may be used again.

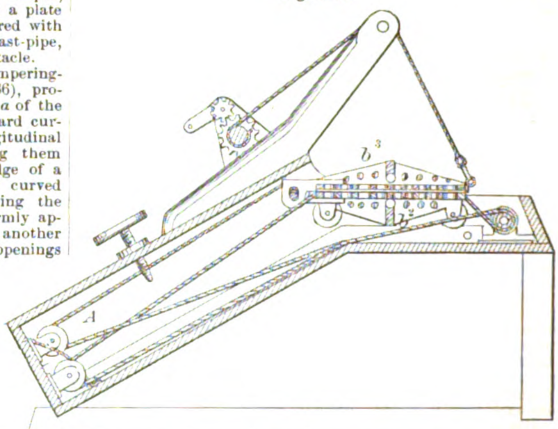
Fig. 6287.

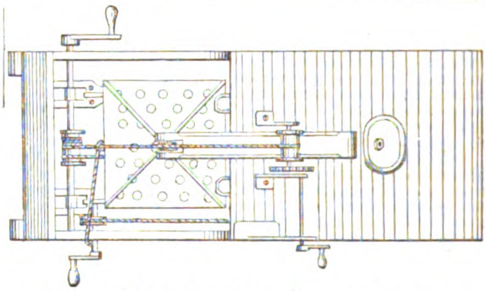




Urban's Tempering-Machine.

Fig. 6288.



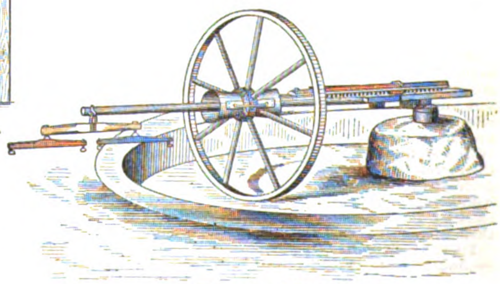


Mercer and Hinton's Machine for Tempering Saw-Plates.

In Mercer and Hinton's machine (Fig. 6288) for tempering saw-plates, the plate is clamped between two perforated plates, strengthened by ribs b^2 b^3, forming a carriage which runs on rails down into the bath *A*. The carriage is raised or lowered by means of a rope or chain passing around pulleys and operated by a winch.

In Crossman's machine for tempering scythe-blades, the blade, after being properly heated, is placed between two jaws, which are forced together by depressing a treadle, clamping the blade, and at the same time immersing it in a tank beneath.

Fig. 6289.



Tempering-Wheel.

Tem′per-ing-wheel. A device for inking and tempering clay for making brick, etc. The wheel is of cast-iron, and revolves on an axis, one end of which is pivoted to an upright in the center of a circular pit, and the other has means of attachment for a horse or horses. A rack and gear-wheels connected with the axle cause the wheel to alternately approach and recede from the center of the pit dur-

ing its onward movement, exposing every part of the clay to its action.

Tem'per-screw. 1. (*Well-boring.*) A piece by which the tools are suspended from the walking-beam, and are lowered as the drilling progresses.

2. A *set*-screw for adjustment. One which brings its point against a bearing or an object.

Tem'plate. See TEMPLET.

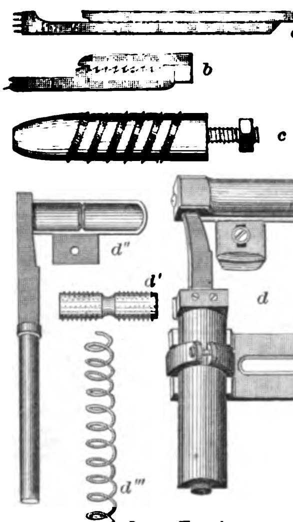
Tem'ple. 1. (*Weaving.*) An instrument for keeping cloth its proper breadth while the reed beats up against it in the process of weaving. In a loom weaving 100 picks per inch, the vibration of the reed being 4 inches, the reed passes over each portion of the warp-threads 800 times. If, therefore, the cloth be not extended so as to bring the warps nearly parallel to the motion of the reed, the selvedge-threads become chafed.

To obviate this difficulty the temple is designed.

The old form is shown at *a*. It consists of two pieces of hard wood with points at the ends to catch the selvedge at either side. They are adjusted as to length for the width of the goods.

b shows Stillman's jaw temple, patented in 1826. The cloth was released and allowed to slide forward when the lay was full up against it, and shut together, holding it out to a proper width when the lay retired. *b* shows the part which held the cloth

Fig. 6290.



Loom-Temples.

The first rotary temple was patented by Ira Draper in 1816. In this, the cloth was held by a horizontal wheel having a row of teeth set obliquely to its axis. It was improved in 1829 in fastening it to the breast-beam by a spring to give it elasticity. George Draper's patent of 1840 added another row of teeth to prevent its leaving a track in the cloth.

c is the Kayser temple which holds the cloth extended by needle-pointed rings turning at an oblique angle to the plane of the breast-beam, thereby automatically stretching the cloth as it passes through

d is the "Dutcher" temple, now in general use. It has small cylindrical toothed rolls holding the cloth by two or more inches of its breadth. It works nearer to the reed than the others, and has a reciprocating action whereby the lay beating against it produces a motion corresponding with and equal to the motion of the cloth. The lower figure shows several parts, — the spiked roller *d'*, its case and bar *d''*, and the spring d''' detached; also the device *d* complete.

2. One of the bars on the outer ends of the spectacle bows by which the spectacles are made to clasp the head of the wearer.

Tem'plet. 1. A mold or pattern used by molders, bricklayers, machinists, etc., in laying off their work. It frequently consists of a flat, thin board, whose edge is dressed and shaped to the required conformation, and is laid against the object being molded, built, or turned, so as to test the conformity of the object thereto.

In the examples, *a* is a *templet* for a *baluster*, which is turned in a lathe.

b is a templet for a steam-engine cylinder, the mold of which is made of *loam work.* See CASTING.

Fig. 6291.

Templets.

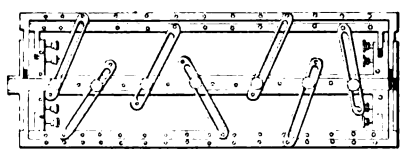
Templets or pattern plates of hardened steel are used for testing the progress and perfection of curved works that are shaped by the file. Sheet-metal works, not required in sufficient quantity to make punches and dies for their production, are fashioned between *templets* in a vice.

The templet for forming the striking wheel of a clock has 12 steps arranged spirally on its edge. A number of brass disks are clamped between two of such templets, and then dressed by a file in correspondence with the pattern at each end of the pack

In making lenses, *templets* of sheet-brass are first made corresponding to the curves of the lenses. These templets are used in making the *shells* and *runners*, between which the lenses are ground to shape.

Perforated templets are used by boiler-makers and others to lay out the holes for punching In order to allow one section

Fig. 6292.



Adjustable Templet.

of pipe to slip into another, the holes around the plate are not punched in rectangular patterns.

Williams's adjustable templet has movable perforated side bars, combined with T-shaped heads upon the central bar; also adjustable and perforated slides combined with each other and with the central bar.

2. (*Shipbuilding.*) *a.* A mold of a certain figure to test or direct the conformation of a timber or other object.

b. A perforated piece or strip by which a line of rivet-holes is marked on a plate to be punched.

c. One of the wedges in a building-block.

3. (*Building.*) *a.* A short piece of timber or large stone placed in a wall to receive the impost of a girder, brestsummer, or beam, and distribute its weight; a wall-plate; a *torsal.*

b. A plate spanning a window or door space to sustain joists and throw their weight on the piers.

4. (*Weaving.*) The templet of the horsehair-loom is a pair of jaws for each selvedge. See TEMPLE.

Temse. (*Milling.*) A bolting cloth or sieve. *Tamise.*

Ten. (*Mining.*) A measure (local) containing 420, and in other cases 440 bolls, Winchester measure.

Te-nac'u-lum. (*Surgical.*) *a.* A fine hook, attached to a handle, which is thrust through the parietes of a blood-vessel to draw it out and enable it to be tied.

a, pocket-tenaculum.

b, aneurism-tenaculum

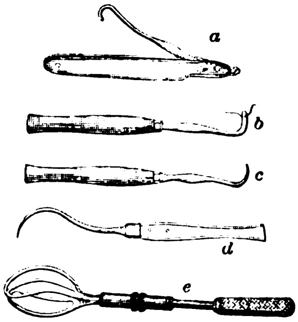
c, aneurism-needle

d, ordinary tenaculum.

e, tenaculum-forceps.

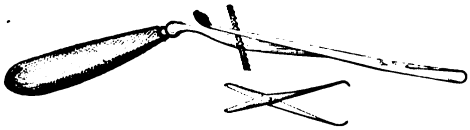
The double tenacula (Fig 6294) consist of two hooks, pivoted after the

Fig. 6293.



Tenacula.

Fig. 6294.



Double Tenacula.

manner of scissors, for more effectually holding the ends of a severed artery.

b. Bone-nippers.

Te-nac'u-lum-for'ceps. (*Surgical.*) An instrument, known as Assalini's tenaculum, for grasping the parietes of an artery, to facilitate tying. The instrument has a pair of bifurcated claws which close into each other upon the artery by the force of a spring.

The tenaculum-forceps with a sliding ring was used in old Rome. One was disinterred at Pompeii in 1819 by Dr Cavenko of St. Petersburg, in the Via Consularis. It is pictured in Smith's "Dictionary of Antiquities," page 274, and is in the Museum of Portici.

e (Fig. 6293) is an instrument invented by Prince, which acts the part of a tenaculum and forceps combined. The upper bow is that of the tenaculum, and beneath it are the bow jaws of the forceps. The blades of the jaws are made wide enough to stop the bleeding, and when the noose of the ligature is over the largest swell of the blades, it slides into its position without catching upon the point of the tenaculum.

Te-naille'. 1. (*Fortification.*) A low work located in the ditch and in front of a curtain to protect the curtain and flanks of the bastions. A passage is left between each end and the adjacent flank. See BASTION.

2. (*Surgical.*) Nippers: *tenaille incisive*, cutting nippers; bone nippers.

Tenettes. Craniotomy forceps.

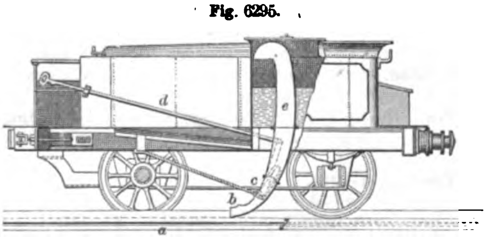
Te-nail'lon. (*Fortification.*) A low outwork having a salient angle; it was formerly usual to place one on each side of a ravelin to increase its strength and cover the shoulders of the bastion.

Ten'ant-saw. See TENON-SAW.

Tend'er. 1. (*Railroading.*) The carriage which is attached to a locomotive and contains a supply of fuel and water. See LOCOMOTIVE.

In 1854, Angus W. McDonald, of New Creek Depot, Va., patented a plan for filling the tanks of locomotive tenders with water without stopping the train, by using an inclined scoop, which was caused to dip into reservoirs placed at suitable intervals alongside of or beneath the track. This method, which met with little favor in this country, has been adopted on several English railways. As there practiced, a long water-trough *a*, made up of cast-iron sections, is laid upon the sleepers between the rails, and at such an elevation that the scoop *b* may be immersed into the water a depth of two inches, just equal to the depth of its mouth, which has a width of 10 inches. The scoop is hinged at *c*, and, when not in use, is tilted upward by a counterbalance weight. When one of the supply-troughs is approached, the scoop is depressed by means of the rod *d*, and the onward movement of the train causes the water to rush into the mouth and be forced up the delivery-pipe *e*, having a downwardly opening mouth through which it is discharged into the tank. On releasing the handle of the rod *d*, the scoop ceases to operate.

Fig. 6295.

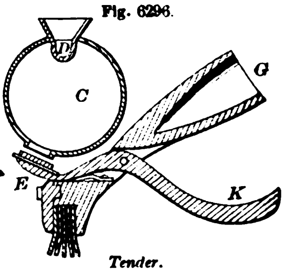


Self-Supplying Tender.

2. (*Nautical.*) A small vessel employed to tend upon a larger one, with supplies of provisions, to carry dispatches, to assist in the performance of shore duty, in reconnoitering, etc.

3. (*Household.*) A small reservoir attached to a mop, scrubber, or similar utensil.

Fig. 6296.



Tender.

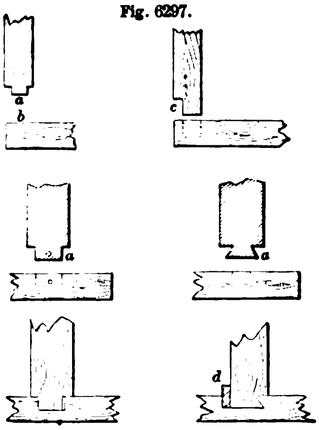
In the example, the socket *G* receives the mop-handle, the tender *C* is supplied through the trough *D*, and the water is caused to flow by compressing the arm *K*, opening the valve *E*, which is afterward closed by a spring.

Ten'der Por'ce-lain. A ware composed of a vitreous frit rendered opaque and less fusible by addition of calcareous clay. Its glaze is a glass of silica, alkali, and lead.

Ten'do-tome. (*Surgical.*) A subcutaneous knife, having a small oblanceolate blade on the end of a long stem, and used for severing deep-seated tendons without making a large incision or dissecting down to the spot. See TENOTOME.

Ten'on. (*Carpentry.*) The projecting end of a piece of timber fitted for insertion into a mortise, formed by cutting away a portion on one or more sides; sometimes made cylindrical. The usual joint in putting up wooden frames, whether of buildings or machines.

Fig. 6297.



Tenons.

a, tenon.
b, mortise.
c, relish.
d, dovetail tenon and key.

Tenons are secured in their mortises by pins, or by giving them a dovetail, which is driven into the undercut mortise by means of a wedge or backing-block *d*.

Fig. 6298 shows tenons of various forms.

A tenon on the top of a post to receive two beams meeting each other at right angles is a *tease*-tenon.

Ten'on-au'ger. The ends of movable blind-slats are usually turned down to a round tenon by a hollow auger *a* (Fig. 6299). The end of the tenon is afterward dressed by a *bur b*; *c* is a shoulder-bur.

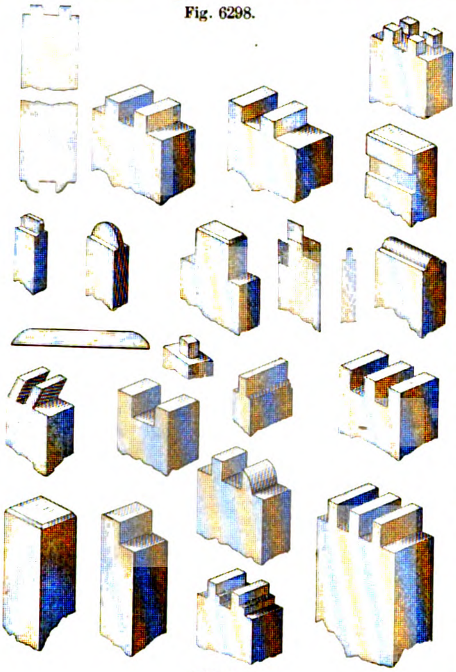
Ellis's blind-slat tenoning-machine operates by a pair of equalizing saws upon each end of the tenon, cutting the shoulders, rounding the tenon, and cutting the slab to a length at one operation.

In Fig. 6300, the cutter is obliquely placed in the snail-shaped holder, so as to make a draw-cut on the stuff. It embraces the hollow mandrel, which in turn incloses the graduated shank. The tube is adjusted on the shank so as to determine the length of the spoke-tenon, and is secured by a temper-screw.

Ten'on-ing-chis'el. A double-blade chisel which makes two cuts, leaving a middle piece which forms a tenon. The two chisels are connected by steady pins and a key to the stock, and are adjusted into exact parallelism by two right and left handed set-screws.

Ten'on-ing-ma-chine'. (*Wood-working.*) A machine for cutting timber to leave a tenon. It may

Fig. 6298.



Tenons.

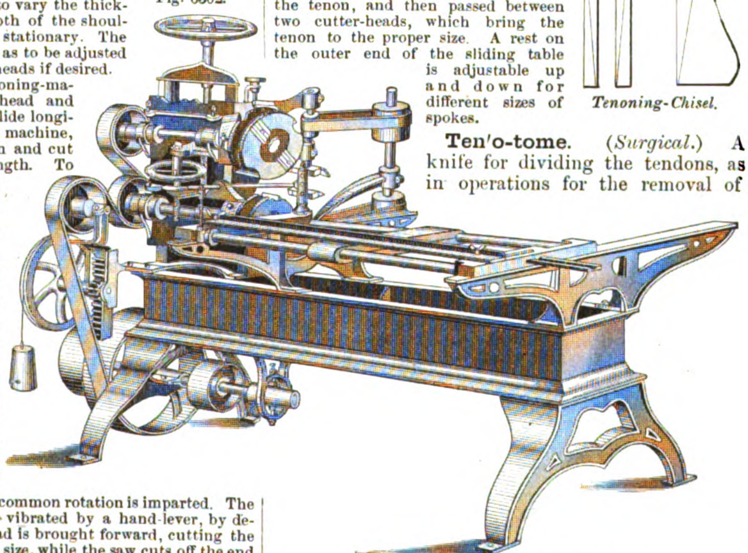
have either a hollow auger, which cuts the stuff away down to the shoulder (see TENON-AUGER); or it may be of the nature of a planing-machine, which, by revolving cutters, removes the stuff from the side, giving the *shoulders* at the sides, and the *relish*, if any (see TENON); or it may be of the nature of a mortising-machine, where chisels cut away the stuff and leave a projecting piece, which constitutes the tenon (see MORTISING-MACHINE).

Fig. 6302 is a machine particularly designed for sash and door work. It is provided with single cutter-heads and double copes. Both cutter-heads are raised and lowered by a screw and band wheel to each, and are readily adjustable, to vary the thickness of the tenon or the depth of the shoulder, the carriage remaining stationary. The coping heads are so arranged as to be adjusted independently of the cutter-heads if desired.

Fig. 6303 is a blind-slat tenoning-machine. The rotary cutter-head and saw-carriers are arranged to slide longitudinally on the bed of the machine, so as to simultaneously tenon and cut off slats of any required length. To provide for this, the main driving-pulleys are made of an elongated form, permitting a considerable range to the belts.

The machine, Fig. 6304, is designed for forming oval tenons on the ends of spokes, obviating the necessity of wedging when the rim is put on. The wheel is held by two chucks which receive the ends of the hubs, and the spoke being operated on is seized by two geared clamps which open and close simultaneously, presenting its end to the action of the cutters and a saw, which are carried on a spindle placed eccentrically to a gear-wheel, by which their common rotation is imparted. The upper part of the machine is vibrated by a hand-lever, by depressing which the cutter-head is brought forward, cutting the oval, which may be varied in size, while the saw cuts off the end of the spoke.

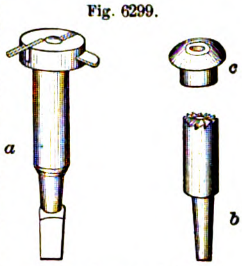
Fig. 6302.



Sash and Door Tenoning-Machine.

Fig. 6305 is a machine for cutting mortises and tenons on the ends of heavy framing-timbers; especially the sill-pieces of railway-car frames. The cutter-heads are fitted to a horizontal spindle running in self-oiling bearings, fixed to a traveling head, which is moved vertically by means of a rack, pinion, and hand-wheel. Tenons may be worked on each end of timbers without turning them around, by passing them along lengthwise across the gap, previously raising the cutters out of the way by turning the hand-wheel.

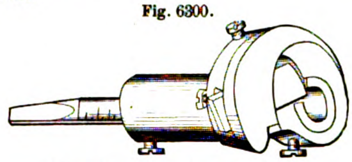
Fig. 6299.



Tenon Auger and Bur.

Ten'on-saw. A thin saw with a thicker metallic backing; used for fine work, such as sawing tenons, dovetails, miters for joints, etc.

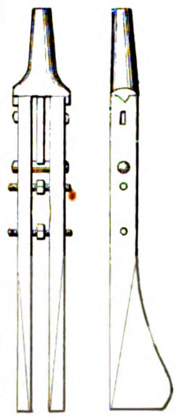
Fig. 6300.



Stearns's Hollow Auger for Spokes.

Some varieties are known as *sash*, *carcase*, and *dovetail* saws. The tenon-saw has 8 teeth to the inch; the carcase-saw, 11 teeth to the inch; the sash-saw, 13 teeth to the inch; the dovetail-saw, 15 teeth to the inch

Fig. 6301.



Tenoning-Chisel.

Ten'on-tru'ing Ma-chine'. (*Wood-working.*) A machine for truing or sizing the tenons of spokes and cutting the tenons to the desired length at the same operation. It has an upright spindle with two cutter-heads, the upper one being adjustable to vary the thickness of the tenons.

The spoke is laid on a small sliding-table, pushed forward to a circular saw, which cuts off the end of the tenon, and then passed between two cutter-heads, which bring the tenon to the proper size. A rest on the outer end of the sliding table is adjustable up and down for different sizes of spokes.

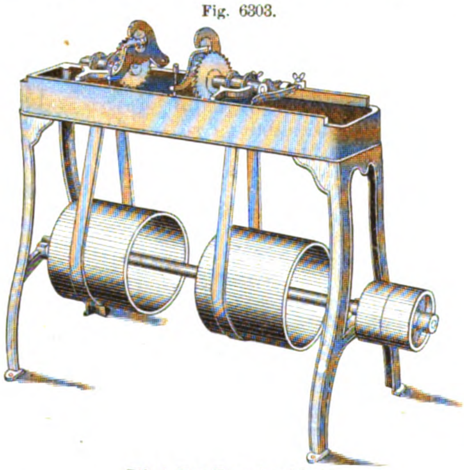
Ten'o-tome. (*Surgical.*) A knife for dividing the tendons, as in operations for the removal of

loxarthrus, or deviation of the joints, as in club-foot.

a, pocket-tenotome.
b c d e, tenotomes of various shapes, to suit special needs.

Ten'sile Strength. The cohesive power by which a material resists an attempt to pull it apart in the direction of its fibers. This bears no relation to its capacity for resisting compression; cast-iron, for

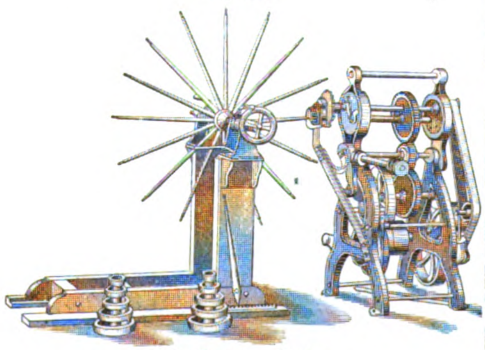
Fig. 6303.



Blind-Slat Tenoning-Machine.

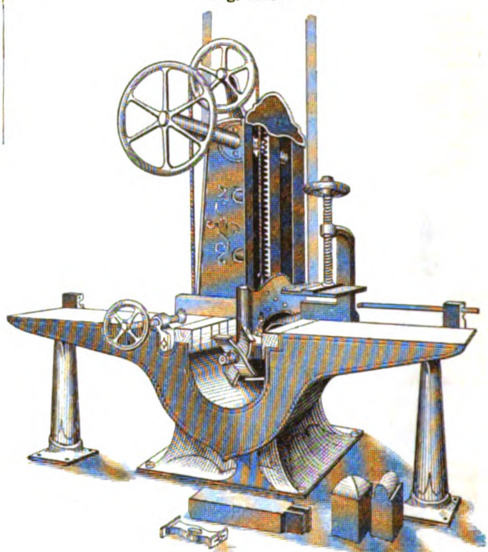
example, which possesses a comparatively low tensile strength, say 30,000 pounds, requires a force of 100,000 pounds or more to the square inch to crush it; while good bar-iron, having nearly double the tensile strength, is crushed by a force of 40,000 pounds to the square inch. The difference is still more marked in the case of stone and similar materials. The table appended gives the usually accepted data. The experiments of General Rodman, Ordnance Manual, 1861, give generally much higher tenacities to the different specimens of wood tested by him. See TESTING-MACHINE.

Fig. 6304.



Spoke-Tenoning Machine.

Fig. 6305.



Fay's Gap-Bed Tenoning-Machine.

Weight or Power required to tear asunder one Square Inch.

METALS.

	Lbs.		Lbs.
Copper, wrought	34,000	Iron, Clyde, No. 1	16,125
Copper, rolled	36,000	Iron, Clyde, No. 3	23,468
Copper, cast, American	24,250	Iron, Calder, No. 1	13,735
Copper, wire	61,200	Iron, Stirling, mean	25,764
Copper, bolt	36,800	Iron, mean of American	31,829
Iron, cast, Low Moor, No. 2	14,076	Iron, mean of English	19,484

	Lbs.
Iron, Greenwood, American	45,970
Iron, gun-metal, mean	37,232
Iron, wrought wire	103,000
Iron, best Swedish bar	72,000
Iron, Russian bar	59,500
Iron, English bar	56,000
Iron, rivets, American	53,300
Iron, bolts	52,250
Iron, hammered	53,913
Iron, mean of English	53,900
Iron, rivets, English	65,000
Iron, crank shaft	44,750
Iron, turnings	55,800
Iron, plates, boiler, American	48,000 / 62,000
Iron, plates, mean, English	51,000
Iron, plates, lengthwise	53,800
Iron, plates, crosswise	48,800
Iron, inferior, bar	30,000
Iron, wire, American	73,600
Iron, wire, American, 16 diameter	80,000
Iron, scrap	53,400
Lead, cast	1,800
Lead, milled	3,320
Lead, wire	2,580
Platinum, wire	53,000
Silver, cast	40,000
Steel, cast, maximum	142,000
Steel, cast, mean	88,657
Steel, blistered, soft	133,000 / 104,000
Steel, shear	124,000
Steel, blister	133,000
Steel, puddled, extreme	173,817
Steel, puddled or semi-iron	121,408
Steel, plates, lengthwise	96,300
Steel, plates, crosswise	93,700

	Lbs.
Steel, razor	150,000
Tin, cast, block	5,000
Tin, Banca	2,122
Zinc	3,500
Zinc, sheet	16,000
Brick, well burned	750
Brick, fire	65
Brick, inferior	290 / 100
Cement, blue stone	77
Cement, hydraulic	234
Cement, Harwich	30
Cement, Portland, 6 months	414
Cement, Sheppy	24
Cement, Portland 1, sand 3	380
Chalk	118
Glass, crown	2,346
Gutta-percha	3,500
Hydraulic lime	140
Hydraulic lime mortar	140
Ivory	16,000
Leather belts	330
Limestone	670 / 2,800
Marble, Italian	5,200
Marble, white	9,000
Mortar, 12 years old	60
Plaster of Paris	72
Rope, Manilla	9,000
Rope, hemp, tarred	15,000
Rope, wire	37,000
Sandstone, fine grain	200
Slate	12,000
Stone, Bath	352
Stone, Craigleth	400
Stone, Hailes	360
Stone, Portland	857 / 1,000
Whalebone	7,000

COMPOSITIONS.

Gold 5, copper 1	50,000	Copper 8, tin 1, gun-metal	30,000
Brass	42,000	Copper 8, tin 1, small bars	50,000
Brass, yellow	18,000	Tin 10, antimony 1	11,000
Bronze, least	17,698	Yellow metal	48,700
Bronze, greatest	56,788		
Copper 10, tin 1	32,000		

WOODS.

Ash	14,000	Cypress	6,000
Bay	14,000	Deal, Christiana	12,400
Beech	11,500	Elm	13,400
Box	20,000	Lance	23,000
Cedar	11,400	Lignumvitæ	11,800
Chestnut, sweet	10,500	Locust	20,500

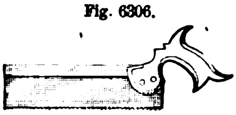
	Lbs.		Lbs.
Mahogany	21,000	Pine, pitch	12,000
Mahogany, Spanish	12,000	Pine, larch	9,500
Mahogany, Spanish	8,000	Pine, American white	11,800
Maple	10,500	Poplar	7,000
Oak, American white	11,500	Spruce, white	10,290
Oak, English	10,000	Sycamore	13,000
Oak, seasoned	13,600	Teak	14,000
Oak, African	14,500	Walnut	7,800
Pear	9,800	Willow	13,000

Ten'sion. 1. (*Telegraphy.*) Power of overcoming resistance.

2. (*Mechanics.*) The lengthwise straining force on a member of a truss or frame.

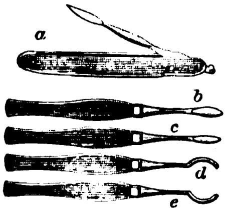
3. (*Sewing-machine.*) A pressure upon the thread to prevent its running too easily from the spool. By adjustment of the pressure at the tension device, the required tightness of stitch is obtained.

Fig. 6306.



Tenon-Saw.

Fig. 6307.



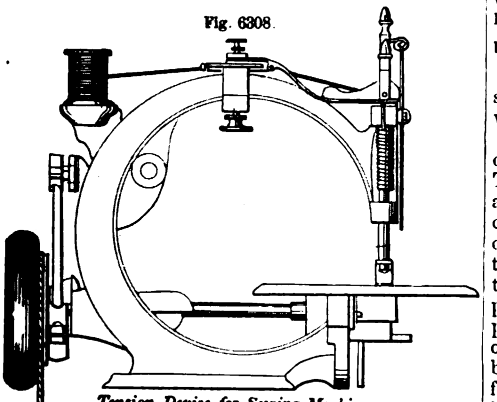
Tenotomes.

In Fig. 6308, the thread passes between two plates secured to the pressure-foot arm, one of which plates is operated by means of a spring acting as a lever, by which the tension is rendered self-adjusting, according to the thickness of the cloth.

There are many other kinds of *tensions*, in different machines. See list, Division F, section 25, page 2112.

Fig. 6309 shows the Willcox and Gibbs automatic tension, a mechanism to hold the thread firmly, so that none can be drawn through until at a fixed point, and then suddenly release it, allowing whatever is required to be freely drawn through. The amount of thread taken at each stitch being of course just what is required to inclose the goods being taken out of the slack

Fig. 6308.



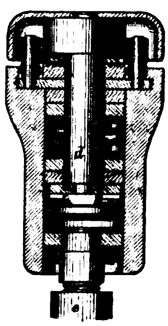
Tension-Device for Sewing-Machines.

thread formed by the descent of the needle-bar take-up, it follows that when the take-up rises and the looper continues to revolve, a point is reached when some more thread must be allowed to escape through the tension, or the thread will be broken. At this time the loop cast off from the looper being drawn up to the under side of the material, the tension opens, and just enough thread is taken to make good the loss.

The automatic tension-device, shown above the actual size in Fig. 6309, and in situ in Fig. 4865, is placed in the standard of the machine, and the thread passing from the spool to the *pull-off* is then led past two pins and between two disk surfaces, one of which is ridged to make the bite upon the thread more effective. The spiral spring shown around the stem *d* is the agent in this grasp of the thread, but at a certain part of the stroke, as above explained, the rod *e* is lifted by an eccentric, and by this positive motion the stem *d* and upper disk are lifted, allowing the thread to be pulled through by the motion of the needle-arm. This elegant device is worthy of a more detailed description.

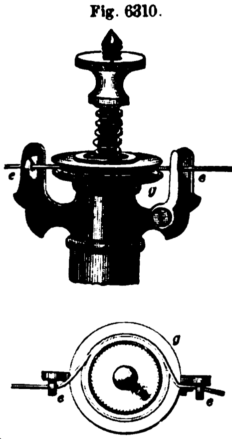
Fig. 6310 shows the W. G. Wilson device for controlling the degree of tightness of the thread of a sewing-machine. The upper thread and the shuttle-thread should have the same tension in a lock-stitch machine, so as to pull the bights of the threads into the middle of the fabric. The under-thread tension is regulated by springs or pins on the shuttle, or by holes in it,

Fig. 6309.



Willcox and Gibbs Automatic Tension

Fig. 6310.



Wilson Tension.

and, in revolving-hook machines, by other means. The upper thread is usually passed against two standards *e e*, between which it is wrapped around a grooved sheave *g*, and its tightness is controlled by the pad, spring, and tension nut, which offers more or less impediment to the rotation of the sheave.

Ten'sion-bridge. A bridge constructed on the principle of the bow, the arch supporting the track by means of tension-rods, and the string acting as a tie. See BOWSTRING-BRIDGE.

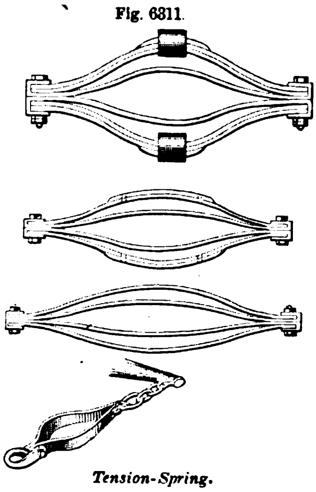
The name may also be applied to a bridge much advocated some years back, for short spans, in which long wooden strips were anchored at each end, and strained as nearly level as possible.

The tension principle abounds in the lower longitudinal members of all truss-girders.

Ten'sion-rod. A *stay* or *tie-rod* in a truss or structure, which connects opposite parts and prevents their spreading asunder.

Tension-spring. A spring for wagons, railway-carriages, etc. The inner leaves, and, in some cases, the outer ones, are free in the center, so as to elongate independently under pressure. The outer leaves may be of any suitable form, so that they impart a tensile strain to the inner ones, which are preferably of *cyma reversa* curvature. Under heavy strains the inner leaves elongate, so as to nearly form cords to the arc of the outer leaves; this limits the inward flexibility of the spring.

Fig. 6311.



Tension-Spring.

Tent. 1. A portable shelter of fabric or other flexible material. Skins have been used for the purpose among barbarous tribes from time immemorial.

The tent is the original of the most graceful of all styles of

architecture, — the Chinese. No plane-surfaced roof, whatever its pitch, can vie in beauty with that which simulates the covering of a tent or pavilion.

Its form permits an amount and kind of graceful ornamentation, checker-work, stripes, barge-boards, and scalloped bordering, which become *it*, and are mere arbitrary and extraneous ornaments to the more formal styles.

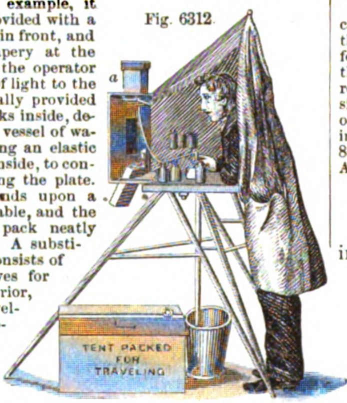
Tents form an important part of the equipment of an army in the field, and much ingenuity has been exerted in endeavoring to secure the maximum of accommodation and comfort with a minimum of weight and space. See ACCOUTERMENTS, Fig. 19. They are known as

Bell-tent,	Marquee,	Sibley-tent,
Hospital-tent,	Shelter-tent,	Wall-tent, etc.

The tent of Achilles was a wooden hut covered with reeds. Such were sometimes used by the Romans in winter. On the Trajan and Antonine columns are four-square tents with slanting roofs, and also conical tents. They were sometimes of leather, usually of cloth. Nero had an octagon tent of great beauty. The Oriental tents were of silk, and gorgeously furnished. That of Attila was very spacious and magnificent. Alexander placed 200 persons in one pavilion.

2. (*Photography.*) An instrument for field-photography; a substitute for the usual dark room.

Fig. 6312.



Photographer's Tent.

As shown in the example, it consists of a box provided with a yellow glass window in front, and furnished with drapery at the back, so as to cover the operator and prevent access of light to the interior. It is usually provided with shelves and racks inside, developing-tray, and a vessel of water *a* overhead, having an elastic tube passing to the inside, to convey water for washing the plate. The instrument stands upon a tripod or skeleton-table, and the whole is made to pack neatly for transportation. A substitute for the tent consists of arm-holes and sleeves for reaching the interior, the progress of development being observed through a yellow window.

3. (*Surgical.*) A roll of lint, sponge, etc., of cylindrical or conical shape, introduced into an ulcer or wound to keep the external portion open and induce it to heal from the bottom.

Sponge-tent is made by dipping the sponge into melted wax plaster and pressing it till cold between two iron plates. It is then cut into pieces.

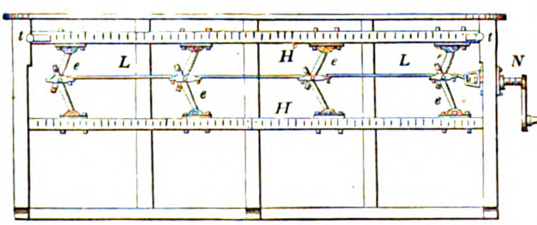
Paper pulp, to which grated sponge has been added, is used for making a paper which may be rolled up to form a tent.

Ten-ta′tion. A mode of operating or adjusting by essay, trial, or experiment, as in

1. (*Locksmithing.*) A mode of picking locks in which the bolt is pressed backward constantly, and the tumblers released one by one from the stud.

2. (*Compass-adjusting.*) Professor Airy's mode of adjusting compasses in iron ships, in which boxes of iron chain and magnets are experimentally placed and shifted in position until the disturbing influence of the iron hull is neutralized. See page 1398.

Fig. 6313.



Tenter-Bar.

Ten′ter. 1. A frame used to stretch pieces of cloth, to make them set even and square. The selvedges of the cloth are attached to the frame by sharp hooked nails, called *tenter-hooks.*

2. A drying-room.

Ten′ter-bar. A device for stretching cloth.

In the apparatus, Fig. 6313, the cloth is attached by hooks to bars *H H′*, which are then drawn apart equally throughout their length by a succession of toggle-levers *e e* actuated by a crank-screw *N* and rods *L L*, which connect the hinging-joints of the toggles.

Ten′ter-hook. One of a set of hooks arranged on the inside margin of a frame and used in stretching cloth, the margin of which is held fast by the hooks.

Ten′ter-ing-ma-chine′. A machine for stretching fabrics.

In one form of the machine, combinations of adjustable oblique traveling selvedge-feeding and carrying devices are used, which, in some cases, operate in connection with endless belts, bands, or cords arranged to hold the selvedges of the fabric in between them and the carrying-devices; the intermediate portion or body of the fabric is run over a divided longitudinally expanding and contracting friction-frame or drag arranged between the selvedge carrying and stretching devices.

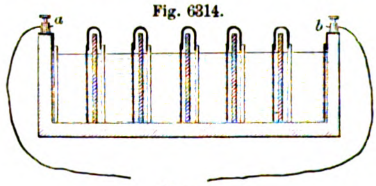
Another machine has an arrangement of separate selvedge carrying, stretching, and feeding devices on opposite sides of the machine, driven in a positive manner, with facility not only for driving said devices on one side of the machine and not on the other, but of positively driving them at different velocities relatively with each other, to adjust the stretch or feed on opposite sides, as required. A roller on the delivery side at the foot of the chains stretches the fabric in its passage from the stretching-devices to the first drying-cylinder. See Palmer's patents, 88,504, March 30, 1860; 148,082, March 3, 1874; and 161,896, April 13, 1875.

Tent′ure. Paper-hangings; wall-paper.

Term. (*Shipwrighting.*) See TERM-PIECE.

Ter′mi-nal. (*Electro-magnetism.*) The clamping-screw at each end of a voltaic battery, used for

Fig. 6314.



Battery.

connecting it with the wires which complete the circuit. One terminal *b* is at the copper or *negative pole*, and the other *a* at the zinc or *positive pole*. Their connection by wire starts the battery into action.

Ter′mi-ni. (*Architecture.*) Busts or figures of the upper portion of the human body, terminating in a downwardly tapering block; employed as pillars, balusters, or detached ornaments for niches. Non-detached ornaments for support may be found under ATLANTES; CARYATIDES; PERSIANS; TELAMONES; etc.

Term-piece. (*Shipbuilding.*) One of the pieces of carved work extending from the end of the taffrail to the foot-rail of the balcony.

Terne-plate. Thin iron plate coated with an alloy of tin and lead.

Ter′ra-al′ba. Literally, *white earth.* Armenian bole; pipe-clay. Used as an adulteration of confectionery, for adding to paper to increase its weight, and for other purposes. The name is also applied to other materials similarly used: as, for instance, calcined or powdered gypsum; calcined, powdered, and floated sulphate of barytes.

Ter′ra-cot′ta. (Fr. *terre cuite*, baked clay.) A compound of pure clay, fine-grained, colorless sand or calcined flints, and pulverized potsherds, is molded, dried in the air, and baked in a kiln. It is especially used for architectural decorations, figures, vases, etc.

Blanchard's terra-cotta (Exposition, London, 1851) was a composition of white pipe-clay, crushed potsherds, calcined flint, flour glass, and white sand, well compounded. The molded articles were burned at a high temperature.

A good article of terra-cotta is more durable when weather-exposed than most stone.

Ter'ras-es. (*Masonry.*) Hollow defects in marble or fissures filled with nodules of other substances. The hole, being cleaned out, is filled with marble dust and mastic of the same color. See BADIGEON, page 207.

Ter'ra-sphere. A term for the TELLURIUM (which see).

Terre'-plein. (*Fortification.*) The upper part of the rampart which remains after constructing the parapet. See BASTION.

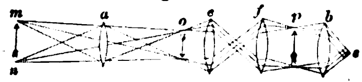
Ter-res'tri-al Eye-piece. (*Optics.*) An eye-piece with three or four lenses, so arranged as to present the image viewed in an erect position. An *erecting eye-piece.* See TERRESTRIAL TELESCOPE.

Ter-res'tri-al Globe. A spherical map representing the land, seas, etc., of the world. In contradistinction to the *celestial* globe, on which are depicted the constellations.

Ter-res'tri-al Tel'e-scope. A telescope differing from the *astronomical refracting* in having two additional lenses, so as to restore the inverted image to an erect position.

The focal lengths of the additional lenses *f b* are usually the same as that of the eye-glass. The two pencils of rays proceeding from the points *m* and *n* cross each other in the anterior

Fig. 6315.



Terrestrial Telescope.

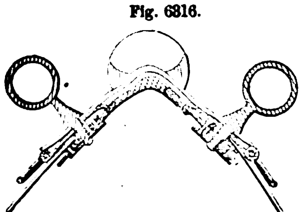
focus of the second lens *f*, and, falling parallel on that lens, form in its principal focus an inverted image of *o*, and consequently an erect image of the object *m n*.

This image *p* is seen by the eye at *s* through the lens *b*, as the rays diverging from *p* in the focus of *b* enter the eye in parallel pencils.

When the first three lenses are equal, the magnifying-power is the same as that of the astronomical telescope, whose object and eye glasses are the same as *a e*. See TELESCOPE.

Rheita was the first to employ the combination of three lenses, known as the *terrestrial* telescope. Scheiner, in 1630, had used a combination of two convex lenses, the image being inverted; to this he afterward added two other glasses, which again reversed the images, making them appear in their natural position.

Fig. 6316.



Gig-Saddle, with Terrets.

Ter'ret. (*Saddlery.*) A ring attached to the pad or saddle and hames of harness, through which the driving-reins pass.

Ter'ri-er. An *auger.* A *wimble.*

Ter'ro-met'al. A composition of several clays, possessing, when baked, peculiar hardness, introduced by Mr. Peake, a potter, of Burslem, England.

It is principally employed for making tiles of various kinds.

Ter'ry. (*Rope-making.*) An open reel.

Ter'ry-fab'ric. (*Weaving.*) (Fr. *tirer*, to draw, to draw out.) A pile fabric, such as plush or velvet; probably from the *drawing out* of the wires over which the warp is laid to make the series of loops seen in Brussels carpet or uncut velvet.

In some looms for weaving pile fabrics, mechanism is employed for actuating the wires, the *terry* loop forming the pile being obtained by inserting wires in a shed formed between the body warp and pile warp, which wires are woven in the fabric, to be again withdrawn in succession when a sufficient number of wires have been woven in the fabric to secure the loops or woven pile against the strain produced in the process of weaving.

Ter'ry-vel'vet. A silk plush, or ribbed velvet.

Tes'sel-at-ed Pave'ment. A pavement composed of square dies or tesseræ made of baked clay or stone, generally of various colors, and forming regular figures. It was employed by the ancients, particularly by the Romans, whose remains furnish the greatest number of existing specimens of ancient art in this line, and is much in vogue in the East, particularly at Damascus.

A pavement of this character, made of cubes of red, blue, black, and white marble, is mentioned in Esther i. 6.

Colored glass cubes were substituted for marble, and were common in the time of Augustus.

Tes'sel-at-ed Tile. Tile made of clay of a particular color, or mixed with coloring matters and formed into flat cakes by cutting or pressing, and used for making a tesselated pavement.

Tes'se-ræ. Colored tiles or bricks, usually cubical, laid in patterns, as a mosaic pavement. See Adam Clark on Revelation ii. 17. See also ABACUS.

Test. 1. (*Metallurgy.*) *a.* A *cupel.*

b. A cupeling-hearth used in a refining-furnace where lead is separated from silver on a large scale. The *test* is an oval iron frame containing a basin-shaped mass of powdered bone-ash, which is brought to a consistence by a solution of pearlash. The *test* is fixed as a cupeling-hearth in the reverberatory furnace, and is subjected to a blast from a tuyere, which removes the floating oxide of silver and furnishes oxygen for its elimination from the alloy under treatment.

Pattinson's process has nearly superseded the plan just described. See SILVER FROM LEAD, EXTRACTING.

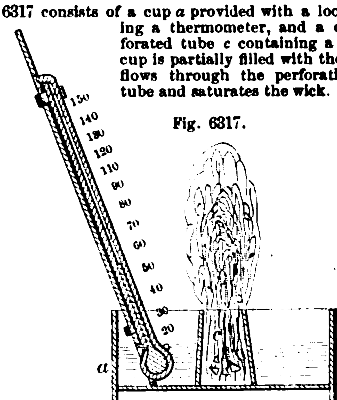
2. The proof of condition of a sirup, which is generally a matter of practice with the sugar-boiler, but has been reduced to a system by Payen. See PROOF.

3. In chemistry, a body which is used to detect the presence of another body in solution, indicating the said presence by a peculiar behavior, or by producing a specific effect. The behavior may be a change of color, as with litmus or turmeric paper. The effect may be a change in the solution as to color, limpidity, evolution of gas, precipitation, heat, congelation, etc.

4. An apparatus for proving petroleum and similar hydrocarbon oils by ascertaining the temperature at which they evolve explosive vapors.

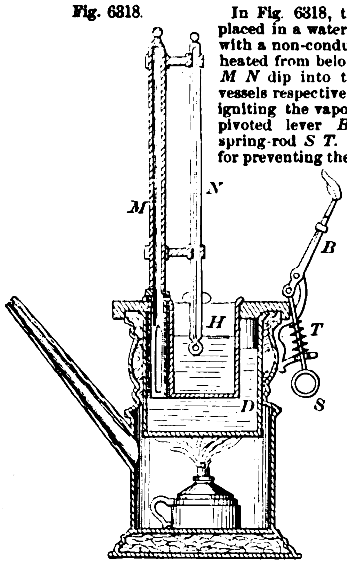
Fig. 6317 consists of a cup *a* provided with a loop for holding a thermometer, and a central perforated tube *c* containing a wick. The cup is partially filled with the oil, which flows through the perforations in the tube and saturates the wick. The latter, being ignited, heats the oil to the vaporizing point and sets fire to the vapor.

Fig. 6317.



Petroleum-Test.

Fig. 6318.



Carbon-Oil Fire-Tester.

In Fig. 6318, the oil-vessel H is placed in a water-bath D provided with a non-conducting jacket, and heated from below. Thermometers M N dip into the water and oil vessels respectively. The brand for igniting the vapor is carried by a pivoted lever B operated by a spring-rod S T. A cap is provided for preventing the vapor from being disturbed by currents of air, and a spigot for ensuring a uniformity in the level of the water and oil.

Test-cock. (*Steam-engine.*) A small cock fitted to the top or bottom of a cylinder for clearing it of water. It is generally constructed with a ball or reverse valve at its mouth, so as to allow of being kept open without the entrance of air, when there is a vacuum on the side of the piston with which it communicates. A *cylinder cock*.

Tes'ter. 1. The square canopy of a four-post bedstead.

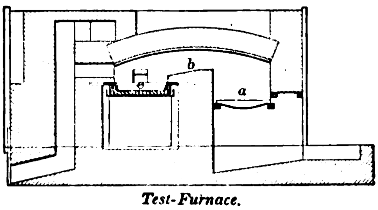
2. The canopy over a pulpit or tomb.

Tes'tes-sup-port'er. A suspensory bandage for the scrotum.

Test-fur'nace. (*Metallurgy.*) One form of refining furnace for treating argentiferous alloy, such as that of lead rich in silver.

It is of the reverberatory kind, a being the fire-grate, b the fire-bridge; c is the cupel or test, consisting of an oval ring of iron provided with cross-bars, into which a bone-ash mixed with water containing a small proportion of pearlash is packed, so as to form a reservoir for the molten metal. The test, when packed, is secured to an iron ring built into the masonry, and a low heat is applied to expel the moisture; this is afterward in-

Fig. 6319.

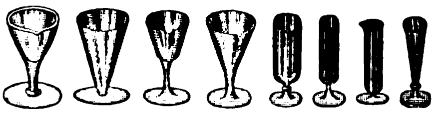


Test-Furnace.

creased until the test becomes heated to a cherry red, when the argentiferous lead previously melted in another furnace is poured in. This soon becomes covered with a grayish dross, and on increasing the heat litharge begins to form. The blast is now turned on, sweeping the litharge from the surface of the alloy and over the breast, where it is received in a proper vessel. As the metal decreases in volume, more is added, and the operation continued until that remaining at the bottom of the test is sufficiently rich to be drawn off; unless this be done at the proper point, a proportion of the silver is carried off with the litharge. When all the argentiferous alloy has been thus treated, it is again subjected to cupellation in the same or a similar furnace, by which the lead is converted into litharge, the silver remaining at the bottom of the cupel, which is then allowed to partially cool, is removed from the furnace, and the plate of silver detached. See ALLOY; AMALGAMATION; ASSAY; PARTING; CUPEL.

Test-glass. A glass vessel of conical or cylindrical form, having a foot and sometimes a beak; used for holding chemical solutions.

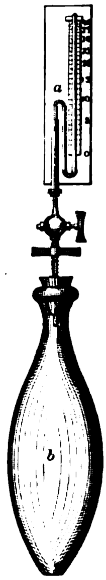
Fig. 6320.



Test-Glasses.

Test'ing-gage. In Fig. 6321, a is an instrument for ascertaining the pressure of gas in soda-water bottles, in order to check the work of the bottlers or test the soda-water of different makers.

Fig. 6321.



Testing-Gage.

It consists of a bent mercurial gage with graduated scale, having a tube with cock and screw-point at its lower end, which is inserted through the cork; on the cock being turned, the gas in the bottle b operates on the mercurial column in the bent tube. The ordinary pressure in bottles of soda-water is found to be from 40 to 60 lbs. per square inch, seldom rising to 70 lbs. See also TEST-PUMP.

Test'ing-ma-chine'. *a.* One for determining the strength of materials with strains of different kinds, tensile, transverse, and what not.

b. A machine for determining the lubricity of oils and other materials used to avoid friction between moving parts.

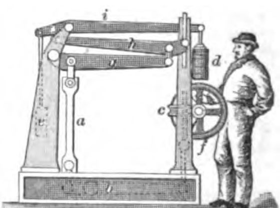
c. A machine for testing the power of motors. See DYNAMOMETER; also *infra*.

The machine, Fig. 6322, is designed for testing the tensile strength of metals. The rod a to be tested is cut to one square inch in section, and is held between clamps attached respectively to the levers b g. The lever b is acted on by a worm-wheel c and worm operated by a hand-wheel f, bringing the tensile strain upon the scale-beam levers g h i; to the long arm of the latter weights d are applied until the bar a is ruptured or the required testing-strain is reached. e is a counterbalance-weight for the levers g h i.

In Fig. 6323, A is an end and B a side elevation of a testing-machine designed by Major Wade for the United States Ordnance Department.

The lever a to which the power is applied has its fulcrum at a', supported by an interior frame b attached to the screw c, which passes through the axis of the bevel-wheel d above. The knife-edge e, from which the weights are suspended, is 72 inches, and the knife-edge f is 3.6 inches, from the fulcrum, or in the proportion of 20 to 1. From the latter is suspended the stirrup g, which receives the knife-edge of the long arm of the lever h, fulcrumed at h', 60 inches distant, and supporting the knife-edge of the stirrup i at a point 6 inches distant from the fulcrum. A force applied at e is thus multiplied 200 times at the latter point. By means of a crank j having a pinion gearing with the wheel k, the axis of which carries a bevel-pinion mashing with the wheel d, the screw c is raised, lifting the frame b, and with it the lever a. The long arm of this lever passes through a slotted guide l, which is simultaneously lifted by the turning of the rod m, which has a pinion at each end mashing with racks on the frame b and guide l respectively. The object of these arrangements is to keep the lever always in a very nearly horizontal position.

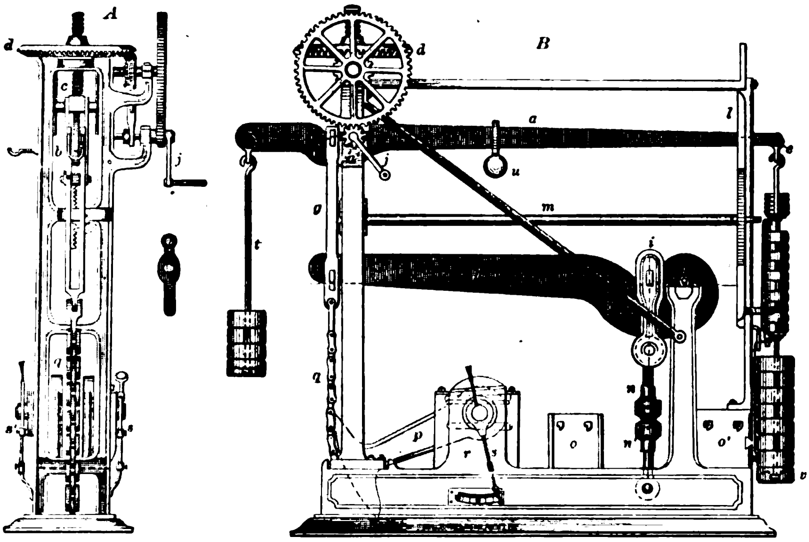
Fig. 6322.



Testing-Machine.

n n' are the devices for holding a bar which is to be tested by extension; these may be replaced by suitable devices for exerting a crushing force, and others for exerting a transverse upward pressure on a bar when drawn up against steel cross-bars placed transversely in the hollow blocks o o', cast with the bed-plate of the machine. p is the torsion-lever connected by a chain q with the stirrup g. In experiments in torsion the lever a is elevated bodily by the screw c through the medium of the crank j and its gearing, the bar to be tested being firmly held by the pedestal r at one end, and keyed to the journal of the torsion-lever at the other. The lever h is not in this case

Fig 6323.



Ordnance Department Testing-Machine.

brought into action. There is an index s s' on each side for indicating the degree of torsion, which, as the bar has a limited amount of play in its fastenings, is determined by the difference of the indexes.

The weights usually employed are of ½ pound, 5 pounds, and 25 pounds, representing strains of 100, 1,000, and 5,000 pounds.

The rod t with its platform and weights is used for adjusting the equilibrium of the machine, and also for counterbalancing the platform v suspended from the long arm of the lever when tensions of less than 5,000 pounds are being investigated. u is a movable weight for equilibriating the holding devices suspended from the stirrup i.

The apparatus (Fig. 6324) invented by Professor R. H. Thurston, of the Stevens Institute of Technology, Hoboken, N. J., is designed for testing and automatically registering variations in strength, elasticity, and ductility of materials; also showing the absolute tensional or torsional strength.

The framework a a' supports two arms b c turning upon independent axes in the same line. The arm b carries a weight d, and the arm c a handle e by which it is moved. To the frame is attached a guide-curve f, so formed that its ordinates are precisely proportional to the strain exerted by the arm b on the material to be tested. This arm also carries a pencil-holder containing a pencil which is pushed outward by the curve f as the arm is deflected from the perpendicular. A table g, to which the record paper is fastened, is attached to the arm c. A pointer j traversing the arc k serves as a check upon the record of maximum strength made by the pencil on the paper.

The axes of the arms b c are alike (B), and have rectangular recesses l designed to receive the ends of the pieces of material when experimenting with torsional strains; the ends of the pieces are made square, and are turned circular at the center, as shown at C D; one end is accurately fitted into the recess on the axis b', and the other into the corresponding recess in c', and force is applied to the arm c, which is transmitted through the piece being tested to the weighted arm b. The normal position of this arm is vertical, but under the influence of the applied pressure it rises, the weight d exerting a greater leverage as it rises; the guide-curve f is therefore so shaped as to cause the pencil to move equal distances with equal increments of force.

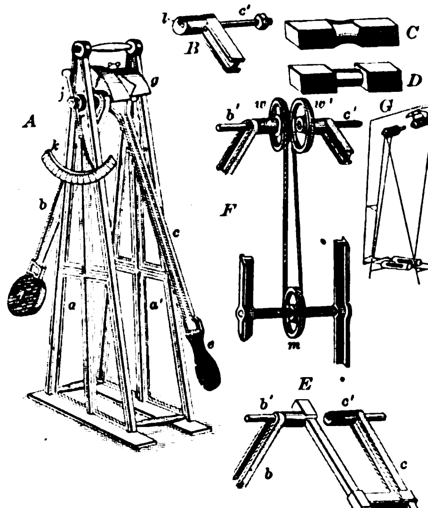
If the material to be tested were devoid of elasticity, the amount of movement of the arms b c would be exactly equal, and the pencil would describe a straight line; but as all materials yield more or less, the arm b will have less angular movement than c after the point is reached at which the fibers of the test-piece begin to change their relative positions, and the difference of their angular movements affords a measure of the distortion produced in the specimen, which is recorded by the curve traced by the pencil.

The paper may be ruled previous to being placed on the table g, according to a scale previously determined from the total movement of which the pencil is capable and the known powers required to lift the weight d to any angle between the vertical and horizontal; in this case the base line of the diagram is placed parallel to the planes in which the two arms move; the pencil is placed at the intersection of one of the lines parallel thereto with one of the other series, which are vertical to it; these serve respectively as the ordinates and abscisses by which the curve showing the behavior of the material being tested is measured. If the paper be not previously ruled, a line drawn between the points at which the pencil was first applied, and at which it rested when the separation of the piece was effected, serves as a basis for constructing the co-ordinates, their origin being reckoned from the first point.

The record thus made is a curve, whose length depends on the amount to which the specimen was twisted before giving way entirely, and its depth shows the maximum force exerted to produce this result. The position of the pencil momentarily changes with each variation in the resistance of the material, and it is at the same time carried along on the periphery of the recording cylinder to a distance proportional to the amount of distortion or the total angle of torsion. As the applied force increases, the specimen yields, and finally, rupture occurring, the pencil returns to the base line at a distance from the starting-point which measures the angle through which the test-piece yielded before its fracture became complete.

The curves described vary greatly according to the character of the material. Considerable irregularities in their outline denote a want of homogeneity. They afford means of determining the elastic resistance, the resistance producing a given set, the ultimate resistance, the resiliency, the effect produced by a given weight on a given cross-section, the effect of blows or shocks either originally or when the material has been already subjected to a given tension, and the effect of a series of stresses.

Fig. 6324.



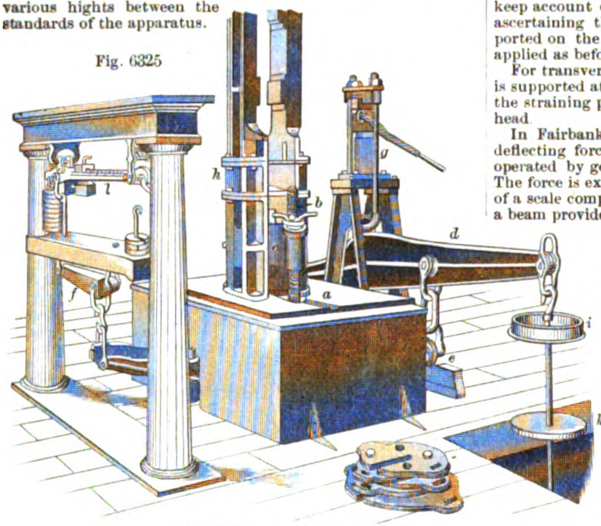
Thurston's Testing-Machine.

E shows the arrangement for investigating transverse strains; the bar to be tested is held in sockets n n, one of which is fitted to the recess l in one of the axes, and the other in a socket adjustable on the arm c.

F is employed for directly testing tensile strengths; the wire or rod is fastened at its extremities to the two wheels w' w' at-

tached to the ends of the axes $b' \ c'$ and passes around a wheel m, which may be adjusted at various hights between the standards of the apparatus.

Fig. 6325

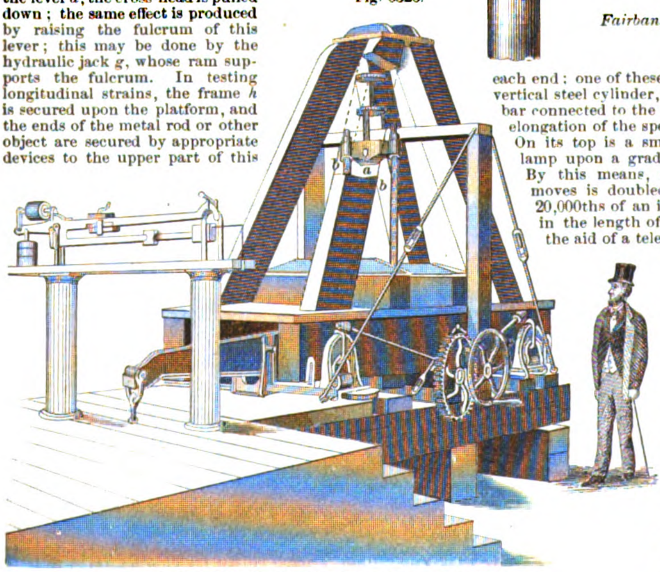


Colt's Armory Testing-Machine.

For heavy work a modification G of the machine is employed in which a spring balance or balances, instead of the weight, and a worm-wheel and worm in place of the simple lever c, are used; the recording apparatus is somewhat differently arranged, the pencil guide-plate being replaced by a spring, cords, and guide-pulleys.

Fig. 6325 is Richards's machine, used at Colt's Armory, Hartford, Conn. It has a platform a with a central opening, through which pass two screws (one shown at b) entering the cross-head c, and connected at their lower ends to the two arms of a forked lever below the floor; the long arm of this lever is coupled with the differential levers $d \ e \ f$, which act upon the scale-beam in such a manner that by depressing the free end of the lever d, the cross-head is pulled down; the same effect is produced by raising the fulcrum of this lever; this may be done by the hydraulic jack g, whose ram supports the fulcrum. In testing longitudinal strains, the frame h is secured upon the platform, and the ends of the metal rod or other object are secured by appropriate devices to the upper part of this

Fig. 6326.



Fairbanks's Testing-Machine (Perspective View).

frame and to the cross-head; weights are then applied upon the scale-pans $i \ k$ until the desired stress is applied, or the tensile limit of the specimen reached. The arms of the levers are so proportioned that one pound in either of the pans exerts a force of 120 pounds upon the specimen, and the strain thus applied is measured upon the scale-beam l, so that it is not necessary to keep account of the weight actually placed in the pans. For ascertaining the resistance to crushing, the specimen is supported on the platform beneath the cross-head, and pressure applied as before.

For transverse strains, the frame h is removed, the specimen is supported at each end over the opening in the platform, and the straining pressure exerted by a knife attached to the cross-head.

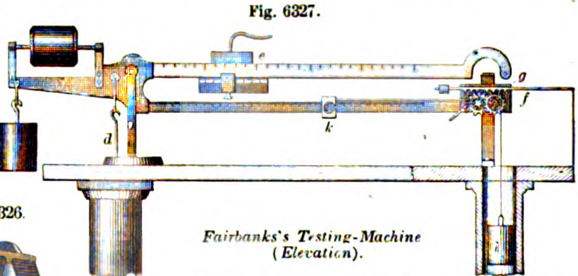
In Fairbanks's testing-machine, the crushing, breaking, or deflecting force is applied to the specimen by a cross-head a operated by gearing and screws $b \ b$ moved by a hand-wheel c. The force is exerted through the specimen upon the platform of a scale composed of a series of multiplying levers and having a beam provided with peculiar arrangements for automatically indicating the equivalent weight of the force.

In the illustration, d is the rod connecting the beam with the multiplying levers, e a sliding poise which is set at a point rather below the stress which it is intended to apply. When the force is applied, the beam rises, causing the small lever f pivoted at g to engage a stop h; this lifts the teeth of a rack on its under side out of engagement with one of the wheels of a clock-work train, and permits the weight i connected to the poise k on the lower beam to act, drawing out the poise until the equilibrium is restored, when the weighted end of the lever falls, re-engaging the wheel; the poise indicating the exact weight equivalent to the force applied. A fly l retards and equalizes the motion of the clock-work.

If greater force be then applied, the beam again rises, and the mechanism operates as before, until the crushing or breaking strain is reached.

In the machine designed by Colonel Flad, used for testing the stone employed in constructing the St. Louis bridge, the specimen is inserted into two collars, one at

Fig. 6327.

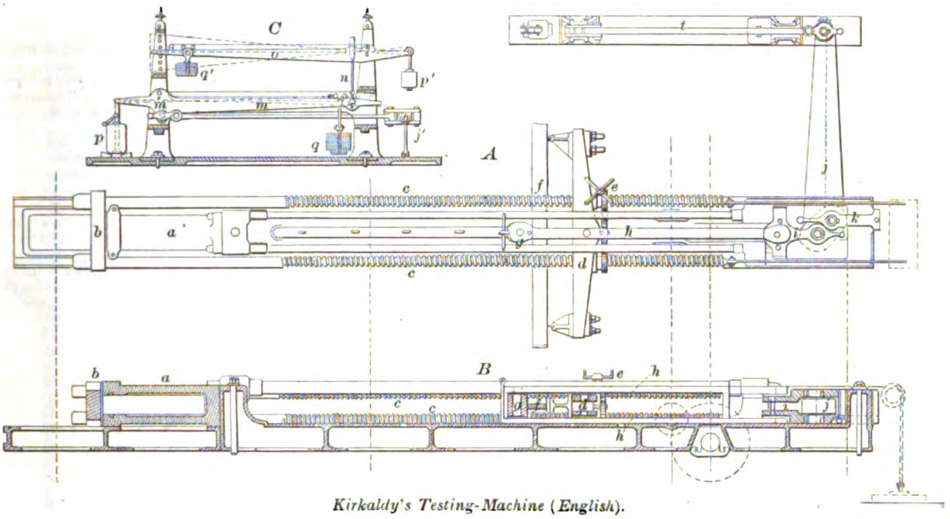


Fairbanks's Testing-Machine (Elevation).

each end; one of these has a flat projection supporting a small vertical steel cylinder, which is pressed by a spring against a bar connected to the other collar, so that any compression or elongation of the specimen tends to turn the cylinder around. On its top is a small mirror, which reflects the light of a lamp upon a graduated arc concentric with the cylinder. By this means, the angle through which the cylinder moves is doubled upon the arc, which is graduated to 20,000ths of an inch, so that alterations of that amount in the length of the specimen become visible, and, with the aid of a telescope, 200,000ths of an inch may be estimated.

Fig. 6328 illustrates Kirkaldy's testing-machine (English patent, No 2970 of 1863). A is a plan, B an elevation of the main frame, and C an elevation of the strain-indicating apparatus. The ram of a hydraulic cylinder a is connected to a cross-head b, which slides upon guides on the frame of the machine, and to this cross-head are attached four screw-threaded rods $c \ c$, passing through a second cross-head d, which by means of nuts simultaneously turned by connected bevel-gears operated by the handle e is caused to have a longitudinal movement along the rods $c \ c$, for the purpose of adjusting it at the proper position on the frame, according as a bending, crushing, or tearing effect is to be produced. At A the machine is represented in the act of bending a bar of metal f, the center of which bears against a knife-edged projection on the hollow block g, secured in the frame by a strong pintle, and connected by rods h to a T-piece i, having a central opening to receive the end of the lever j. A pin passes through i and j, having a knife-edge rest-

Fig. 6328.



Kirkaldy's Testing-Machine (English).

ing against a suitable bearing in the former. A forked piece k receives a similar pin passing through it and the lever j, and serving as a fulcrum when a strain is brought on the lever through the medium of the rods h. The lever is supported at each end upon struts (one seen at j'), and its longer end acts upon a link l connected with the downwardly projecting branch m' of a steel-yard-beam m, so as to convert the horizontal movement of the lever into a vertical movement of the beam m. This beam is used in testing strains of moderate amount. When powerful strains are to be tested, the pressure is transferred by means of an extensible strut n to an upper beam o. In each case, as throughout the machine, the levers turn on knife-edge bearings.

The longer arms of each beam are counterpoised by weights $p\ p'$. The weights $q\ q'$ by which the strain is measured are suspended from carriages running on the upper edges of the beams, and traversed by cords passing over pulleys.

The arrangements for testing, crushing, bending, transverse, compressing, punching, or indenting strains are in general similar; the specimen being placed in the space between the cross-head and cylinder, so as to be subject to a compressive force, while for applying tensile or drawing and similar strains it is placed on the other side of the cross-head, so as to be drawn toward the cylinder a. Special appliances for each of these requirements are provided.

See also Greenwood's testing-machine, page 58*, Class VII. Vol. I., "Official Catalogue of English Exhibition of 1862." See also WEIGHING-SCALE.

In the hydraulic tensile testing-machine (Fig. 6329), the ram of the cylinder being pushed back, the specimen is held by the two clips $a\ b$, and the pump, operated by the lever c, causes the ram to exert a pulling strain upon it, which is communicated to a rod connected with the scale-beam, which has a sliding weight and removable weights, indicating the force applied in tons and hundredweights (112 pounds). To remove the iron under test, release the top valve and push back the ram for another test. It is used in testing rods for various purposes, and also for testing links of chain-cables.

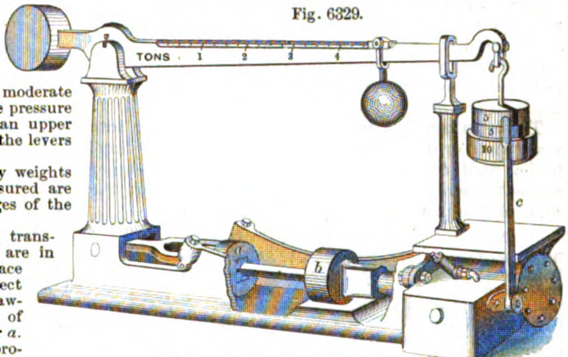
Fig. 6330 is Professor R. H. Thurston's machine for testing the value of lubricants, simultaneous dynamometrical and thermometrical readings being obtained.

In using the machine, a small and determinate quantity of the oil to be tested is placed on the journal F, and the pressure being adjusted by the screw K to that at which the oil is desired to run under test, the machine is started at a speed which will give the desired relative velocity of rubbing surfaces. Observations are made at short intervals, and recorded, until the test is closed by rapid heating, as shown by the thermometer, and excessive increase of friction, as indicated by the arm $H\ H$ swinging up against its chocks. Competing oils are similarly tried, and the records afford a perfect means of comparison.

Thus sewing-machine builders desire oil of long endurance, and small frictional resistance and viscosity; on locomotives, an oil that will bear high pressure for the greatest length of time without heating is the most desirable, even although not as limpid and of as slight frictional resistance. The relative power of resisting high temperatures without decomposition is another important point which may be tested. See THERMO-ELECTRIC ALARM; TEMPERATURE-ALARM; THERMOSCOPE; etc.

Fig. 6331 is Emerson's apparatus for testing water-wheels. The wheel b is secured to the shaft of the water-wheel, and its speed is regulated by the friction-band a, which is connected

Fig. 6329.



Hydraulic Tensile Testing-Machine.

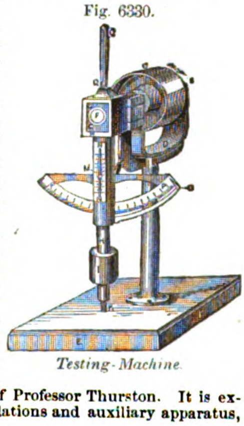
with the scale-beam as shown, the point of connection describing a circumference of 15 feet. The rim of the wheel and the friction-band are hollow, and are kept cool by streams of cold water passing through them. The wheel b is made of cast-iron, and the friction-band of gun-metal. The hands of the counter are operated by worm gear, and move like the hands of a clock.

The hand-wheel m has a universal joint, to prevent fraud. The pivot of the scale-beam and its connections with the friction-band are knife-edged.

The weights are suspended at one end of the beam, as shown at c: the other end has attached a plunger working loosely in the cylinder d, which is filled with water; this forms the hydraulic regulator for steadying the scale-beam.

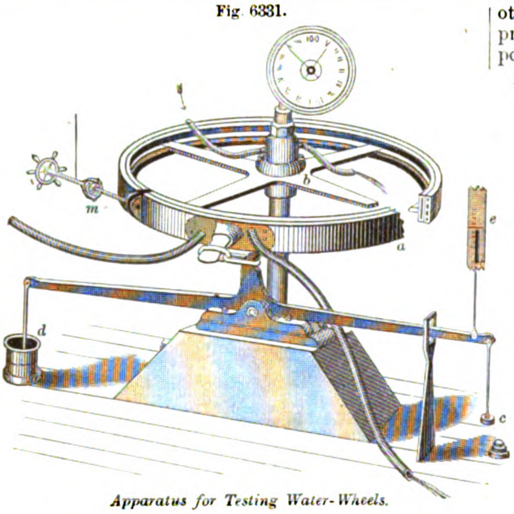
The A. H. Emery testing-machine of 400 tons capacity is expected to be completed and at work at the Watertown Arsenal this year. It has an independent straining mechanism, fitted with a strain diagram apparatus, designed by C. E. Emery to produce diagrams somewhat like those of the autographic testing-machine of Professor Thurston. It is expected to cost, including foundations and auxiliary apparatus, about $ 50,000.

Fig. 6330.



Testing-Machine.

Fig. 6331.



Apparatus for Testing Water-Wheels.

Test′ing-slab. A square plate of white glazed porcelain, having cup-shaped depressions for containing liquids to be examined which give colored precipitates.

Test-mix′er. A tall cylindrical bottle having a wide foot and provided with a stopper. It is graduated into 100 or more equal parts, commencing at the bottom, and is used in preparing test-alkalies, test-acids, and similar solutions, by diluting them down to the required strength.

Test-pa′per. A paper prepared by dipping into a solution or decoction of a substance and drying; to be used to detect the presence of a substance whose presence causes a reaction and a change in the color of the paper.

Paper.	*Changes to*	*By presence of*
Brazil-wood paper	Purple	Alkali.
Brazil-wood paper	Red	Strong acid.
Buckthorn-paper	Red	Acid.
Cherry-juice paper	Red	Acid.
Dahlia-paper	Green	Alkali.
Dahlia-paper	Red	Acid.
Dahlia-paper	Yellow	Caustic alkali.
Indigo-paper	Decolored	Chlorine.
Iodine-paper	Blue	Acid solution of starch.
Lead-paper	Black	Sulphuric hydrogen.
Litmus-paper (blue)	Red	Acid.
Litmus-paper (blue)	Green	Alkali.
Rose-paper	Green	Alkali.
Starch-paper	Blue	Iodine.
Turmeric-paper	Brown	Alkali.

Fig. 6332.

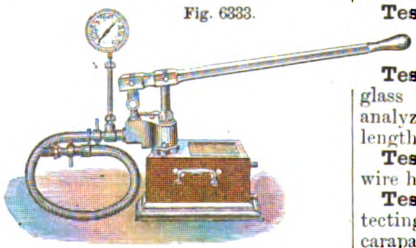
Test-Mixer.

Test-plate. 1. A finely ruled glass plate used in testing power and defining quality of microscopes. See NOBERT'S TEST-PLATE, pages 1531, 1532.

2. A glass slip used in stirring tests.

Test-pump. A force-pump for testing the strength of boilers, tubes, and other hollow articles by hydraulic pressure. It is provided with a gage for showing the pressure in pounds applied to the square inch.

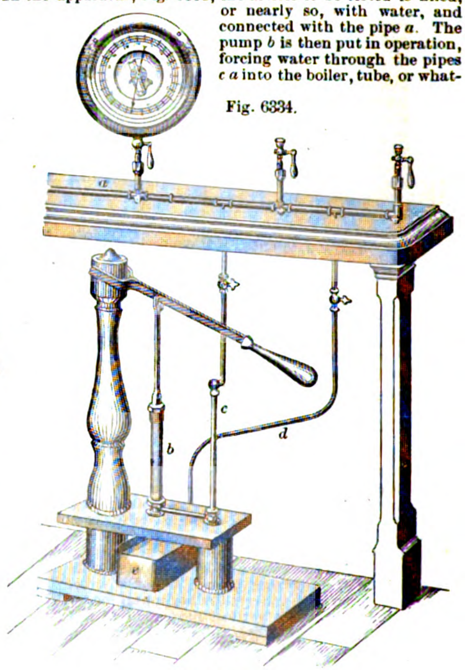
Fig. 6333.



Test-Pump.

In the apparatus, Fig. 6334, the article to be tested is filled, or nearly so, with water, and connected with the pipe *a*. The pump *b* is then put in operation, forcing water through the pipes *c a* into the boiler, tube, or whatever the object may be, until it bursts or the maximum proof-pressure is reached; its amount is shown by an index upon a dial. The water in the pipes is, after use, returned to the cistern through the pipe *d*.

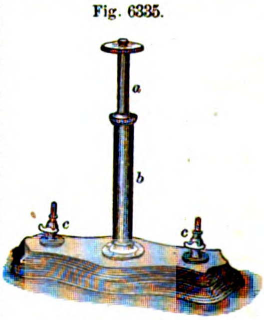
Fig. 6334.



Test-Pump.

Shaw's (Fig. 6335) is particularly designed for testing steam and hydraulic gages. The plunger *a* has an interior screw-thread fitting over a screw running the whole length of the cylinder *b*, and is turned by means of a hand-wheel, testing pressures up to 800 lbs. to the square inch; water is introduced into the cylinder through an opening at the top of the plunger, which is closed by a thumb-screw. *c c* are the valves, having screw-threaded nipples, to which gages to be tested are attached.

Fig. 6335.



Shaw's Test-Pump.

Test-spoon. A small spoon used for taking up small quantities of powders, fluxes, etc.; used in blow-pipe or chemical experiments. The handle may be used as a spatula.

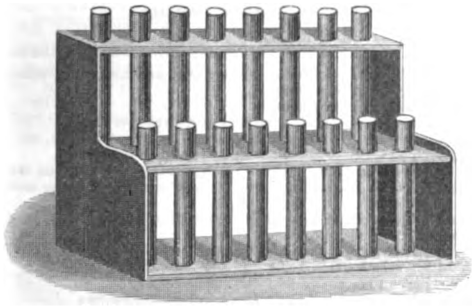
Test-stir′rer. A round glass rod, having one end pointed for dropping tests, and the other end rounded.

Test-tube. (*Chemical.*) A thin cylinder of glass with a rounded bottom, used in testing and analyzing liquids. They are made of various sizes and lengths. Fig. 6336 shows a stand with test-tubes.

Test-tube Brush. A small spiral brush with a wire handle for cleansing test-tubes.

Tes′tu-do. 1. (*Military Engineering.*) A protecting device; so called from its resemblance to the carapace of a tortoise. The term was applied by the ancient Romans to a covering formed by joining the

Fig. 6336.



Test-Tubes and Rack.

shields of the soldiers over their heads, so as to constitute a species of roof, affording protection from missiles thrown from above; also to a structure movable on rollers or otherwise, for protecting sappers in an attack; and is now applied to objects similar in shape and design employed as defenses for miners, etc., when working in ground or rock which is liable to cave in.

Fig. 6337.

Test-Tube Brush.

2. (*Music.*) A species of ancient lyre, the idea of which is said to have been derived from the carapace of a tortoise. See LYRE.

Tete-a-tete. Two chairs with seats attached and facing in opposite directions, the arms and backs forming an S-shape.

Tete-de-pont. (*Fortification.*) A *redan* or *lunette* resting its flanks on the bank of a river and inclosing the end of a bridge for the purpose of protecting it from an assault.

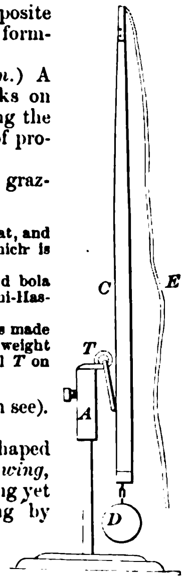
Teth'er. A rope by which a grazing animal is tied to a stake.

The rope is frequently termed a lariat, and is secured to an iron picket-pin, which is driven into the ground.

Catching animals with the lasso and bola are both shown on the paintings of Beni-Hassan in Egypt.

In Fig 6338, the tethering-rope *E* is made fast to a swinging upright *C*, having a weight *D* at bottom and connected to a swivel *T* on the post *A*.

Fig. 6338.



Tether.

Tew'el. 1. A TUYERE (which see).

2. A pipe or chimney.

Tew'ing-bee'tle. A spade-shaped instrument for beating hemp; *tewing*, *touseling*, *tawing*, or *teasing* being yet existing terms for the working by pulling and beating.

Tex'as. (*Nautical.*) A structure on the hurricane-deck of a Western steamboat, containing the pilot-house, officers' cabins, etc.

Tex'tile Fab'ric.

RAW PRODUCTS USED IN TEXTILE MANUFACTURES.

Common Name.	Botanical Name of the Genus and Species of the Plant by which the Fiber is produced.	Native Place, or where chiefly grown.	Qualities, Uses, etc.
Agave, or American aloe	Agave americana	Mexico, etc.	Various fabrics and paper are made from this and other species of agave.
Amadon	Polyporus formentarius.	Europe	The source of "German tinder."
Bamboo	Bambusa arundinaceæ.	Tropics	Paper, cloth, etc., of coarse kinds.
Banana	Musa sapientum	Tropics	Various fabrics; the fiber resembles flax.
Bast	(See Cuba and Lime)		Twine. Tying up cigar-bundles, etc.
Bowstring-hemp	Sanseviera zeylanica	India	Strong. Used for cordage, etc.
Cactus fiber	Opuntia tuna, etc	Tropics	From layers of the stem. Baskets, ornamental work, etc.
China grass, or Rhea	Bœhmeria nivea	China, India, etc.	Fine. Linen, cambrics, nets, etc.
Cocoa-nut, or Coir	Cocos nucifera	Tropics	Strong and coarse. Cordage, mats, brushes, bags, ropes, etc.
Cotton	Gossypium herbaceum, etc.	Warm countries	Length, strength, etc., of fiber, various. East Indian generally coarse and short: American finer and longer. Sea Island and Egyptian have the longest fibers.
Cotton (silk)	Bombax ceiba	S. America	A silky substance unfit for spinning. Used for stuffing cushions, etc.
Cuba bast	Paritium elatum	Cuba, etc.	A bark. Used to tie up cigars.
Daphne	Daphne papyracea; Edgeworthia gardneri.	India	Fibrous bark. Used for making paper, etc.
Date-palm	Phœnix dactylifera	N. Africa and interior deserts	Plaited work, baskets, from the leaves.
Esparto-grass	Lygæum spartum	S Europe, etc	Coarse. Matting, cordage, baskets, paper, etc.
Fan-palm (dwarf)	Chamærops humilis	Spain, Italy, Tropics	Mats, baskets, caps, etc., from the leaves.
Flax	Linum usitatissimum	Temperate climes	Varieties numerous. Yarn, linens, cambrics, etc.
Flax (New Zealand)	Phormium tenax	New Zealand, etc.	Strong. Cloth, baskets, cordage, etc.
Grasses	Very numerous	Generally	Some species, as wheat-straw, used for making paper. All afford fiber variously used; plait for bonnets, brushes, etc.
Grass-wrack	Zostera marina	Europ'n sea-coasts	A sea-weed. Used for making mattresses, packing, etc.
Gunny, or jute	Corchorus capsularis	India	A coarse kind of jute. Used for making bags, matting, etc.
Hair-moss	Polytrichum	England	A moss. Used for stuffing cushions, etc.
Hemp	Cannabis sativa	Cool climates and India	In Europe used for cordage, coarse cloth, etc. In India grown for its intoxicating qualities.
Ita-palm	Mauritia flexuosa	British Guiana	Affords thread from leaves; of which baskets, fans, mats, etc., are made.
Ivy	Hedera helix	Temperate climes	Coarse. Rope, etc.
Jute	Corchorus capsularis	India	In India for "gunny-bags." In England used as an addition or substitute for hemp, flax, and silk.
Lace bark	Lagetta lintearia	Jamaica	A bark resembling fine lace; made into collars, sleeves, purses, etc.
Lime bast	Tilia europæa	Europe	Affords the material of "Russia matting," etc.

Common Name.	Botanical Name of the Genus and Species of the Plant by which the Fiber is produced.	Native Place, or where chiefly grown.	Qualities, Uses, etc.
Mallow	Malva (numerous)	Generally	The tribe comprises cotton, etc., and numerous other fiber-giving species.
Manila-hemp	Musa textilis	Philippine Islands.	Various textile fabrics.
Maroot-fiber	Sanseviera zeylanica	Madras, etc.	Resembles and is used as a substitute for flax.
Marsh-gladden	Scirpus lacustris	British marshes etc.	A sedge. Made into baskets, bee-hives, hassocks, etc.
Mulberry	Morus nigra, etc.	China, etc.	The Chinese make coarse cloth out of the bark.
Mulberry (paper)	Broussonetia papyrifera.	Polynesia, etc.	The source of "Tapa" cloth, made by beating out the bark by mallets, etc.; resembles both hemp and paper.
Namaqua bark	Brosimum namaqua	Grenada, North of S. America, etc.	Resembles hemp. Bark made into sacking, and used for beds, etc.
Nettle-fiber	Urtica dioica, etc.	Generally	Irish variety, worked up into collars and other fancy articles.
New Zealand flax	Phormium tenax	New Zealand, etc.	(See Flax.)
Neyanda-fiber	Sanseviera zeylanica	Ceylon	Resembles and is used as a substitute for flax
Palm	Very numerous	Tropics	Species very numerous; all afford fiber of some kind.
Palmite	Juncus serratus	S. Africa	A rush. Used for plaiting, thatching, baskets, etc.
Palmyra-palm	Borassus flabelliformus.	Tropical Asia	Leaves made into mats, baskets, carpets, hats, umbrellas, etc.
Paper mulberry	Broussonetia papyrifera.	Fiji, etc.	(See Mulberry.)
Papyrus (paper)	Cyperus	Egypt, etc.	A kind of sedge from which ancient Egyptian paper was made.
Piassaba	Attalea funifera	Brazil, etc.	Coarse fiber. Made into brooms, ropes, etc.
Pine	Pinus (various)	Europe, etc.	Coarse fiber. Fit for ropes, etc.
Pine	Thuja gigantea	N. W. America	Bark affords a fiber resembling hemp. Baskets, hats, mats, etc.
Pineapple	Bromelia ananas	Tropics	Fiber suitable for fine articles; as muslin, cambrics, etc.
Pita-fiber	Bromelia pita, etc.	Tropics	Resembles flax, for which it is an excellent substitute.
Plantain	Musa paradisiaca, etc.	Tropics	Various fibers for cordage, etc.
Rattan-cane	Calamus rotang	Tropics	When split, used for caning chairs, brooms, etc.
Rhea-fiber	Bœhmeria nivea	China, India, etc.	Various textile fabrics; the coarse kinds afford cordage, sails, fishing-nets, etc.
Rice	Oryza sativa	Europe, India, etc.	Fiber affords a soft porous paper.
Rice-paper	Aralia papyrifera	Formosa, China.	The pith of the tree is cut cylindrically, by sharp knives, into thin sheets, affording "Rice paper," used for artificial flowers, painting, etc.
Ruffia	Raphia ruffia	Madagascar	Thread is made from the leaves of the palm, and woven into Malagasy cloth, used as garments by the natives.
Rushes	Juncus (various)	Generally	Brooms, mats, brushes, baskets, hassocks, etc.
Screw-pine palm	Pandanus spiralis	Tropics	The fiber resembles hemp, and may be similarly used.
Sedges	Cyperus (various)	Generally	Brooms, mats, brushes, baskets, etc.
Silk-cotton	Bombax ceiba	S. America	(See Cotton.)
Straw	Various, as from wheat, rye, barley, rice, etc.	Generally	Largely used for making paper, bonnet plait, etc.
Sugar-cane	Saccharum officinarum, etc.	India, W. Indies, America, etc.	Fiber may be used for making paper, etc.
Sunn-hemp	Crotalaria juncea	India	Fiber; an excellent substitute for flax.
Talipot-palm	Corypha umbraculifera.	Ceylon	Leaves used as umbrellas, tent-covers, etc.
Teazle	Dipsacus fullonum	England, etc.	The flower of the plant used to raise the nap of woolen cloth.
Tucum-palm	Astrocaryum vulgare	Brazil, etc.	Leaves woven to make hammocks, etc. They also afford thread.
Willow	Salix (various)	Temperate climes.	Baskets, bonnets, plait, etc.
Yercum-fiber	Calotropis gigantea	India	Resembles flax; the seeds are inclosed in a silky fiber, like thistle-down.

Text-pen. An engrossing pen.

Thal-las-som'e-ter. A TIDE-GAGE (which see).

Thal'li-um. A metal discovered by means of the spectroscope by W. Crookes, in 1861. A rare metal resembling lead in appearance, allied by action with the alkaline metals.

Tharm. Twisted gut.

Thatch. Roof covering of straw, reeds, or rushes; of dried grass or palm-leaves in the tropics.

Thatching is performed with reeds, straw, or fern. It is very unusual in the United States, but is a common and excellent roof in many countries of Europe. The best material is the marsh reeds of Eastern England and of Holland. The reeds are cut in the winter, made into sheaves, dried and stacked With care, a roof of thatch will last over 100 years. Reed-thatched roofs in Holland are shown which are 200 years old, and in good preservation.

The reeds are laid in successive courses 8 or 9 inches in thickness, the buts toward the eaves, and are held down to the roof spars by *sways* or rods, which are tied to the roof-spars by rope-yarns passed through the reeds by a needle. The total thickness given at the eaves is 18 or 20 inches, and the buts of each succeeding course overlap on the course below. The *legget*, a square piece of board with an oblique handle, is used for driving up the buts of the reeds and making them lie compactly. The ridge of the roof, where the small ends of the reeds meet, is capped with straw.

The most ancient mode of roofing was of boughs, or, in Oriental countries, of leaves. Thatch of reeds or straw is also very ancient. Servius and Plautus mention thatch, and Herodotus mentions a thatch of reeds as the usual covering of the houses in Sardis. The northern nations of Europe are noticed as using thatch, as did also the Helvetii and Anglo-Saxons.

Shingles were used in Rome till A. U. C. 470. Slates, with iron pins, have been found in Roman remains, and in England of the date 1322.

Tiles of clay are declared by Pliny to have been invented by Cinyra, son of Agriopé. Byzes used stone slabs; others marble, even gold, but more usually bronze gilt. Hollow tiles were used in the construction of tombs. Anglo-Saxon and Norman tiles were taken from the Roman. Pantiles were used in the Middle Ages, and very generally in the fifteenth century.

The most ancient existing roofs in England are of wooden boards covered with lead.

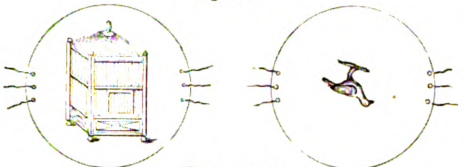
Thatch-wood Work. (*Hydraulic Engineering.*) A mode of facing sea-walls with brushwood. Underbrush of say twelve or fourteen years' growth is cut down, fagoted at its full length, and spread over the face of the banks. It is kept down by strong stakes, which have cross pins at their upper ends to rest upon the brush, which breaks and disperses the waves and protects the earth beneath.

Thau'ma-trope. The theory of the duration of visible impressions was taught by Leonardo da Vinci, who was born in 1452. Many curious toys and scientific devices have been made, founded upon this

principle. The THAUMATROPE, and, more lately, the PHENAKISTOSCOPE, ZEOTROPE, STROBOSCOPE, and ANORTHOSCOPE, are examples. See under these heads.

The idea of this contrivance originated with Sir John Herschel, and depends upon the limit to the rapidity with which visual images may be substituted and separately distinguished Mr. Babbage mentions the circumstances under which the idea was

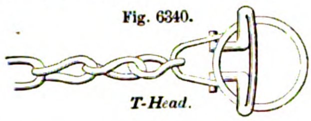
Fig. 6339.



Thaumatrope.

brought into practice, which was effected by spinning a shilling with such rapidity that the visual image combined the figures on each side of the coin. It was subsequently made in the form of a toy, in which the respective sides showed a horse and his rider, a bird and his cage, a rat and a trap, etc., according to the taste or ingenuity of the contriver.

Fig. 6340.



T-Head.

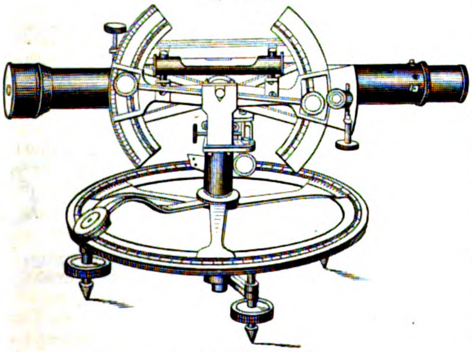
T-head. A cross-bar with two prongs on the end of a dog-chain, watch-chain, or elsewhere, to engage in a ring.

The-at′ri-cal Ma-chine′. Made of wire cloth running on rollers, and wound up and unwound by power. Parsons' patent, June 2, 1874.

The-od′o-lite. An instrument for measuring horizontal and vertical angles, but particularly adapted for accurately measuring the former. Its principle is identical with that of the altitude and azimuth instrument; the construction and purpose of the two, however, differ, the latter being employed for astronomical purposes, while the theodolite is used for land surveying; but the better instruments of this class may be employed for observing the altitudes of celestial bodies. The vertical circle is not generally, however, of sufficient size, nor so graduated as to be available for very accurate astronomical observations.

This instrument has been used in extensive geodetical operations in England and in this country, such as the British Ordnance Survey and the United States Coast Survey, while in France the repeating circle of Borda has been preferred The telescope has a motion on a horizontal axis, and has a vertical graduated circle, which has also a horizontal.

Fig. 6341.



Everest's Theodolite.

See under TELESCOPE for notice of the first use of telescopes in triangulation or measuring angles.

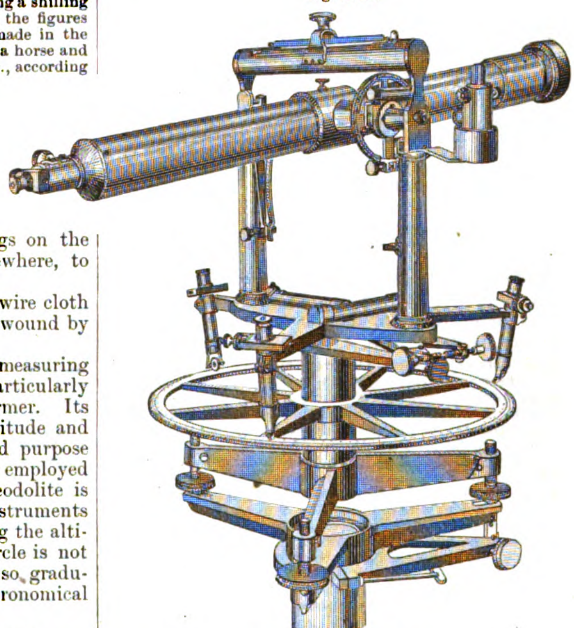
The first survey made by an instrument with a perfect circle is said to be that of Zealand, by Bugge, in 1762 - 68.

Ramsden's theodolite had a circle 3 feet in diameter, and was completed in 1787. It had two telescopes of 36 inches focal length. It was used for a triangulation to connect the observatories of Greenwich and Paris, and also in the English, Irish, and Indian trigonometric surveys.

The telescope circle and stand are capable of motion round a vertical axis. The altazimuth may be considered a modification of the transit instrument, and has been called a transit theodolite, being adapted for meridional or extra-meridional observations indifferently. Everest's theodolite is so called from its designer, Sir G. Everest, late of the East Indian Survey, and is among the best of its class.

The Wurdemann's theodolite, used by the Coast Survey, is mounted upon a repeating stand, that is, one which has an axis of its own, having a clamp and tangent so as to read any angle on any part of the limb. This stand has adjusting feet for leveling, so as to bring the axis vertical on uneven ground. The base of the instrument proper consists of a leveling tripod, from which rises a central column forming the barrel of the

Fig. 6342.



Würdemann's Theodolite.

axis; on the outside of the column the main *limb* of the instrument is fastened. The central column is of cast-iron, and the principal vertical axis of steel plays within the column. The upper or large end of the axis has attached to it a plate carrying, firstly, three reading micrometer microscopes, 120° apart; secondly, two columns with Y's for receiving the pivots of the telescope axis. The pivots rest with one half of the diameter in the Y's, the other half projecting for the legs of the striding level to rest upon.

The telescope is 38 inches focal length, the object-glass $2\frac{9}{10}$ inches aperture, provided with a 4-inch vertical finder-circle for use in taking solar or star azimuths, and on the right-hand side of the telescope is the usual clamp and tangent for vertical fixture and movement. A small central reflector of $\frac{1}{10}$ inch diameter throws the light from a lamp attached outside to the cross lines of the eye-piece. The light from the lamp, passing through the telescope axis to the center of the tube, is reflected upon the wires by the reflector. The wires are contained in a micrometer eye-piece.

The clamp and tangent for the horizontal movement of the alidade is not, as usual, attached to the horizontal circle, but on a collar immediately underneath the alidade on a separate disk. The clamp arm fitting on this disk contains a piece of steel which is pressed against the disk by means of the clamp-screw, which fixes the arm, a small portion of the clamp-ring being cut out opposite to the screw, so that there are but three points of contact in clamping. To the outer end of this clamp-arm is attached one portion of the tangent screw, whilst the other holds to a projecting part of the alidade plate.

Two cross levels on the alidade plate afford means for perfectly leveling the instrument. The micrometer microscopes read to one minute of arc to one revolution of the screw. The drum of the screw is divided into 60 divisions, each having the value of 1″, of which tenths are generally estimated, and are quite perceptible.

The peculiar features of the instrument are, —

1. The circle is freed from the clamp and tangent, being independent.

2. The optical power is high. Without this, mere size of the instrument is of little advantage. For instance, the microscopic readings on the limits may be read to as great accuracy, 10‴, as the five-foot mural circle of the Naval Observatory, Washington.

Lengths of a Degree of Longitude on the Parallels of Latitude, for each Degree of Latitude from the Equator to the Pole.

Lat.	Miles.	Lat.	Miles	Lat.	Miles.	Lat.	Miles	Lat.	Miles
1°	59.99	19°	56.73	37°	47.92	55°	34.41	73°	17.54
2	59 96	20	56.38	38	47.28	56	33 45	74	16.54
3	59.92	21	56.01	39	46.63	57	32 68	75	15.53
4	59.85	22	55.63	40	45.96	58	31.79	76	14.52
5	59.77	23	55.23	41	45.28	59	30.9	77	13.5
6	59.67	24	54.81	42	44.59	60	30.	78	12.48
7	59.55	25	54.38	43	43.88	61	29.09	79	11.45
8	59.42	26	53 93	44	43.16	62	28.17	80	10.42
9	59.26	27	53 46	45	42.43	63	27 74	81	9 38
10	59.09	28	52 97	46	41.68	64	26.3	82	8.35
11	58 89	29	52.48	47	40 92	65	25.36	83	7.31
12	58.69	30	51.96	48	40.15	66	24.4	84	6.27
13	58.46	31	51.43	49	39.36	67	23.44	85	5.23
14	58.22	32	50.88	50	38.57	68	22.48	86	4.18
15	57.95	33	50.32	51	37.76	69	21 5	87	3.14
16	57.67	34	49.74	52	36.94	70	20 52	88	2.
17	57.38	35	49.15	53	36.11	71	19 53	89	1.05
18	57.06	36	48.54	54	35.27	72	18.54	90	.00

NOTE. — Degrees of longitude are to each other in length as the cosines of their latitudes.

The-od′o-lite–mag′net-om′e-ter. An instrument employed as a declinometer to measure variations in declination, and as a magnetometer in determinations of force.

It consists of a graduated horizontal circle, mounted as in the ordinary surveyor's theodolite, upon which is fixed a small wooden box. In the top of this box a vertical glass tube is fastened. The magnet is suspended in the box by means of one or two filaments of unspun silk, which pass up through the tube and are fastened at its top. The magnet consists of a perfectly turned steel tube, in one end of which there is a glass head. On this head a scale is engraved, which is so delicate that it is scarcely visible to the naked eye. The other end is closed with a lens which brings the rays of light in parallel directions to the scale. Connected with the horizontal circle of the instrument is a small telescope, mounted so that its axis shall lie in the produced axis of the box. In each end of the box is a small glass window, so that when the apparatus is properly adjusted, the light will come through the magnet to the eye of an observer, and the scale on the magnet-head will be visible.

To determine the magnet declination we have only to make the vertical wire of the telescope coincide with the axis of the magnet, and note on the horizontal circle the angle which this line makes with the direction of the true meridian, which is before determined. The variations in declination may then be determined from time to time by noting the reading of the magnet-scale.

In observations for magnetic force, Gauss's method is generally employed. The suspended magnet is made to swing horizontally in the box through a very small arc, and the time of a single oscillation is noted. The same magnet is then made to deflect another suspended magnet, from a certain fixed position and at a known distance, and the angle through which the second magnet is deflected is observed. Each of these experiments determines a value which is due to the combined effects of the magnetism of the earth and of the magnet. But these effects are, in the two cases, combined in different ways, so that, by a proper combination of the two values, we may eliminate the effect due to the magnetism of the magnet, and obtain that due to the horizontal magnetic intensity of the earth alone.

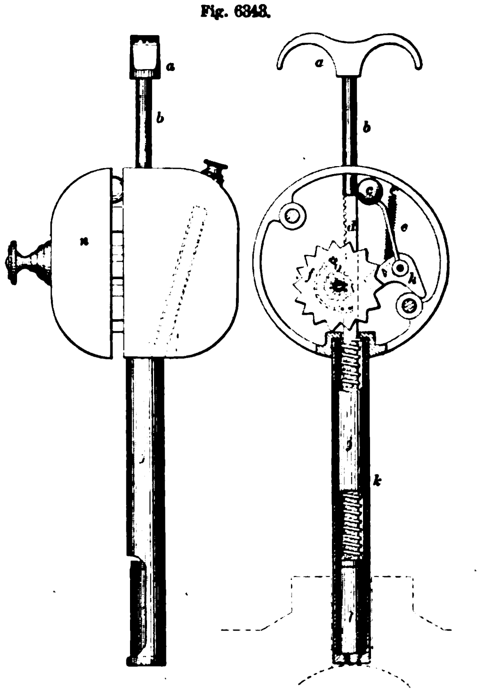
The-or′bo. (*Music.*) A large lute, having two heads, to each of which strings are attached.

"One slovenly and ugly fellow, Signor Pedro, who sings Italian songs to the theorbo most neatly." — PEPYS's *Diary*, 1664.

Ther′mal A-larm′. An attachment for giving indication of a hot-bearing.

A tube *j* has a plug *l* of such material or alloy as will melt at the degree at which it is desired the alarm should be given.

Fig. 6343.



Hot-Bearing Alarm.

See table of fusible alloys, page 62. As the plug melts on the hot-bearing and escapes at the hole beneath, the spring *k* forces down the spindle *b*, giving motion to the rack *d*, pinion *o*, and striking-wheel *f*. The wheel *f* operates the pallet *h* and hammer *c*, causing the latter to strike the gong *n*. *a* is the handle for withdrawing the spring in inserting a plug. See Fig. 6346.

Ther′mal Mo′tor. A machine in which the expansion and contraction of an object or material, by changes in the temperature, is made a means of motion. The term is usually applied to machines operated by natural thermometric changes.

Coxe, 1827, in London exhibited a timepiece which was kept in continual action by the rise and fall of a column of mercury in a barometric tube attached thereto.

The plan has been frequently tried elsewhere.

In Washburn's thermal motor, July 4, 1865, the expansion and contraction of a bar of metal, under the influence of natural heat, are gathered up by means of springs and levers, so that the power can be used for propelling machinery, clock-work, and similar purposes.

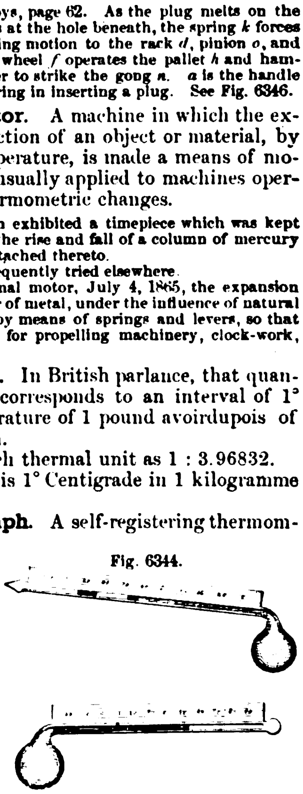
Ther′mal U′nit. In British parlance, that quantity of heat which corresponds to an interval of 1° Fah. in the temperature of 1 pound avoirdupois of water at 39.10° Fah.

It is to the French thermal unit as 1 : 3.96832.

The French unit is 1° Centigrade in 1 kilogramme of water.

Ther-met′o-graph. A self-registering thermometer, recording the maximum and minimum of temperature in a given time.

Fig. 6344.



Rutherford's Thermetograph.

Fig. 6344, Rutherford's thermetograph, consists of two thermometers, one containing mercury and the other alcohol. A steel wire is pushed before the column of mercury and left at the maximum point reached. An enamel slide in the

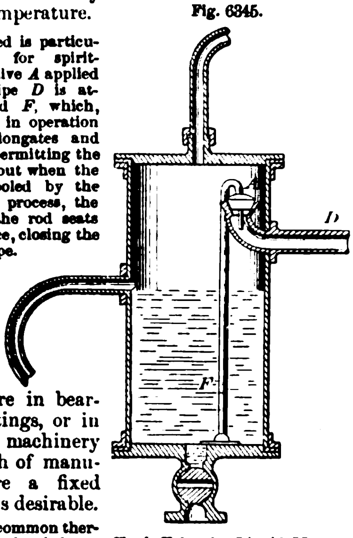
alcohol thermometer is drawn back by the liquid and left at the minimum point.

Ther'mo-ba-rom'e-ter. An instrument for measuring altitudes by means of determining the boiling-point of water. See HYPSOMETER; EBULLIOSCOPE; BAROMETER.

Ther'mo-dy-nam'ic Valve. A valve depending for its operation upon the expansion and contraction occasioned by changes of temperature.

That illustrated is particularly designed for spirit-meters. The valve *A* applied to the pump-pipe *D* is attached to a rod *F*, which, when the still is in operation and heated, elongates and lifts the valve, permitting the liquor to flow; but when the apparatus is cooled by the stoppage of the process, the contraction of the rod seats the valve in place, closing the mouth of the pipe.

Fig. 6345.

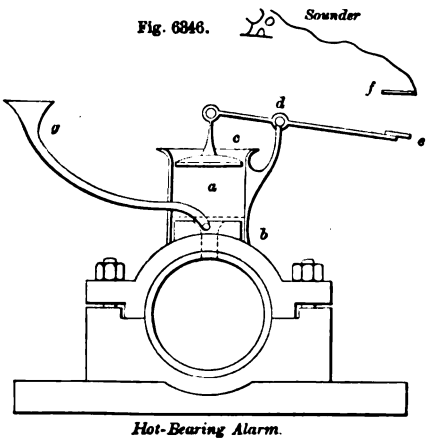


Check-Valve for Liquid-Meters.

Ther'mo-e-lec'tric A-larm'. An apparatus designed to indicate the rise of temperature in bearings for shaftings, or in any kind of machinery or any branch of manufacture where a fixed temperature is desirable.

It resembles a common thermometer, except that it has a wire secured at top and bottom. The wire at the bottom passes through the bulb and touches the mercury. The other wire enters the glass at the top and extends part way down the inside Each of these wires is connected with a small open circuit having a battery and an electric bell. When this connection is made and the battery in order, the glass may register (say) 40°. The upper wire hangs down in the glass (say) to 85°, the circuit being open by the space between the top of the column of mercury and the bottom of the wire. When the mercury rises and touches 85°, the circuit is closed and the bell sounded. When the column of mercury sinks, the circuit is broken and the bell stops. The upper wire may be adjusted to any figure on the scale. For refrigerators, the end of the wire may touch the freezing-point; for chambers or school-rooms, it can be set at 70°; to indicate the presence of fire, it may be set at 100° or upward. In the case of hotels, a glass in every room, each with its wire circuit, may ring an alarm-bell in the office the instant the temperature rises above a fixed hight. To indicate the particular room, a common electric annunciator is attached to the system of circuits, and the clerk or watchman informed of the exact position of the danger. By fixing the glasses at a comparatively low figure (say 90°), they serve a double purpose, — show if the room is too warm from overheating or in danger from fire. When used as an indicator of the want of oil or other lubricant on bearings for car-wheels, shafts, and the like, the hot journal quickly raises the mercury, and, by closing the circuit, starts the alarm-bell, which continues to ring till the shaft is stopped or cooled. For this purpose a hole is drilled in the bearings, and the thermometer sunk in it till the bulb rests on the shaft. This device is also used to indicate any required temperature in boiling drugs, dye-stuffs, or other liquids.

Fig. 6346.

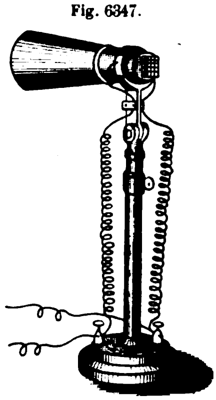


Hot-Bearing Alarm.

Fig. 6346 consists of a cylindrical box *a* provided with a perforated bottom *b*, and placed directly over the journal. The box is filled with a prepared grease which melts at a certain temperature, to which it must be raised by the shaft becoming hot. As the compound liquefies and escapes through the perforations, a disk *c*, which rests thereon, descends, thereby tilting the lever *d*, and so making contact between the plates *e* and *f*. The latter are connected by an electric circuit with a bell which sounds when the current is established. The pipe *g* serves for the ordinary lubrication of the journal.

See also TEMPERATURE-ALARM; THERMOSCOPE; THERMOMETRIC ALARM; etc. See also TESTING-MACHINE, Fig. 6330.

Fig. 6347.



Thermo-Electric Pile.

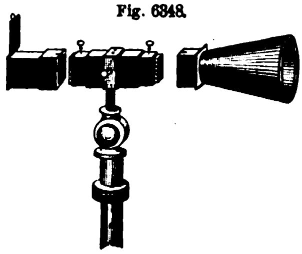
Ther'mo-e-lec'tric Bat'tery. (*Electricity.*) One in which an electric current is established by applying heat or cold to one of the junctions in a circuit composed of two different metals. It was first shown by Seebeck of Berlin in 1821. See Deschanel's "Natural Philosophy," Part III. pages 652, 653.

Figs. 6347, 6348, illustrate ordinary forms of the apparatus.

Fig. 6349 shows the battery or pile of Melloni. *b c* are an enlarged view and a section of the elements.

At the Exposition of 1867 were exhibited three batteries of this class: those of Farmer, American; Marcus, Austrian; and Ruhmkorff, French.

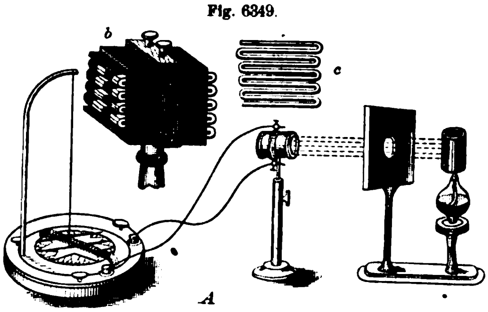
Fig. 6348.



Thermo-Electric Pile.

The former consists of strips of copper and wedge-shaped blocks of an alloy arranged alternately in the form of a ring. The strips of copper are soldered at each end alternately, and insulation between the metals is effected by interposed plates of mica. Heat is applied to the inner edge of the ring by means of a circular gas-burner. It was stated that thirty-six elements of this battery were equal to one of Grove's.

Fig. 6349.



Melloni's Thermo-Electric Battery.

In the battery of Professor Marcus, the positive and negative elements are both alloys: the former consisting of 10 copper, 6 zinc, and 6 nickel; and the latter of 12 antimony, 5 zinc, and 1 bismuth. The bars are arranged after the manner of the rafters of a house, and soldered together at their alternate extremities, separated by a slight interval, no insulating material being

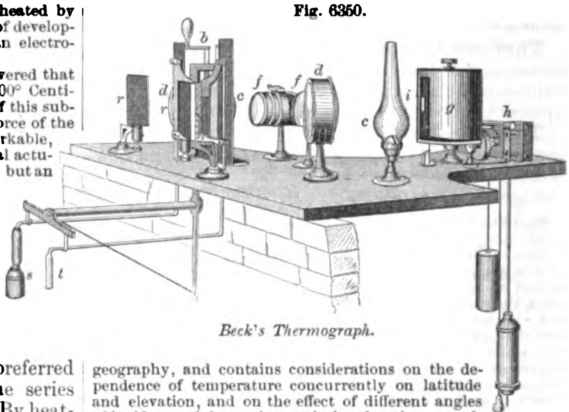
employed. Their lower ends are immersed in water heated by a spirit-lamp. 65 pairs of this battery were capable of developing a lifting force of from 25 to 50 kilogrammes in an electro-magnet.

Becquerel's battery was invented in 1865. He discovered that artificial sulphide of copper when heated to 200° or 300° Centigrade is strongly positive, and that a couple formed of this substance and metallic copper has nearly ten times the force of the ordinary antimony and bismuth couple. This is remarkable, as the native sulphide is strongly negative. The metal actually used for the negative element is not pure copper, but an alloy of 90 copper and 10 nickel (German silver). The elements are arranged in a manner resembling that of Marcus, their ends being immersed in water heated by means of a gas-burner. Eight or nine of these elements are considered by M. Becquerel to be equal to one of Daniell's. With fifty couples an electro-magnet has been made to sustain a weight of 100 kilogrammes (220 lbs.).

Ther'mo-e-lec'tric Pile. A series of metallic plates, or a chain of links of alternate metals, — antimony and bismuth are preferred as being farthest apart of the metals in the series Bi., Pt., Pb., Sn., Cu., Ag., Zn., Fe., Sb. By heating one or more of the junctions, electricity is developed. See THERMO-ELECTRIC BATTERY.

Ther'mo-graph. An instrument for automatically recording variations of temperature.

Fig. 6350.



Beck's Thermograph.

In the apparatus, Fig. 6350, this is effected by means of photography. The instrument when in use is inclosed in a box, and all light is excluded except that which is admitted through an air-speck in each thermometer. *g* is a cylinder on which the photographic paper is wound, and is rotated by clock-work *h* once in forty-eight hours; *i*, shutter cutting off the light for four minutes every two hours, and leaving a white line when the paper is developed; *s*, wet-bulb thermometer; *t*, atmospheric thermometer; *b*, screw for adjusting thermometers to the required hight; *c c*, gas-lights; *d d*, condensers throwing the light on to the mirrors *r r* through air-specks in the thermometers, the light passing through slits *e e*; *f f*, photographic lenses throwing an image of the air-speck in each thermometer upon the paper on the cylinder *g*. and leaving two irregular dark lines corresponding to the varying hights of the wet-bulb and atmospheric thermometers.

Ther-mom'e-ter. A heat-measurer. The term is generally applied to a glass tube, terminating in a bulb, which is charged with a liquid, usually mercury or colored alcohol. The liquid contracts or expands with changes of temperature, falling or rising in the tube against which is placed a graduated scale.

Perhaps the earliest account we have of an instrument for measuring the heat of the atmosphere is that noticed in the "Spiritalia" of Hero of Alexandria, about 150 B. C., which is described as a tube or vessel wherein the water is made to rise or fall by the changes of heat and cold.

The Spanish Saracens had detected the variation in the density of liquids by changes in temperature, but appear not to have noticed the variation in volume. They therefore used a *hydrometer* as a measurer of temperature See AREOMETER.

The air-thermometer of Santorio, of Padua, constructed about the beginning of the seventeenth century, consisted of a glass tube *a* having at one end a glass ball and open at the other; this tube, having been heated to rarefy the internal air, had its open end placed in a cup of colored liquid, which, by the pressure of the atmosphere, was forced up into the tube.

The expansion by heat of the air in the bulb depressed, and its contraction at a lower temperature elevated, the liquid in the tube. This instrument still lives in a modified form in the SYMPIESOMETER (which see), and was in fact a better barometer than thermometer, though in fact all barometric readings need thermometric corrections. See also AIR-THERMOMETER, Fig. 116.

Santorio employed the instrument as a clinical thermometer to measure the heat of the skin in diseases, and at different periods in the same disease. See also SPHYGMOMETER.

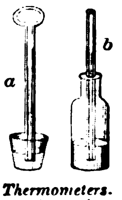
The instrument of Santorio was improved by Boyle, who inserted a tube *b*, open at both ends, through the neck of a bottle containing some colored liquid. A portion of the liquid was then drawn up into the tube The mouth of the bottle being hermetically sealed, the expansion of the contained air caused the column of liquid to rise, and its contraction caused it to fall The bottle could be dipped in hot or cold liquids. The instrument was faulty, as the liquid was subject to contamination and evaporation. This was before the time of mercury as a charging liquid.

The Florentine Academicians introduced the present mode of construction, — a tube with a bulb on its lower end to contain the liquid, and an exhausted stem hermetically sealed.

A work of Albertus Magnus, bearing the title of "Liber Cosmographuris de Natura Locorum," is a species of physical geography, and contains considerations on the dependence of temperature concurrently on latitude and elevation, and on the effect of different angles of incidence of the sun's rays in heating the ground.

"In the department of the distribution of temperature and meteorology, attention was already directed, at the end of the fifteenth and beginning of the sixteenth centuries, to the decrease of temperature with increasing western longitude (the inflection of the isothermal lines); to the law of rotation of the winds, generalized by Francis Bacon; to the diminution of atmospheric moisture and of the quantity of rain, caused by the destruction of forests; and to the decrease of temperature with increasing elevation above the level of the sea and the lower limit of perpetual snow. That this limit is 'a function of the geographical latitude' was first recognized by Petrus Martyr Anghiera in 1510." — HUMBOLDT.

Fig. 6351.



Thermometers. *a. Santorio.* *b. Boyle.*

Previous to the introduction of the plan of completely inclosing the temperature-measuring fluid in an air-exhausted tube, — the work of the Florentine Academicians, it was impossible to obtain reliable data as to the relative distribution of heat and the winter and summer variations of temperature upon different parts of the earth's surface. At present, thanks to the numerous and systematic observations which have been made at all points generally accessible to civilized observers, the laws by which this distribution is governed have been in a great degree ascertained. Nor does this apply to air-currents alone. By the aid of the thermometer the Gulf Stream and the other great oceanic currents have been discovered and mapped out, and light has been thrown upon their origin, and the effects which they produce in modifying the climate of extensive regions of the globe, and influencing the characters of their flora and fauna.

Since the days of Dr. Franklin, who by its aid first positively determined the existence of the Gulf Stream, this little instrument has become of great importance to the mariner, who may frequently, by the decreased temperature of the water, ascertain his proximity to land and to icebergs or other dangers, when it cannot be detected readily by other means.

On an average, the thermometer falls about 1° for each 300 feet of elevation above the surface of the sea. Were it not for the great fluctuations in its indications, due to various causes, this might be availed of as a rough method of determining vertical hights. The determination of the boiling-point of water, which depends upon the absolute density of the atmosphere and not upon the temperature, falling 1° for each 450 feet of elevation, affords a much more accurate means of approximately determining hights above the sea-level. With a simple apparatus specially contrived for this purpose and a good thermometer, a degree of accuracy approaching that of the barometer may be attained. See HYPSOMETER.

In making thermometers, tubes are selected having as nearly as possible a uniform bore throughout. A column of mercury an inch or less in length is then introduced, and the tube connected to a flexible india-rubber bag at each end.

By means of screws, one bag is compressed while the other is expanded, and the mercury is thus gradually forced from one end of the tube to the other, the space which it occupies at each part of the tube is noted, and, in graduating, the degrees at each portion of its length are made longer or shorter in proportion to the length occupied at that part by this short column of mercury; this preliminary process is called *calibration*.

The required dimensions of the bulb are found approximately by weighing a measured length of the mercurial column, and computing the capacity of the bulb from the known expansion of mercury and its specific gravity.

The bulb may be formed upon the tube previous to calibration, or attached afterward. This is done by heating one end of the tube in the blow-pipe and forcing in dry air from an india-rubber bag.

For putting in the mercury, a small reservoir of paper or glass

containing mercury is fixed upon the upper end of the tube. Heat is then applied to the bulb, which, driving out the air, forces the mercury to descend by atmospheric pressure. The upper end of the tube is next heated and drawn out, ready to be hermetically sealed. The mercury is then boiled in the tube, its vapor driving out all traces of air, and, while in a state of ebullition, the tube is sealed by directing the flame of a blow-pipe against its upper end, which fuses the glass and closes the aperture.

Another mode of filling is to heat the bulb and immerse the open end of the tube in a reservoir containing mercury.

The freezing-point is determined by placing the bulb in finely pounded ice, from which the water drains away as it melts. This temperature is fixed and invariable under all circumstances.

The boiling-point is obtained by placing the bulb in steam having the same elasticity as that of the atmosphere: a peculiar apparatus, devised by Regnault, being generally employed for the purpose. As the temperature of boiling water varies with different barometric pressures, it is necessary that a uniform standard should be assumed; this is taken at 30 inches in this country and England, or 760 millimetres in France; and should the hight of the barometer vary from this at the time, a correction of the apparent boiling-point on the tube is necessary to give the true hight of that point.

At the Tower Manufacturing Company's establishment, Chester, Pa., the tubes, which are received in lengths of about one yard, are nicked and broken off to the proper length. The bores are then examined with a lens, and the tubes assorted into ten sizes, and then passed to the glass-blowers. Each of these is provided with an oil lamp and a pair of foot-bellows. Melting the glass at one end, he blows it into a bulb proportionate in size to the bore of the tube by forcing in air from an india-rubber ball applied to the other extremity, and while yet hot he immerses this end in mercury, which, as the bulb cools, rises and partially fills it. The tube is then withdrawn, and a short india-rubber tube attached to the open end; into this mercury is poured, and that in the bulb is boiled to expel the air, which rises through the mercury in the rubber tube, leaving the upper part of the bulb and glass tube filled with mercurial vapor; as this condenses, the mercury in the rubber tube descends and takes its place; this tube is now removed, the bulb heated, and the open end of the tube is hermetically sealed. The bulb and lower part of the tube are then immersed in the water from melting ice, and afterward in baths at 62° and 92° Fah., and the hight of the mercury marked. The lengths of these spaces are carefully measured, and if they are equal the bore of the tube is assumed to be so, and the length of each degree laid upon the brass scale is the same; if otherwise, by means of a peculiar dividing-engine, they are lengthened or shortened to correspond with the variation of the bore. The figures and letters are next punched, and the plate is passed laterally between rollers to remove the bur left by the tools. It is then silvered and lacquered, the tube attached, and the whole inserted in its japanned case.

As to graduation, the Florentine Academicians took the cold of ice and snow for their zero, and the greatest summer heat of Florence for the upper limit of graduation. These being variable were inefficient.

Boyle suggested a fixed point obtained by thawing oil of aniseseed, as it was, unlike ice, always procurable.

Hooke suggested freezing water as one point.

Halley proposed spirit boiling as another point.

Newton suggested the boiling point of oil, as the range would be so much increased. He next suggested melting ice and boiling water as two points; the interval to be divided into an arbitrary number of degrees which were to be continued up and down. These standards obtained general acceptance.

The use of mercury in the tube was suggested by Halley, about 1697. This fluid is very convenient for the purpose, as having a range of over 700° Fah. between its freezing and boiling points, and expanding very nearly uniformly with equal increments of heat.

Fahrenheit, a native of Dantzic, established as an instrument-maker at Amsterdam, first practically carried out Halley's suggestion. He divided the space between the freezing and boiling points of water into 180°, and commenced the graduation of his scale at the point to which the mercury fell when the bulb was plunged into a mixture of pounded ice and salt; this, producing the greatest degree of cold known to him, he termed zero; and as it corresponded to 32 of the 180 equal spaces between the boiling and freezing points of water, the latter was marked 32°.

Reaumur, about 1730, using spirits of wine, adopted the freezing and boiling points as the two standard points of his scale; the space between these was divided into 80°, and the former was assumed as the zero from which the graduations were extended in each direction. De Luc introduced mercury instead of the spirits of wine.

This thermometer was in use in France until the revolution of 1789, but is now generally superseded by the Centigrade.

Celsius, a Swedish astronomer, in 1742 divided the space between the freezing and boiling points into 100°; this thermometer, known in the North of Europe by his name, and elsewhere as the Centigrade, is that in common use on the Continent of Europe, and is very generally employed in scientific investigations elsewhere.

Fahrenheit's is almost wholly confined to the United States, Holland, and to Great Britain and her colonies.

Delisle's thermometer, used to some extent in Russia, has its zero at the boiling-point, and is graduated downwardly, the freezing-point being at 150°.

To find the degrees Fahrenheit corresponding to a given number of degrees Centigrade, multiply by 9, divide by 5, and add 32 to the quotient; thus, 100 C. $\times 9 \div 5 = 180$; $180 + 32 = 212$. By a reversal of the process, that is, by subtracting 32 from Fahrenheit degrees, multiplying by 5, and dividing by 9, we find degrees Centigrade corresponding to those of Fahrenheit; thus, $212 - 32 = 180$; $180 \times 5 \div 9 = 100$. The same rule, using 4 instead of 5, serves to change degrees of Fahrenheit into those of Reaumur and vice versa.

Among the varieties of thermometers may be cited the

Air-thermometer; that of Santorio and Boyle. See *ante*, page 53, Fig 116.

Balance-thermometer; an invention of Kewley, by which mercury inclosed in a balanced tube is caused to make one or the other of its ends preponderate, in order to open and close a window or damper. See page 216.

Barometrical thermometer: a form of boiling-point apparatus for measuring hights, invented by Dr. F. Wollaston. See HYPSOMETER, Fig 2531, page 1160.

Chemical thermometer; one so contrived that its scale is kept out of contact with coloring or corrosive liquids when these are being tested.

Clinical thermometer: one used for detecting the heat of the person. It is conveniently constructed to be applied to the surface of the skin, to the axilla, or in the mouth. See *infra;* also page 567.

Differential thermometer; records differences, say the maximum and minimum during the period of exposure. See Fig. 1650, page 701.

Electrical thermometer; an air-thermometer, designed to show the expansion of air when an electric spark is passed through it.

Marine thermometer; one in which the lower part of the tube is protected by curved bars or otherwise, to prevent its being readily broken by rough handling. See Fig. 3064, page 1393.

Maximum thermometer; one for recording the highest point attained during an observation. See *infra;* also page 1412.

Mercurial thermometer; the common thermometer, in which mercury is the measuring liquid.

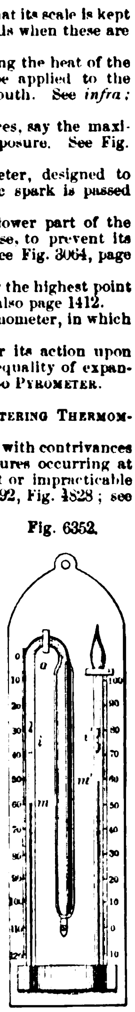
Metalline thermometer; one depending for its action upon the expansibility of a single metal, or the inequality of expansion of different metals, as Breguet's. See also PYROMETER.

Minimum thermometer. See *infra*.

Registering thermometer. See SELF-REGISTERING THERMOMETER.

The *self-registering* thermometer is provided with contrivances for indicating the highest or lowest temperatures occurring at times or in situations where it is inconvenient or impracticable to observe them directly. See also page 2092, Fig. 1828; see also THERMOGRAPH; THERMETOGRAPH.

Fig. 6352.



Six's Register-Thermometer.

Six's *self-registering* thermometer was invented in 1782, but has since been modified. It registers the maximum and minimum temperature that may occur between observations.

a is a long bent tube having a bulb filled with alcohol which reaches to m; from this point mercury reaches to m', above which is a second body of alcohol, which expands into an exhausted and hermetically sealed bulb. $i\ i'$ are two indexes of steel, covered with glass, and having pellets of enamel at their ends. A bristle is wound around each index, so as to enable it to hold its place in the tube unless in adjusting it for an observation, which is done by a magnet.

In operation, each index is brought down by a magnet, so as to rest upon the surface of the mercury in its own leg of the tube. An increase of temperature after the adjustment will expand the alcohol and raise the index i'; should the temperature afterward fall, the index will retain its place, the mercury falling away from it. Should the temperature fall, and the alcohol in bulb a contract, the mercury will raise the index i, which will cling to the side of the tube, the alcohol flowing past it. Graduations are attached to each leg.

Brookes's *self-registering* thermometer is used in the Greenwich Observatory, England, and consists of a zinc case around the shaft, and a float on the surface of the mercury. On an arm attached to this float is thrown a ray of prepared light, which is thence directed upon a piece of sensitive photographic paper. The paper travels by clock-work, and upon it are shown the variations of temperature, the cross lines on the paper indicating time, as the motion is regular and the rate is known.

A *solid* thermometer, to indicate temperatures higher than

the boiling-point of mercury under one atmosphere (676° Fah.), is called a PYROMETER (which see).

Spirit-thermometer; one in which spirit is employed instead of mercury.

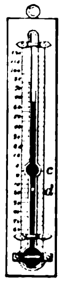
Statical thermometer; a kind of air-thermometer arranged to open and close a window or ventilator by the expansion and contraction of its contained air. See THERMOSTAT.

For Rutherford's instrument, see THERMETOGRAPH.

For Beck's instrument, see THERMOGRAPH.

In Phillips's *maximum* thermometer, about ½ inch of mercury at the end of the column is separated from the rest by a minute particle of air. This index is pushed along the tube as the mercury expands, and remains in the same position, when the mercury contracts, thus showing the greatest degree of heat to which the instrument has been exposed. The separated portion is returned to its place by a jerking motion imparted to the thermometer. The instrument, for use, is laid or suspended in a horizontal position.

Fig. 6353.



Twining's Thermometer.

Twining's maximum thermometer is a spirit-thermometer, having about ⅓ of the way up the tube a bulbous enlargement in which a globule of mercury is lodged. This permits the spirit to flow past it in expanding, but when it again begins to fall, the globule is carried down with it, becoming elongated in the narrower bore of the tube; this is graduated each way from the bulbous enlargement; the number of degrees indicated by the mercury on the lower scale, added to the temperature shown by the spirit in the upper part of the tube, gives the greatest heat reached.

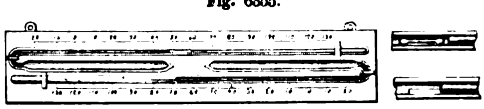
A recent form of automatic *registering* and *printing* thermometer consists of a glass tube bent in the form of a siphon, the closed leg of which is filled with alcohol and the open one with mercury. On the surface of the mercury in the open end there rests an ivory float suspended from a delicate balance, having platinum wire attached to each end of the lever. When the column of mercury in the thermometer tube rises or falls from the effect of temperature, the platinum wires dip in small mercury cups underneath them, thereby causing a current of electricity to pass through one of two electro-magnets operating mechanism for giving motion to a fine micrometer screw. The motion of this screw elevates or lowers the balance, thereby breaking the circuit. Whenever a change of temperature equal to one tenth of a degree Fahrenheit occurs, the magnetic circuit is completed, and the screw is moved a space equivalent to the change in the hight of the mercury in the thermometer. At the same time the clock-work moves the type-wheels indicating the temperature, which is printed at the end of each hour on a slip of paper moving in front of them. A pencil held against a revolving drum also records a continuous curve, exhibiting at a glance the hight of the thermometer.

Fig. 6354.

Maximum Thermometer.

In Negretti and Zambra's *maximum* thermometer (Fig. 6354) the tube is contracted near the bulb, so that the mercury is not withdrawn into the bulb by contraction, but remains at the maximum indication of temperature reached during its exposure.

Fig. 6355.



Self-Registering Thermometer.

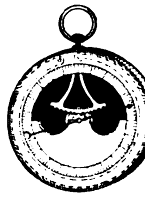
Rutherford's *self-registering* thermometer (Fig. 6355) has a maximum and a minimum tube on the same plate. The first carries a small piece of iron at the end of its mercurial column, pushed forward by expansion, but remaining stationary after the mercury begins to contract; the latter contains spirit, in which is a small index of glass or enamel, shaped like a dumb-bell. This retreats as the fluid contracts, until the lowest temperature is reached, at which point it remains, but permits the fluid to flow past it during expansion.

Fig. 6356.

Breguet's Thermometer.

Breguet's thermometer (Fig. 6356) consists of a helix formed by soldering together three strips, — silver, gold, and platinum. The silver, which is most expansible, is placed on the interior, and the platinum, as being least expansible, on the exterior. When the temperature rises the helix unwinds, and as it falls it contracts again, either movement causing an attached needle at the lower end to traverse a graduated arc.

Fig. 6357.



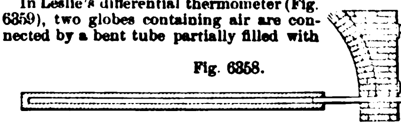
Dial-Thermometer.

Fig. 6357 is a dial-thermometer. The case contains a double circularly bent strip of steel and brass, fixed at one end, and having at the other a lever whose longer arm carries a toothed sector working into a pinion, to which a pointer is attached. The unequal expansion of the two metals under changes of temperature causes the pointer to traverse back and forth upon the arc.

Fig. 6358 is Brogniart's *pyrometer*, consisting of an iron bar lying in a groove in a porcelain slab; one end of the slab rests against the bottom of the groove, and the other moves an indicator outside of the furnace. The expansion of the iron by heat is considerable, compared with that of the porcelain, and their difference measures the temperature.

In Leslie's differential thermometer (Fig. 6359), two globes containing air are connected by a bent tube partially filled with liquid. When both globes are at the same temperature, the liquid stands at equal hights in each branch of the tube; but if their temperature be unequal, the greater expansion of the air in the more heated globe causes the liquid in the opposite leg to stand at a higher level.

Fig. 6358.



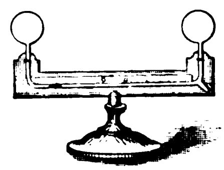
Pyrometer.

Fig. 6359.

Leslie's Differential Thermometer.

Rumford's thermoscope (Fig. 6360) is analogous to the foregoing, the vertical branches of the tube being shortened. An alcohol index remains at the center or zero of the horizontal tube when the bulbs are of equal temperature, but is pushed toward one or the other end when they differ.

Fig. 6360.

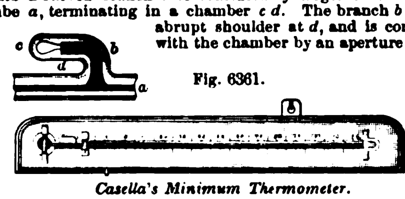


Rumford's Thermoscope.

The two latter thermometers do not measure the absolute temperatures, but serve to show the relative differences of heat between two objects in close proximity to each other.

Casella's *minimum* thermometer (Fig. 6361) has near the bulb a curved branch *b* of considerably larger bore than the tube *a*, terminating in a chamber *c d*. The branch *b* has an abrupt shoulder at *d*, and is connected with the chamber by an aperture having a diameter exceeding that of tube *a*. The instrument is adjusted for use by tilting it so as to expel all mercury from the chamber, and suspending it in a horizontal position. The hight of the mercurial column in tube *a* then indicates the temperature of the surrounding air. When the temperature falls, the mercury contracts in the direction of least resistance, along the main tube *a*, the resistance offered by the shoulder *d* preventing its passage into the chamber; but when again expanded by increase of heat, the orifice connecting the tube *b* and the chamber, being larger than the bore of the main tube, offers less resistance than the latter to the passage of the fluid, which consequently flows into the chamber, remaining stationary in the main tube, and indicating the lowest temperature to which the instrument has been exposed.

Fig. 6361.



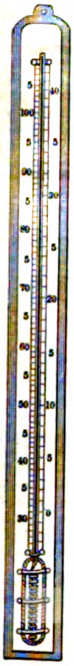
Casella's Minimum Thermometer.

A very sensitive thermometer is formed by substituting for the ordinary bulb a tube coiled in spiral form, either flat or elongated, thus exposing a large surface of mercury in proportion to its mass to the influence of the external heat.

At the Paris Exhibition of 1862 were exhibited a series of thermometers designed to show the relative absorbent powers

of different colors for radiant heat. These were filled with alcohol tinged of different colors, and when exposed side by side to a common radiant source, all differed from each other; but when removed from the light to an apartment of uniform temperature, their indications exactly coincided.

Fig. 6362.



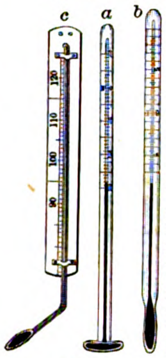
Coil-Chamber Thermometer.

Thermometers specially designed for *clinical* purposes have very thin bulbs, in order to render them more sensitive.

a b are the *surface* and *fever* thermometers of Dr. Seguin. The former has a flat bulb, and is designed to be applied to the surface of the skin; while the latter may be placed in the axilla or other suitable place, or in one of the natural cavities of the body. The natural temperature of the body is assumed as the zero point of the scale, and the graduations read in each direction from this point.

c is Casella's maximum clinical thermometer. It has a globule of mercury serving as an indicator, separated from the mercurial column by an air-space.

Fig. 6363.



Clinical Thermometers.

Cripp's continuous self-registering thermometer has a glass bulb, rather more than an inch in diameter, blown on a tube 12 inches long, and having a bore of $\frac{1}{8}$ inch. The tube is then coiled round the bulb in a close spiral, and two needle-pointed pivots are fixed to the bulb. When these pivots are placed in proper upright supports, the thermometer swings freely, like a delicately balanced wheel. Enough spirit is now placed in the thermometer to fill the bulb, and about 4 inches of the tube at 60° Fah. Mercury is introduced until 4 inches of the tube, above the spirit, is filled with it. The spirit is then heated to 120° Fah., which sends the mercury to within one quarter-inch of the extremity, and the tube is then closed, containing of course a minute quantity of air. The whole apparatus is placed in its supports. If the temperature falls and the spirit contracts, the mercury follows it, and the center of gravity is immediately altered. The thermometer accommodates itself to the change by a partial revolution upon its axis, the direction being opposite to that in which the mercury moves. By the simple operation of the two forces heat and gravity, a positive mechanical motion is produced which is transmitted to a minute endless chain placed vertically and carrying a pencil. Facing the pencil is a vertical cylinder moved by clock-work and revolving once in 24 hours. This cylinder carries a strip of paper ruled with one hundred lines one twentieth of an inch apart, and each representing 1° Fah. Across these are twenty-four dark lines for the hours, and lighter ones for the quarters. To prevent friction from the movement of the pencil over the paper, the former is kept constantly one tenth of an inch from the paper, and a small striker taps it every five minutes, or oftener, driving its point against the paper. The movement of the coiled thermometers, and therefore the temperature, is registered by a series of dots.

A registering thermometer, designed to measure and register the temperature of ocean depths, of deep borings, or other inaccessible places, or of any locality at any desired time, is composed of a mercurial thermometer, curved in inverted V-shape, and fixed on a scale graduated to Fahrenheit degrees. The cylindrical tube which contains the mercury is slightly bent at the zero point. The instrument is connected with a clock, on the lower portion of the dial of which is a supplementary hand pointing to the numbers 1 to 12. By placing this pointer at any determined number, when that hour is reached the clock-work causes the thermometer to revolve one revolution. The effect of this is to break the mercurial column at the bent portion at 0°, and turn it into the other leg of the tube, where it remains, its hight indicating the temperature at the time for which the dial was previously set.

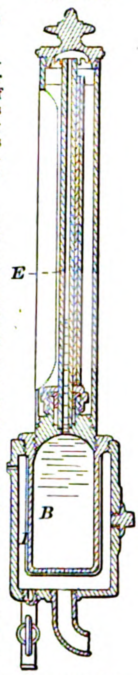
Ther′mo-met′ric A-larm′. An instrument to release an alarm when a dangerous heat is reached in an apartment. A form of *fire-alarm.*

A bent glass tube with a bulb at each end, one of which with a part of the stem contains ether; the other with a part of the stem containing mercury and open to the external air. The tube is poised on its center by gravity. Should the temperature be raised by the presence of fire, the ether would be expanded, the mercury driven into the bulb, the instrument tipped over on its axis, and the alarm sounded. See THERMAL ALARM; THERMO-ELECTRIC ALARM; THERMOSCOPE; THERMOSTATIC ALARM.

Ther′mo-met′ric Steam-gage. A steam-gage which indicates the amount of pressure in a boiler by the amount of expansion of a fluid at the temperature due to the pressure.

In the example, the reservoir *B*, containing mercury, is inclosed in a steam-chamber *I* connected directly with the steam-space of the boiler. The mercury rises in the glass tube *E*, which has a scale directly indicating the pressure in pounds. The reservoir *B* is coated with copper or other suitable material, to prevent steam from penetrating its walls and condensing inside.

Fig. 6364.



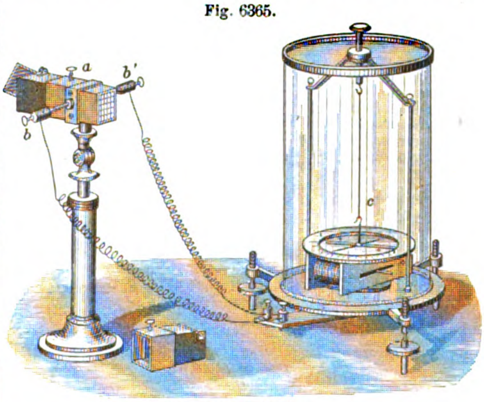
Thermometric Steam-Gage.

Ther′mo-met′ric Ven′ti-la-tor. A modification of Arnott's chimney-valve. It consists of a circular disk, like the throttle-valve of a steam-engine, accurately balanced on a spindle. On one side of the disk is an inverted siphon, with a bulb at one end and open at the other. The lower portion of the siphon-tube contains mercury and the bulb contains air. Any increase of temperature expands the air in the bulb, depresses the mercury, and disturbs the balance of the valve, which opens and allows air to pass. The reverse action takes place when the temperature falls.

Ther′mo-mul′ti-pli-er. An instrument invented by Nobili for measuring small variations of temperature due to radiant heat. Its action depends on the fact that thermo-electric currents are developed by two metals whose opposite junctions are exposed to different degrees of heat. The pile employed consists of alternate plates of bismuth and antimony.

As improved by Melloni, these are arranged side by side so as to form a square bundle, the ends of which are the alternate junctions of the elements. These are contained in a copper case *a*, having covers at each end, which may be removed to expose that part to heat. The terminals of the pile are connected by metallic rods *b b′*, with wires leading to a galvanometer *c*. When a beam of radiant heat strikes the pile, an electric current is produced, the amount of which is determined by the galvanometer.

Fig. 6365.



Thermo-Multiplier.

Ther′mo-scope. An instrument for indicating relative differences of temperature. The term was applied by Count Rumford to an instrument invented

by him, and similar in principle to the differential thermometer of Professor Leslie. See DIFFERENTIAL THERMOMETER. See also Fig. 6360.

Any instrument which shows variations of temperature, whether or not it indicates the actual differences, is sometimes called by this name, including the thermometer. Such were those of Galileo, who in 1593 constructed thermoscopes, which were dependent concurrently on changes of temperature and on variations in the pressure of the external air. These were probably similar to the aërometers of the Spanish Saracens. See AËROMETER.

As early as 1641 observations of temperature were made at regular intervals with spirit-thermometers similar to our own.

Barker and Mayer's thermoscope, August 26, 1873, is designed to indicate in a manner to be readily discernible to the eye the existence of excessive heat in journal-bearings, etc., and also the proper degree of heat to be employed in various processes in the arts. For this purpose two compounds are used. The first is produced by adding a solution of copper sulphate, mixed with sulphurous acid, to a clear solution of hydrargyro-iodide of potassium; the resulting red precipitate is washed, dried, and, by means of suitable varnish or other agent, applied directly or mediately to the object. It changes color at about 160° Fah., but resumes its natural color when the temperature is reduced.

The second is a bright yellow silver precipitate, produced by adding a solution of silver nitrate to the hydrargyro-iodide solution above.

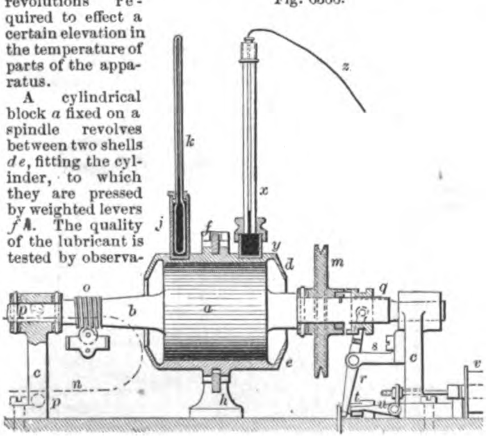
For many purposes the compounds may be applied to cardboard, leather, or thin metal, and by this means attached to the object.

Marcy's thermoscope consists of a thin copper tube of very small bore, and having a bulb at one end. This is inserted within a glass tube, fixed on the periphery of a wheel to which it corresponds in curvature. The tube is hermetically sealed at one end, and in it is poured a certain amount of mercury, which assumes the lowest position in the tube. The axis of the wheel carries a hand which serves as a pointer on a graduated index, and the wheel is balanced on knife-edges. The instrument is particularly designed for experiments on animal heat; the bulb of the copper tube being applied to any part of the body, the contained air expands, displacing the mercury and causing a movement of the index. On being applied to a cooler part, or being cooled by water, the index is caused to move in a reverse direction.

Figs. 6366, 6367, are Stapfer's apparatus for testing lubricants by the number of revolutions required to effect a certain elevation in the temperature of parts of the apparatus.

A cylindrical block *a* fixed on a spindle revolves between two shells *d e*, fitting the cylinder, to which they are pressed by weighted levers *f h*. The quality of the lubricant is tested by observa-

Fig. 6366.



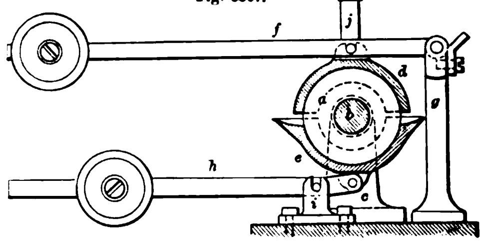
Stapfer's Apparatus for Testing Lubricants. (*Side Elevation and Partial Section.*)

tion of the heat generated by the friction of the opposing surfaces. The upper shell *d* is held down by the weighted lever *f*, which is jointed to the upper end of the standard *g*, the lower shell *e* being pressed upward by the weighted lever *h* that rests upon a fulcrum at *i*. The shells are prevented from revolving with the cylinder by pins in the levers engaging in slots formed in lugs on the shells. A metallic cistern *j* containing mercury is attached to the upper shell, and the bulb of a thermometer *k*, being immersed therein, indicates the temperature to which it has attained.

A band-wheel *m* is mounted on the spindle, and the worm *o* formed on the spindle drives a train in the counter *n*, which registers the number of revolutions. The counter is attached to the standard *c* by two screws, indicated at *p p*.

In another application of the machine, the band-wheel is fitted to revolve loosely on the spindle, and through its engagement with the sliding-clutch *q*, imparts motion thereto. The clutch is changed in and out of gear with the band-wheel by the fork-lever *r*, which is mounted on a stud carried by the bracket *s*, and is acted upon by a spring *t* that tends to throw the clutch out of gear. The clutch is

Fig. 6367.



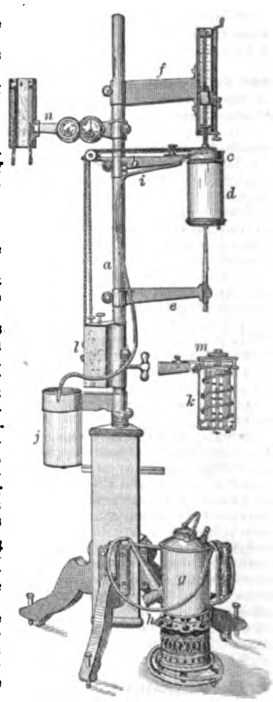
Stapfer's Lubricant-Tester. (*Vertical Transverse Section.*)

retained in gear by a catch on one arm of the bell-crank lever *u*, where it engages with a projection on the lever *r*. The other arm of the bell-crank lever is connected with the armature of an electro-magnet *v* in such a manner that so long as the armature is not attracted by the magnet, the clutch remains in gear, and the cylinder *a* consequently continues to revolve. A battery is connected with the magnet and with the upper end of a thermometer *x*, and the glass tube thereof forms a break in the circuit.

The mercury of the thermometer contained in the metallic cistern *y* fixed to the shell *d* rises with the increased temperature of the shell, caused by the loss of the lubricating properties of the oil, until it touches the end of the wire *z* that projects into the tube.

The mercury then serves to make the circuit, and the armature is attracted, raising the catch from the projection of the lever *r*, and the spring *t* forcing back the said lever, the clutch is thereby disengaged, and the rotation of the cylinder ceases. See also THERMO-ELECTRIC ALARM.

Fig. 6368.



Osborne's Esthermoscope.

Fig. 6368 is a thermoscope of peculiar construction, for meteorological purposes, the invention of J. W. Osborne of Washington. The object of this instrument is to give expression to the aggregate of all the climatic influences which tend at any time and place to affect the normal temperature of the body, or to modify the demand on it for the physiological production of animal heat. As warm-blooded animals, we are constantly losing just as much heat as we make, and therefore in estimating weather or climate, we speak of it as cold or hot in proportion as it cools us rapidly or slowly, irrespective of the nature of the several causes which determine that cooling. The three great factors which affect us thermically are the actual temperature, the moisture of the air, and its motion as wind over our bodies. The first of these alone is all but universally accepted as indicating relative temperatures affecting animal life. A little reflection will show that it does not do so in reality, playing often quite a subordinate part in determining the sensible heat or cold which we experience. A so-called temperate climate, for instance, will, if windy, cool us faster than a cold and frosty one when perfectly still; and a summer temperature of 90° is fresh and pleasant if dry and breezy, while it is almost unendurable if thoroughly moist and free from wind.

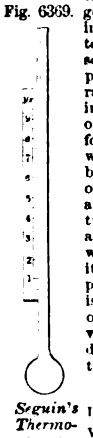
This instrument, shown at Fig. 6368, consists of an upright standard of heavy brass tubing *a*, about six feet high, from which several horizontal brackets extend. One of these *b* carries a ring *c*, from which hangs a cylinder of "bond," or bank-note paper *d*, 100 millimetres diameter, and 150 long (about 4 × 6 inches). The lower end of this is closed by a very thin brass disk, the paper being attached to it and to the ring above by strong rubber bands, or very thin clamping-rings of brass. The arm *e* with the upright wooden pin is used to steady the cylinder when exposed to the wind, or while moving the instrument. The bracket *f* carries a thermometer, the bulb of which is about the center of the cylinder. This cylinder is usually full of cold water, but when an observation is to be made, its temperature is raised to blood heat, or higher, if desired, in the following manner: the copper vessel *g*, being partly filled with hot water, is then elevated above the cylinder, so that the hot water flows in by pipe *h*, and the cold water flows off by the tube *i* into the receptacle *j*. In this way, by simple displacement, any desired temperature can be reached with facility. The cylinder is shown in section at *k*. To maintain the water at an equable temperature throughout, an agitator, consisting of a spiral ribbon, is made to rotate by means of the horizontal pulley *m*, driven by the clock-work *l*, while from the disk below three stationary blades rise perpendicularly, which serve to hold the water from revolving, and force a current to descend the sides and rise in the center against the bulb of the thermometer.

The temperature of the water having been raised to blood heat, or any other point fixed upon, the time in seconds which each degree takes to fall is noted by means of the spring-back stop-watches, on the arm *n* (which also carries the ordinary wet and dry bulb thermometers). These watches are so connected that the movement required to stop one starts the other; whereby a series of intervals can be measured and recorded, each from zero, with perfect accuracy. We thus get the rate of cooling of the mass of water (weighing nearly three pounds) for a series of six or eight degrees, from which a single expression can be calculated.

It will be seen that the cylinder is subjected to influences similar to those which act upon the human body. The paper of which it is made is quite porous, enough to admit of evaporation analogous to that from the skin and lungs. It is cooled by this, and by radiation and convection, as the body is cooled. The rate at which it cools furnishes therefore an expression of the intensity of the aggregate thermal effect, comparable with that experienced by the human body, and proportional for the same or similar instruments at different times and places. The very obvious necessity for the information sought when once pointed out, and the difficulty of obtaining it, give to this invention a peculiar interest.

Fig. 6369 is an instrument devised by Dr. Seguin of New York, to be used in diagnosis. It is intended to detect variations of temperature of the body and the rate of radiation going on therefrom. It consists of a glass tube seven inches long, with a minute bore open at one end, and terminating at the other in a bulb. An adjustable scale is attached to the outside of the tube. To prepare it for use, immerse the bulb in hot water, which rarefies the air inside. The open end is then plunged into cold water and quickly withdrawn, when a drop or two will be found to have entered the tube. This forms a *water index*, which should become stationary within an inch or two of the bulb. If it falls into the bulb, or does not approach it sufficiently, too much or too little heat was applied in the first instance, and it will be necessary to jar the water from the tube and try again. When the index is provided, adjust the scale, bringing its lowest figure on a level with the top of the column of water in the tube, and it is then ready for use. It may be applied to any part of the surface where disturbance of temperature is suspected. It is said to give, by contact, indications of the volume of heat escaping by radiation, and the velocity of loss; and by blowing on the bulb, to indicate the degree of combustion that takes place in the lungs.

Fig. 6369.



Seguin's Thermoscope.

Ther'mo-si'phon. A siphon attachment to hot-water heating-apparatus, invented by two engineers, — Kewley of London, and Fowler of Devonshire, England. They found that the circulation of the water was greatly increased by passing it through the two legs of a siphon, especially when the tubes were irregular in point of horizontal direction, and both above and below the level of the boiler. See Loudon's "Encyclopædia of Gardening," London, 1834, page 597.

Ther'mo-stat. A self-acting apparatus for regulating temperatures.

The balance-thermometer is poised horizontally on an axis, and so arranged that as the mercury contracts or expands in the tube on either side of the mean temperature for which it is adjusted, one end or the other of the thermometer will tip up and actuate a device whereby the heat of an apartment or greenhouse is increased or diminished, as the case may be.

One form was invented by Dr. Cummings of Chester, England, and used to open and shut the windows of hot-houses. A balance-thermometer, patented in England in 1816 by Kewley, was employed to open and shut doors.

An electrical thermostat consists of an ordinary mercurial thermometer, provided with a platinum wire connecting with the mercury in the bulb. Through the other end of the tube is inserted another platinum wire capable of being elevated or depressed. These two wires are in connection with the poles of a battery, and in the circuit is an electro-magnet whose armature controls the opening or closing of a valve for the admission of hot air. If it be desirable that the temperature of the air should not rise above a certain temperature, say 60° Fah., the free end of the movable wire is brought to the required number on the tube. When the heat is such as to cause the mercury to rise to that degree, the electric circuit is completed, the armature closes the hot-air valve until the temperature is diminished, when the circuit is broken, and the valve again opened.

Other forms of thermostat are adapted to open and close the draft openings of furnaces to regulate the admission of fresh air to the fire, and insure a uniformity of combustion.

Dr. Ure, about 1830, contrived a thermostat, the action of which depended on the unequal expansion of two metals by heat, for regulating the safety-valves of steam-engines.

A self-acting statical damper or heat-regulator was invented by Dr. Cummings many years since, and was designed as a mode of opening windows and ventilators in apartments by the variations in the temperature of the included air.

The sash is hung upon centers, so as to oscillate readily, and a cord passes from it to an areometer tube, which is partly charged with quicksilver, and has a body of included air in a bulb at top. The open lower end is plunged in a cup of quicksilver; and as air in the bulb is expanded or contracted by heat, the weight of the suspended tube and bulb becomes relatively less or greater by the variation in the quantity of quicksilver contained, causing the tube to rise or fall, and so operate the sash or valve.

The name *thermostat* was first applied by Dr. Ure to an instrument patented by him in 1831, in which the bending of a spring composed of two unequally expansible metals, as steel and brass, was made to control a valve or damper.

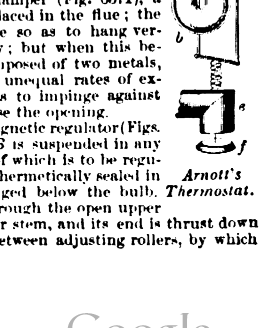
A thermostat was applied by Bonnemain of Paris, in 1777, to his calorifère, by which he heated buildings. The heater consisted of a boiler with an ascending hot-water pipe, which coursed through the stories or apartments of the house, and then descended again to the boiler with its contents comparatively cooled. He heated an incubator in this manner. The variation of temperature seldom exceeded ¼° R. See B, Fig. 2666, page 1178.

The thermostat was inserted in the boiler, and acted upon the door of the ash-pit so as to regulate the admission of air to the fire.

It depended upon the unequal dilation of different metals by heat. It was formed of a bar of iron screwed to one of brass, inclosed in a leaden tube terminating in a ring of brass and plunged into the boiler. The dilation of the leaden tube had the effect of drawing upon the rod and bringing the ring in contact with a claw at the short end of a bent lever communicating by a wire with the ash-pit door, which acted as a damper.

Fig. 6370 shows a form applied by Dr. Arnott to his stove. *a b* is a curved tube containing mercury in the bend *b*: the end *a* is inserted in the combustion-chamber, and as the contained air is expanded by heat, the mercury rises in the outer leg of the tube, carrying with it the float *c*, connected by a rod to the frame *d*, from which is suspended a wire carrying the valve *f*, which closes the opening of the pipe *e* by which air is supplied to the combustion-chamber. A fall of temperature produces the reverse effect. In a simpler form, the lower end of the tube *e* is brought into proximity to a funnel-shaped reservoir of mercury, which on expanding by heat closes its mouth.

Fig. 6370.



Arnott's Thermostat.

In Tamkin's automatic damper (Fig. 6371), a disk turning on an axis is placed in the flue; the disk is weighted on one side so as to hang vertically when the heat is low; but when this becomes excessive, a spring composed of two metals, as copper and iron, having unequal rates of expansion, becomes bent, so as to impinge against the damper and partially close the opening.

In Dr. Sternberg's electro-magnetic regulator (Figs. 6372, 6373), a thermometer *E* is suspended in any apartment the temperature of which is to be regulated. A platinum wire *a* is hermetically sealed in a portion of the tube prolonged below the bulb. An adjustable wire *b* slips through the open upper extremity of the thermometer stem, and its end is thrust down the tube. The wire passes between adjusting rollers, by which

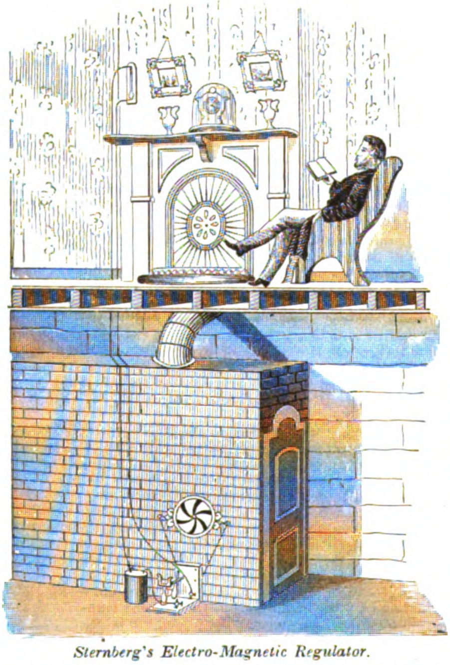
Fig. 6371.

Tamkin's Automatic Damper.

it is raised or lowered until its end stands at any desired degree of the scale. By means of binding-screws, the wires a b have electric communication with the wires c d, which pass to the furnace or heating-apparatus, and are there connected with the apparatus by which the valve or damper is operated. A battery-cup is interposed in the circuit at any convenient locality. When the heat of the room in which the thermometer hangs causes the mercury to rise and meet the point of the adjustable wire, an electric circuit is completed, passing through the helix of a temporary magnet, causing its armature to be attracted, moving a lever by which the valve or damper is closed. This diminishes the heat of the room, and causes the mercury to fall below the point of the wire. The circuit being thus broken, a spring withdraws the armature from the electro-magnet and opens the damper.

Pressure of steam may be regulated by making the steam-gage act as a regulator, the electric circuit being made and broken by the needle of the steam-gage dipping in a cup of mercury. This may be arranged either to govern the supply of air admitted to the furnace or a valve by which steam escapes from the boiler. A modification

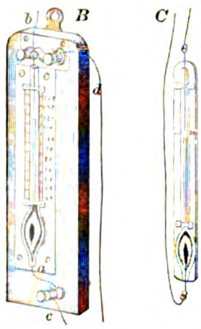
Fig. 6372.



Sternberg's Electro-Magnetic Regulator.

of the apparatus, in which the rising and falling of a float opens and closes the circuit, may be employed as a means of controlling the supply-pipe valve of a reservoir.

Fig. 6373.



Sternberg's Thermometer.

A thermometer (C) in which the upper wire is fixed to a certain graduation in the tube is used for immersion into liquids or gases which are to be maintained at a given temperature.

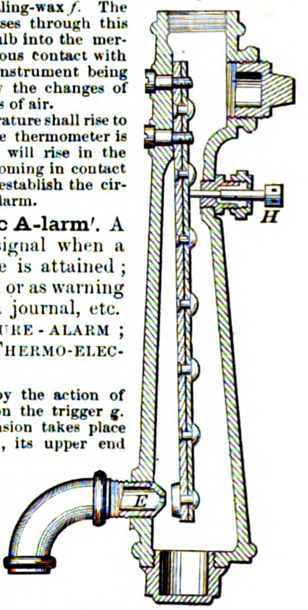
Wilson's thermostat for steam-heaters (Fig. 6374) has a compound plate made of two metals, say of brass and steel, which bends by the unequal expansion of the two metals by increment of heat, and thus stops the steam induction-aperture E. H is adjusting stop-valve screw.

Watkins combines a compound metallic strip a with a closed tubular case m by means of an insulating base b and a metallic conducting-cap i and indicator set-screws n n, whereby, by the expansion or contraction of the compound metallic strip, a galvanic circuit may be closed or opened at any required degree of heat to operate a fire-alarm telegraph-instrument.

In Guest's electrical thermostat (Fig. 6376), the circuit is closed by the rising of a column of mercury in a tube, so as to touch the upper wire d. The instrument has a bulb a with an expansion-tube b, surrounded by an outer vessel c, which is closed hermetically by a cork and sealing-wax f. The end of the wire e passes through this outer vessel and the bulb into the mercury, being in continuous contact with it, the action of the instrument being thus not disturbed by the changes of temperature and access of air.

Whenever the temperature shall rise to the degree to which the thermometer is adjusted, the mercury will rise in the expansion-tube, and, coming in contact with the wire therein, establish the circuit and produce the alarm.

Fig. 6374.

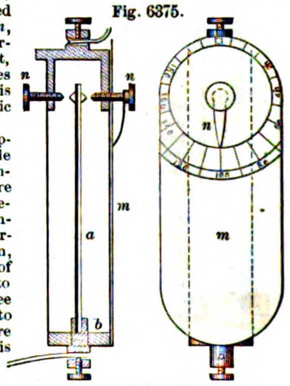


Wilson's Thermostat.

Ther′mo-stat′ic A-larm′. A device to give a signal when a certain temperature is attained; used as a fire-alarm or as warning of the heating of a journal, etc. See TEMPERATURE-ALARM; THERMOSCOPE; THERMO-ELECTRIC ALARM; etc.

Fig. 6377 operates by the action of the thermal bar a upon the trigger g. Whenever lineal expansion takes place in the thermal bar a, its upper end being rigidly fixed to d by the screw-threaded shank, such expansion acts directly and entirely upon the lever e, and through it upon f, causing them to assume the position shown in dotted lines, and releasing g. g may be the trigger or detent of any suitable alarm-apparatus, releasing a wound-up signal-apparatus, or winding up a signal-apparatus by its movement; or it may be simply a circuit, closing or breaking, serving to separate or bring together the two springs i and k attached to insulating-blocks m m, which springs form the terminals of a battery-circuit, as represented by the wires p n, in which circuit is placed any suitable electric apparatus.

Fig. 6375.

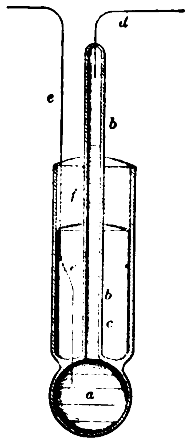


Watkins's Electrical Thermostat.

Fig. 6378 shows the application to a portable thermometer of an alarm-bell operated by the closure of an electrical circuit derived from a battery concealed in the base, the circuit being normally open, but closed by the rising of the mercurial column to any predetermined degree of the scale, according to the degree of temperature required. The operation is as follows: the wire h is represented as extending down the stem of the thermometer to the point on the scale marked 25°. The mercury in the stem stands at about 15°. While this remains the case the circuit is open, and the armature m is not in contact with the poles of the electro-magnet. But when, by reason of increased temperature, the mercury in the stem rises to the point marked 25°, it comes into contact with the end of wire h and closes the circuit, which causes the armature m to be drawn into contact with the electro-magnet l and an alarm to be sounded upon the bell q by the hammer p. When the temperature falls below 25° the circuit is again broken and the armature is drawn away from the magnet by the spring-arms n n. A second hammer, attached to the armature, may be arranged to strike the bell when that fall of temperature occurs. A continuous alarm, if preferred, can be arranged to be operated by the closed current in any of the well-known methods. By sliding the plate d up or down, the end of the wire h may be made to coincide with any desired point on the scale, and the alarm will be sounded when the temperature reaches that degree.

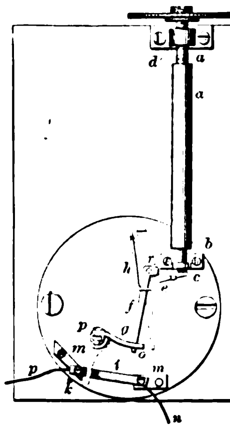
Ther′mo-type. An impression (as of a slice of

Fig. 6376.



Guest's Electrical Thermostat.

Fig. 6377.



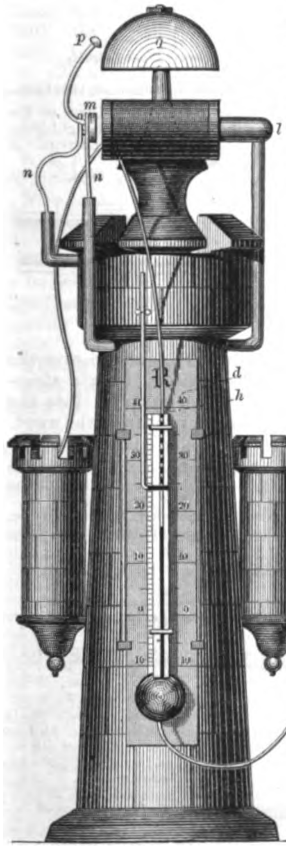
Guest's Thermostatic Alarm.

wood) taken by means of wetting with dilute acid, pressing on the object, and subsequently heating the impression.

Thi'baude. (*Fabric.*) (Fr.) Cloth made from cow-hair.

Thib'et-cloth. (*Fabric.*) A camlet made from goat's hair.

Fig. 6378.



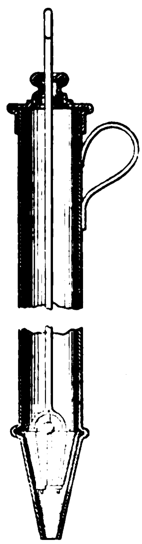
Snow's Electrical Thermostatic Alarm.

Thi'ble. A skimmer or slice. (Old English.)

Thick-and-thin Block. (*Nautical.*) A block having two sheaves of unequal size, in the same plane. A *fiddle-block*.

Thick'en-ing. (*Calico-printing.*) Paste which contains the mordant or dye, in some cases, and forming a vehicle therefor.

Fig. 6379.



Thief-Tube.

Thick'ness. (*Foundry.*) That application of loam in loam-molding which represents the metal, and which is afterward knocked away to leave space for the same.

Thick'ness-ing. (*Wood-working.*) Reducing boards or pieces to an even thickness ready for dressing to shape.

Thick-set. 1. (*Fabric.*) A stout, twilled, napped cotton cloth. A kind of fustian.

2. (*Husbandry.*) Thorn-bushes used in hedging, in England. The thorn does not succeed so well here. One or two of the American thorns are better here than the English hawthorn, but are far from satisfactory.

Thick-stuff. (*Shipbuilding.*) All plank above four inches in thickness.

Thief-tube. A tube for withdrawing samples of liquids from casks, etc. A *sampling-tube*; a *velinche*. Some *burettes*, *pipettes* (see Fig. 3750), and *dropping-tubes* are made on this principle.

Thill. 1. (*Vehicle.*) A *shaft*. One of the two side pieces by which one horse is hitched to a vehicle.

2. (*Mining.*) The floor of the mine.

Thill-coup'ling. A device for fastening the shafts to the fore-axle.

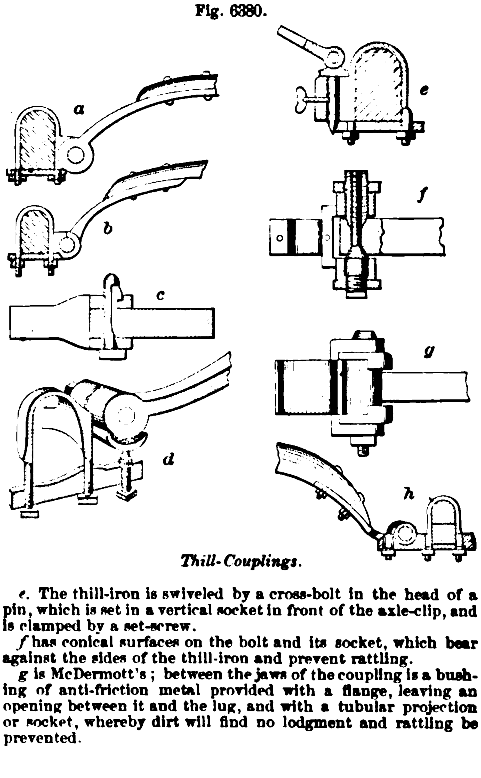
The ordinary mode of coupling (*a*) is by means of a screw-bolt to a clip on the fore-axle. This wears loose and rattles: hence inventions have been brought forward to improve the mode of coupling.

Many patented contrivances, as *b*, depend upon the insertion of a plug behind the pin of the thill, forcing it forward into the hook which is attached to the clip.

***c* consists of a key and spring-latch as a substitute for the screw-bolt, and occupying a similar position, without special adaptation of the other parts.**

***d* is Bridget's coupling. The set-screw beneath the socket-plate and elastic pad raises the thill-iron against its pivotal pin and prevents rattling.**

Fig. 6380.



Thill-Couplings.

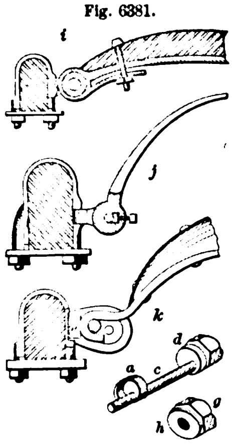
***e*. The thill-iron is swiveled by a cross-bolt in the head of a pin, which is set in a vertical socket in front of the axle-clip, and is clamped by a set-screw.**

***f* has conical surfaces on the bolt and its socket, which bear against the sides of the thill-iron and prevent rattling.**

***g* is McDermott's; between the jaws of the coupling is a bushing of anti-friction metal provided with a flange, leaving an opening between it and the lug, and with a tubular projection or socket, whereby dirt will find no lodgment and rattling be prevented.**

h. The clamp-hook or convex-headed cap is situated between the branches of the forked thill-iron, and forms part of a bolt which is secured in the jack by a nut.

Fig. 6381.



Thill-Couplings.

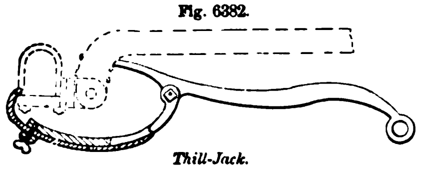
i. An open ring bushing is placed around the bolt, and the loop of the thill-iron is bent around the bushing, which may be of raw hide. The end of the iron is bent around and traversed by a temper bolt.

j. The head of the thill-iron has a recess opening into the hole through which the bolt passes; in this recess is a friction-plate, which is pressed against the bolt by a set-screw to prevent rattling.

k. The thill-hook is placed in the clip, and the bolt inserted. The bolt, being turned half a revolution, brings the eccentric pin *c* against the thill-hook, and forces the latter against an elastic pad *e* in front of the clip The working faces *a a'* of the bolt turn in the eyes of the clip, as does also the collar *h* of the nut *g*, which prevents the return motion of the bolt.

Thill-jack. A tool for attaching the thills of a carriage to the clips of the axle. By means of the lever clamp the rubber, which is placed in contact

Fig. 6382.



Thill-Jack.

with the thills to prevent rattling, is compressed, so that the thills may be easily attached. A *shaft-coupling jack.*

Thill-tug. A leathern loop depending from the harness saddle to hold the shaft of a carriage.

Thim'ble. 1. A frusto-conical metallic sheath used to protect the end of the finger in sewing. Seamstresses use a thimble having a rounded end with numerous small pits or indentations. Those used by tailors, upholsterers, and needle-men generally are open at the end.

The name is said to have been derived from *thum-bell*, having been first worn on the thumb, as the sailor's thimble still is. It was introduced into England from Holland in 1605, by John Lofting, who manufactured them at Islington.

Thimbles of bronze, exactly like the modern, have been found at Herculaneum.

The thimble is sometimes utilized as a tool-holder. The *extension thimble* of the dentist is a prong on the end of the thimble, used to reach into the mouth to hold the foil or a compress, while operating on the teeth

The bur thimble has an open ring for the index or middle finger, and a socket attached, in which rests the end of the drill handle.

The *hand-shield* used by sail-makers and saddlers is called a *palm*.

Silver thimbles are made from coin-silver, cast into ingots, and rolled into sheets, from which circular disks are cut by stamping; these are then placed over a circular opening and subjected to the action of a plunger. The end, side, and rim are turned in a lathe, where they are also polished by a round steel rod dipped in oil.

The ornament near the rim is impressed by means of a rapidly revolving steel wheel; a second wheel forms the ornament near the middle. A third wheel provided with points makes the indentations on the side and end. The inside is then polished in a similar way to that employed for the outside. The thimbles are finally boiled in soapsuds to remove the oil, and then brushed.

Iron thimbles for sewing are *raised* by stamping with five or six blows, between as many pairs of conical dies, which are successively more and more salient. The metal is annealed between each operation.

In Paris they are made from strips of thin sheet-iron, which is punched into disks about two inches in diameter; these are heated red-hot, struck up to the required depth, then placed in the lathe, where the interior is polished, the outside turned off, the pits indented with a kind of milling tool, and a groove formed on the outside to receive the gilding. After being annealed and brightened, the inside is also gilt with a strip of gold-leaf applied by the pressure of a mandrel. A fillet of gold-leaf is similarly secured in the exterior groove.

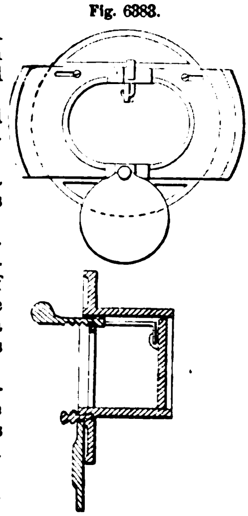
2. (*Nautical.*) An iron ring having an exterior groove worked into a rope or sail, for the purpose of receiving another rope or a lanyard. A large eyelet.

3. (*Machinery.*) *a.* A sleeve or tube through which a bolt passes, and which may act as a stay.

b. A ferrule to expand a tube; specifically, a ferrule for boiler-tubes.

4. A sleeve around a stove-pipe when it passes through a wall or ceiling. In Fig. 6383, the sliding-jaws in the face are capable of embracing pipes of varying sizes, and the opening is closed by a shutter; a damper is placed in the rear end.

Fig. 6383.



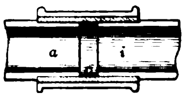
Stove-Pipe Thimble.

Thim'ble-eye. (*Nautical.*) An eye in a plate through which a rope is rove without a sheave. A *dead-eye.*

Thim'ble-joint. A sleeve-joint, with an interior packing to keep the joints of pipes tight during expansion and contraction.

The adjoining ends of the pipes *a i* are turned true on the outside, and have a thimble, or short cylinder of wrought-iron, to inclose them, leaving only a small space for the current. A piece of tin *c*, or inner thimble, is interposed, and made to fit well to the turned parts of the pipes, which, under the influence of heat or cold, work forward or backward, like a piston in a cylinder. In a range of pipes 120 feet in length, there is a motion from expansion of three quarters of an inch; but the usual allowance for the expansion of cast-iron pipes is one eighth of an inch in 10 feet, or $\frac{1}{960}$ of their length.

Fig. 6384.



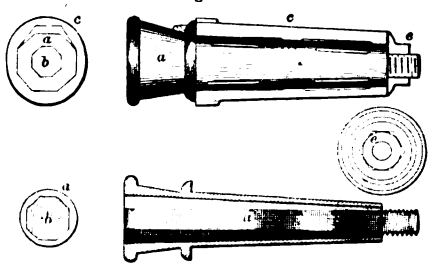
Thimble-Joint.

Thim'ble-skein. (*Vehicle.*) A sleeve over the arm of a wagon-axle; distinguished from a *strap-skein*, which is simply a flat iron strip let into the wood of the axle-arm to take the wear from the wood. See also Axle.

In Fig. 6385, *a* shows a thimble-skein; *b*, the wood of the axle-arm, over which the skein is slipped; *c*, the box of the hub; *e*, the nut on the screw at the end of the skein.

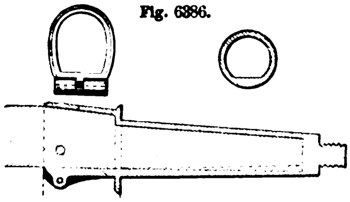
The thimble-skein (Fig. 6386), at its lower bearing surface, has a flat straight seat for the under side of the wooden axle,

Fig. 6385.



Thimble-Skein.

Fig. 6386.



Snyder's Thimble-Skein.

and has a gradual taper from its front to its rear end to facilitate fitting to the axle.

Thirl'ing. (*Mining.*) A worked space connecting the *rooms* of a mine. The *rooms* are galleries proceeding regularly — in coal-mines — from the *dip-head* or *main-level*, and the unworked space forms a *wall*. By cutting gaps in this *wall* at regular intervals, the *wall* becomes a row of *pillars*, the said connecting workings are *thirlings*.

Thir'ty-two. (*Printing.*) A sheet of paper which folds up into 32 leaves or 64 pages. Usually written 32mo.

This'tle-dig'ger. A long narrow spade for cutting the roots of thistles below the crown of the root, and lifting them from the ground. See Fig. 5334, page 2251.

Thole. 1. (*Nautical.*) A pin inserted in the gunwale of a boat to serve as a fulcrum for the oar in rowing. They are arranged in pairs, the space between forming one kind of rowlock. Tholes are shown on the gunwales of ancient Assyrian boats. (Rawlinson's "Five Great Empires," Vol. I. page 550.) Called also *thowls*, *thole-pins*. See ROWLOCK; also Fig. 3360, page 1542.

2. (*Husbandry.*) The *nib*, pin, or handle of a scythe-snath.

3. (*Architecture.*) *a.* The scutcheon or knot at the center of a timber-vault.

b. A place in temples where votive offerings were suspended.

Tho'lo-bate. (*Architecture.*) A cupola, and a base; that part of a building on which a cupola is placed.

Tho'lus. (*Architecture.*) An appellation given to buildings of a circular form. Vitruvius uses it to signify the roof of a circular building. Now frequently applied to the *lantern* which surmounts a dome.

Thong. A leathern strap or lash.

Tho'ra-co-sco'pi-um. (*Surgical.*) A STETHOSCOPE (which see).

Tho'ri-um. A heavy gray metal which burns when heated in the air.

Thor'ough-bolt. (*Shipbuilding.*) A bolt going through from side to side.

Thor'ough-brace. (*Vehicle.*) A strong band or thong extending from the front to the back C-spring and supporting the body.

Thowl. See THOLE.

Thrash'ing-ma-chine'. (*Husbandry.*) One for beating out grain from the heads. The normal form operates upon wheat, barley, oats, rye, and timothy. Some modifications have been made for flax and clover-seed.

In Egypt, the ancient modes of thrashing have been maintained till modern times. (See Fig. 4196.) Their wheat was bearded.

"For the fitches are not thrashed with a thrashing instrument, neither is a cart-wheel turned about upon the cummin; but the fitches are beaten out with a staff, and the cummin with a rod. Bread-corn is bruised; because he will not ever be thrashing it, nor break it with the wheel of his cart, nor bruise it with his horsemen." — Isaiah xxviii. 27, 28.

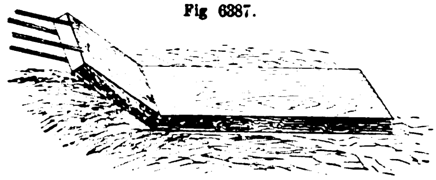
We learn from Amos that the sheaves were carted to the floor. Four instruments of thrashing are mentioned in this passage, — the *flail*, the *drag*, the *wain*, and *treading by cattle*. Another, not mentioned, was the *ripple*; doura, sorghum, or flax was thrashed by drawing across a comb-like instrument. See Fig. 4341.

The practice was, and is, to gather the grain to a spot which is exposed to the wind, and there lay floors of sheaves about a foot thick. As the grain in the sheaf is thrashed, it is heaped in the center of the circular track on which the operation is performed, awaiting a favorable day for winnowing.

Barley harvest preceded that of wheat in Egypt and Palestine, and Boaz winnowed barley at his thrashing-floor when Ruth waited upon him.

1. The thrashing by flails was adopted for the more tender kinds of grain.

Fig 6387.

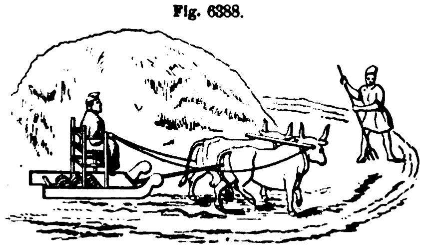


Syrian Mowrej.

2. The drag was a frame of wood shod with iron (or sharp pieces of lava in Palestine); it was sometimes toothed, making it "a new, sharp thrashing instrument, having teeth." (Isaiah xli. 15.) This may have resembled the Roman tribulum, which was a sled drawn by oxen. The driver rode upon it.

3. The *wain* was a frame with a number of axles on which were placed gangs of wheels. It was drawn by oxen around the track on which the sheaves were laid. A man attended with a

Fig. 6388.



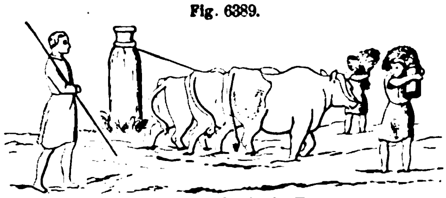
Egyptian Mowrej.

fork to throw in the unthrashed straws and keep a full thickness on the floor beneath the thrasher. Niebuhr and Thompson have described the process at length. It is as it has always been since the first record of such things.

Varro (150 B. C.) describes a Carthaginian machine which traveled on rollers studded with iron knobs and having a seat for the driver.

4. The tramping by cattle needs no particular description. The Hebrew law forbade the muzzling of the mouth of oxen while trampling out the corn.

Fig. 6389.



Tramping out Grain in Egypt.

Dr. Thompson considers the thrasher made of a slab, studded beneath, to be the common form of machine, and states that it grinds the straw up into chaff; the latter makes the winter feed of the animals, who know not hay. The arrangements were similar when Gideon thrashed wheat by the wine-press under the oak in Ophrah, 1249 B. C.; and when the plague was stayed at the thrashing-floor of Ornan the Jebusite (1017 B. C.), at the elevated spot afterward known as the hill of Zion, and which was purchased by David for 600 shekels of gold as a site for the temple his son Solomon was to build.

Among the Romans thrashing was carried on in similar ways: —

1. The ears or the grain in the straw, as it came from the field, was thrashed by the *flail*;

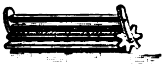
2. Or trodden out by men or horses;

3. Thrashed by a *tribulum*, a loaded board shod with iron bars and drawn by oxen;

4. Thrashed by a *Punic wain*, a frame supporting a rider and running on toothed rollers.

Virgil recommends that the thrashing-floors be spaded up and rammed down with chalk and cow-dung. Pliny advises lime slacked with the amurca of the olive to make a cement floor. Cow-dung and the marc of olives are still used in France for preparing thrashing-floors.

Fig. 6390.



Roller for Thrashing.

Thrashing in Lombardy is generally performed by means of a fluted roller (Fig. 6390) drawn around in a circular track.

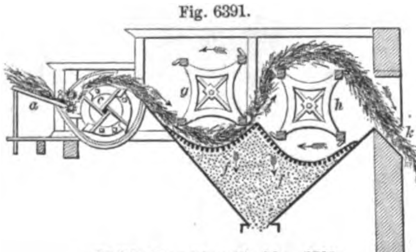
Hohlfield of Hermerndorf, in Saxony, 1711-1771, invented a thrashing-machine while working on the estate of Gusow, in the service of the Prussian minister, Count de Podervils. We are not informed as to its construction; it seems to have given satisfaction. He also invented a straw-chopper and many other machines.

Menzies made a machine in Scotland in 1732, and Stirling of Dumblane another in 1758, but they do not seem to have been successes.

Meikle, of Tyningham, East Lothian, Scotland, invented a machine in 1786, which is the type of modern thrashers. Menzies's had a series of revolving flails, and Stirling's had a cylinder with arms upon a vertical shaft running at high velocity. Meikle invented the drum with beaters acting upon the grain in the sheaf, which was fed between rollers. The English improvement was to make the beating drum work in a concave known as the *breasting*, the grain and straw being scutched and rubbed between the two and carried to the shaker, which removed the straw from the grain and chaff, a large amount of grain also falling through the bars of the concave.

Fig. 6391 shows the Meikle machine, in which the grain in the straw is fed from the board *a* between two fluted rollers to the beater-cylinder *c*; thence passes to another beating-cylinder *g*, which operates above a concave grating; a third cylinder *h*

Fig. 6391.



Meikle Thrashing-Machine, 1786.

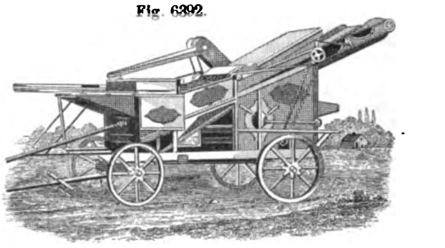
raises and loosens the straw, which parts with its grain *f* through the concaves, and the straw is delivered at *k*. The circular rakes *g* and *h* were added in 1789 by Chillingham. In 1800, the fanning-mill was added.

The American improvement upon this consists mainly — besides numerous details which secure speed, lightness, and effectiveness — in having, upon the drum, spikes or teeth which pass between fixed spikes on the concave; the grain in the straw being subjected to a severe beating and rubbing action as it passes in a zigzag course between the two, being carried by the teeth of the drum. The latter is now usually a skeleton cylinder of iron bars with sword-shaped spikes secured by threaded tangs and nuts. The front edges of the spikes are rounded and smooth, to prevent breaking of the grain; the spikes of the concave have smooth edges presented toward the coming grain for a similar reason. The English still adhere to the flat beaters, like narrow wings or slats, placed longitudinally, and with edges projecting outwardly from the drum. The Americans adhere to the spiked cylinder. A fair trial between the two was had on the farm of Mr. Mechi, Tiptree Hall, Kelvedon, England, in 1853. The American machine was operated by the two persons who had shipped it from the United States; one of them was the present writer. The trial was conclusive. The American machine was driven by a portable engine of six horse-power, and averaged 64 bushels of wheat per hour; 448 bushels of barley were thrashed in six hours, nearly treble the work of the English competing machines, and the grain in much cleaner condition.

The editor of the London "Times," Mr. Mowbray Morris, himself witnessed the operation, and wrote as follows in an editorial of the following day, November 1, 1853: —

"The machine, which is portable, weighs only fourteen hundred-weight, thrashes easily, and without waste, at the rate of one bushel in forty seconds, and turns out the grain perfectly clean and ready for market. It is therefore about twice as light in draught as the lightest of our machines of the same description; does as much if not more work than the best of them, and, with much less power, dresses the grain, which they do not, and can be profitably disposed of at less money than our implement-makers charge. . . . We build thrashing-machines strong and dear enough, and tremendously heavy either to work or to draw. The American farmer demands and gets a machine which does not ruin him to buy or his horse to pull about, which runs on coach and not wagon wheels, and which, without breaking the heart of the power that drives it, yields the largest and most satisfactory results. Nothing, therefore, can better illustrate the difference in mechanical genius in the two countries than this grain-separator as compared with its British rivals."

Fig. 6392.



American Thrashing-Machine.

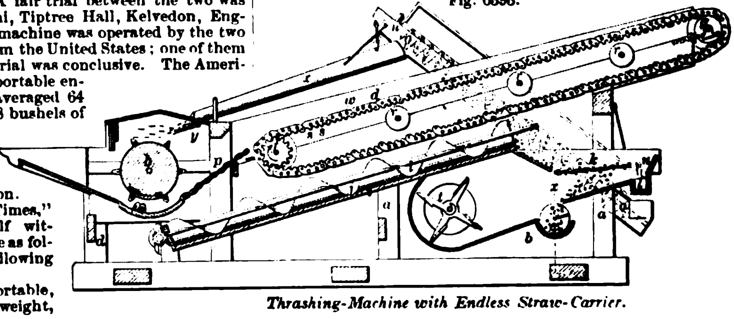
It may be mentioned that the apparent perversity with which the British retain flat beaters instead of the teeth is that in many parts of Britain there is a profitable market for trussed straw; the straw is less broken by the beaters than by the teeth, is in more unbroken lengths, and trusses more readily and handsomely.

The American thrashing-machine has some characteristics common to nearly all its machines. An inclined chute furnishes the sheaf, heads foremost, to the action of the radial teeth that are attached to the skeleton cylinder, and are opposed to the teeth in the concave plates beneath. A straw-carrier elevates and discharges the straw, shaking out the grain, which falls into the well. A lifting screw elevates and forwards the grain and chaff from the well to the vibrating shoe that carries the dividing screens, which, with the aid of the blast from the fan in its rear, separates the grain from its accompanying refuse. The clean grain then falls into a forwarding screw that discharges through a spout into a measure or bag.

An elevator returns the tailings and unthrashed heads to the cylinder to be worked over. An endless belt furnished with transverse slats, and sometimes covered with an apron, takes the straw from the machine. Some machines are also provided with a straw-carrier that elevates and forwards the straw, commonly discharging it on the stack, as seen in Fig. 2570, page 1126. See also STRAW-CARRIER.

The machine (Fig. 6393) has a thrashing-cylinder *b*, a grating *p*, a slatted straw-carrier *w d*, which has cogs *s s* beneath it to shake it as it passes over the rollers *r r*. The straw-carrier is driven by a pinion *f* from the side gearing, and the carrier is

Fig. 6393.



Thrashing-Machine with Endless Straw-Carrier.

tightened by the shiftable roller *g*. Grain is lifted from the well by the conveyor *i j* and discharged on to the screen *k*, where the blast from the fan *t* meets it and blows the chaff over the end of the shoe, the grain falling into the concave *b*, whence it is removed by the screw conveyor *x*, which is axled on *c*. Heavy tailings fall inside the board *u*, and are caught in the tray *l*, discharged into the box *o*, raised by the conveyor *n*, and discharged by the spout *x y* into the cylinder case. *a a* are the stanchions of the machine.

In Fig. 6394, the features are similar in most respects, but differ in the shape somewhat. It also has a beating-cylinder to lighten up the straw as it comes from the thrashing-cylinder, to allow the grain to fall out. The straw-carrier consists of suspended oscillating frames with teeth; these move in two gangs, one set alternating with the other, and shoving the straw forward step by step.

The English thrashing-machines are driven by engines of from 4 to 6 horse-power. The feeding-rollers are $3\frac{1}{2}$ inches in diameter, and make 35 revolutions per minute. The straw-rakes have the same diameter, and make 30 revolutions per minute. The drum has beaters, formed by slats on the ends of radial arms, differing in that respect from the American thrashing-machines, which usually have skeleton-cylinders armed with radial teeth. The mode of feeding in the English machines also differs from ours. The sheaf, with us, after cutting the band, is spread upon the inclined feed-chute by the person who is feeding, and passed gradually into the throat of the machine, head ends first. In some of the English machines, the straw is fed in broadside on, to prevent the breaking of the straw; by this means, only a part of each beater acts upon the ears. Other machines, as above remarked, have rollers which carry the grain in the straw from the feed-board to the thrashing-cylinder.

The diameter of the English drum is $3\frac{1}{2}$ feet, and it makes 300 revolutions per minute. While it has nearly double the diameter of our thrashing-cylinder, it has only about one fourth of the number of revolutions. The space, therefore, is about the same. The American thrasher is more expeditious than the English, does its work as thoroughly, and cleans the grain as well. It is lighter, cheaper, and requires less power for a given amount of work performed.

Fig. 6396 is a longitudinal sectional view of an English form of thrashing-machine in which the opened sheaves are fed between a beater-cylinder and concave; delivered on to an elevator consisting of a number of narrow belts with spikes; thence to a second elevator, the grain and chaff meanwhile falling in a shower upon the shaking shoe beneath, where, by means of riddles and blast, they are separated. The straw is delivered at the rear of the machine to a fan and spout, which carry it away and deliver it on to a stack. The shoe delivers the grain into sacks at *a*, the tailings fall into a pile at *b*, and the chaff at *c*.

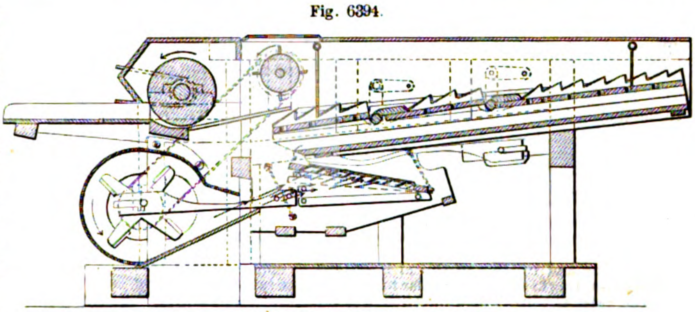
The thrashing-machine of Sir W. W. Wynne, at Wynnstay, Britain, is perhaps one of the most complete of which we have any account. An elaborate description of it, illustrated by cuts, is given in the supplement to Loudon's "Cyclopædia of Agriculture," London.

It separates the grain from the straw, and delivers each into its proper place without any other attention than feeding. The barn is on a declivity, and has three stories. The sheaves are carried into the upper one, where the thrasher is situated. On the second floor is the first winnower and chaff-house, communicating with the straw-house and cattle-yard. On the lower floor is the second winnower and the foot of the elevators, which raise the grain for distribution to the granaries, to the bruisers, which fit it for feed.

It is driven by an overshot water-wheel 18 feet in diameter, 4 feet wide.

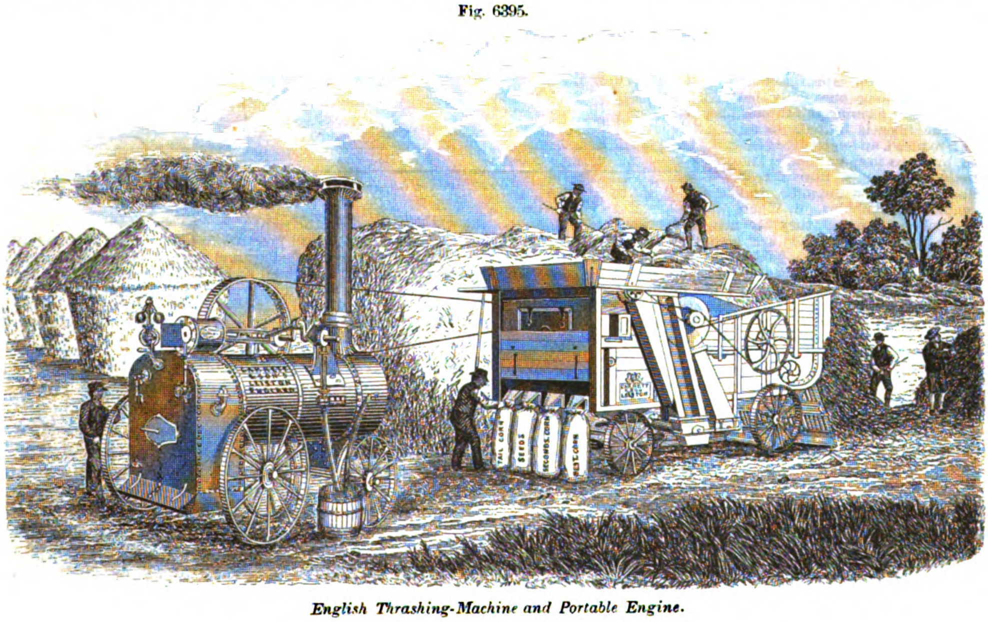
Cresy gives the quantity of wheat thrashed and cleaned by the English machines as from 12 to 24 bushels per hour. This is not over one third of the work performed by an American

Fig. 6394.



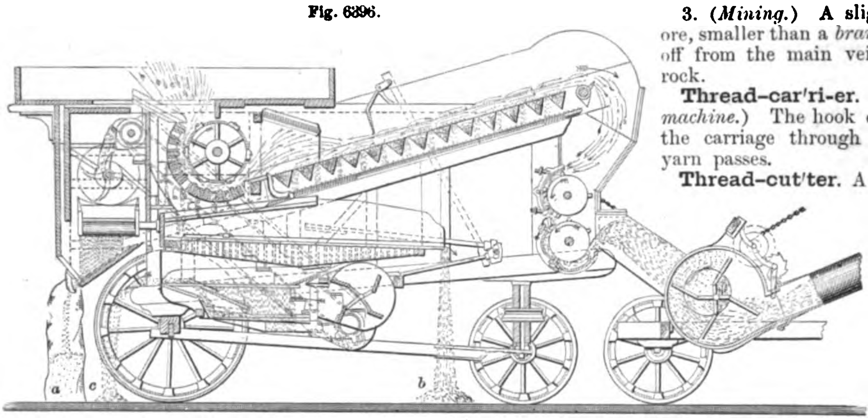
Thrashing-Machine with Oscillating Straw-Carrier.

Fig. 6395.



English Thrashing-Machine and Portable Engine.

Fig. 6396.



Ransome's English Thrashing-Machine (Vienna Exposition).

machine of good quality, on reasonably good wheat. Perhaps Cresy's figures are not up to the present mark.

Thread. 1. In the manufacturer's language, thread is a compound cord consisting of two or more single yarns, doubled and twisted.

In the trade it is divided into

Lace thread.
Stocking thread.
Sewing thread.

Lace thread consists of two yarns, Nos. 140 to 350, twisted together.

Stocking thread varies in the number of its yarns.

Sewing thread consists of three or more yarns united and intertwisted.

The doubling and twisting of thread is effected by spindles and flyers operating in a manner similar to the THROSTLE (which see). The twist is usually in a direction the reverse of that given to the individual yarns.

Thread of fine quality was imported into England from Holland and Flanders for many centuries. The thread for making the Honiton (Devonshire, England) lace was imported from Antwerp.

Long-fibered cotton, as "Sea Island," or Egyptian, is best adapted for making thread. Sewing-thread undergoes the following operations in the process of manufacture: —

1. It is passed through a picker, which separates and arranges the fibers. 2. The carding-machine straightens the fibers and coils the roving or sliver into a can. 3. The combing-machine separates the short fibers, the long ones only being used in forming the thread. 4. The fiber is united, drawn out, reduced, and partially twisted, previous to spinning. 5. The rovings are spun into a very fine thread upon the mule, and wound upon bobbins. 6. When the bobbins are full, they are transferred to the winding-machine, where the threads are wound off, two together, on to other bobbins. 7. These bobbins are taken to the twisting-machine, where the two threads are twisted tightly together and wound upon bobbins again. 8. Three of these doubled threads are wound off as before. 9. They are twisted together, forming a compound thread consisting of six strands or yarns.

The thread thus made is reeled off, tied up into hanks or bunches, and taken to the bleachery, where it passes through the processes of boiling, bleaching, washing, soaping, bluing, and drying; or to the dye-house, where it is thoroughly boiled and prepared, and colored by various dyes. After bleaching or dyeing, the hanks are again returned to the mill and wound upon large bobbins, from whence the thread is wound on the small spools for market.

The spooling-machines automatically wind the thread on the spool, cut the nick, insert and fasten the end of the thread, cut it off, draw the spool off the spindle, drop it into a hopper, replace it by another spool, and continue the winding. Each machine winds eight spools at a time, at the rate of 300 dozen per day.

The thread and gauze manufacture was begun at Paisley, in Scotland, 1759.

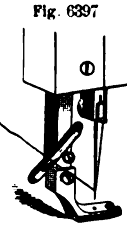
2. The spiral projecting rib on the shaft of a screw.

3. (*Mining.*) A slight vein of ore, smaller than a *branch*, passing off from the main vein into the rock.

Thread-car'ri-er. (*Knitting-machine.*) The hook or eyelet on the carriage through which the yarn passes.

Thread-cut'ter. A small blade attached to a thimble, to a thread-stand, or to a sewing-machine, to cut off a sewing-thread; a substitute for breaking it, or for a pair of scissors. See list, page 2112, SEWING-MACHINE, Class F, section 26.

Fig. 6397



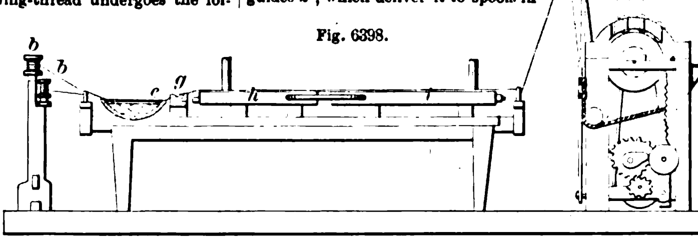
Thread-Cutter.

Thread'er. A device for guiding the thread into the eye of a needle. See NEEDLE-THREADER, Figs. 3312, 3314, page 1520; also list under SEWING-MACHINE, Class F, section 8, page 2111.

Thread-fin'ish-er. A machine in which thread is treated to give it a smooth and polished surface. It usually consists of a sizing and drying operation, which smooths down the fluff of the fiber and imparts a hard, glossy surface.

In the example (Fig. 6398), the thread is shown as going from left to right; from the bobbins *b b* to the size-bath *e*, the wipers *g*, steam-chests *h i*, to the guides *k'*, which deliver it to spools in the winding-frame on the right.

Fig. 6398.



Thread-Finishing Machine.

In Fig. 6399, the thread proceeds from the spools on stand *W* by a guide *j*, thence is coiled around the rollers *d d*, which are in a frame having a horizontal reciprocating motion to rub the threads, in order to harden and round and at the same time rub the fluff from the thread. It then passes by a reciprocating guide-bar *p* to the receiving-spool *N*. See also THREAD-FRAME; THREAD-POLISHER.

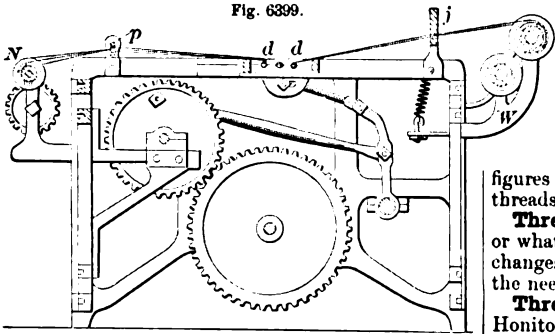
Thread-frame. The doubling and twisting mill by which two or more yarns are combined to form a thread. The yarns as they are unwound from the bobbins or cops are passed beneath the surface of a solution of gum or starch in a trough *a* (Fig. 6400); the wetting enables them to be condensed into a more solid thread; they then pass between rollers *b*, by which they are laid parallel, or nearly so, and are thence conducted to the flyer *c*, by which they are twisted together, and to the bobbin, on which they are wound.

Fig. 6401 shows a machine similar to the throstle, by which

doubling and twisting cotton or linen yarn to form thread is performed.

The view is a transverse section of the machine. *a* is the cast-iron frame; *b*, the *creel* on which the bobbins *c c* are loosely

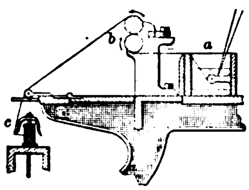
Fig. 6399.



Thread-Finishing Machine.

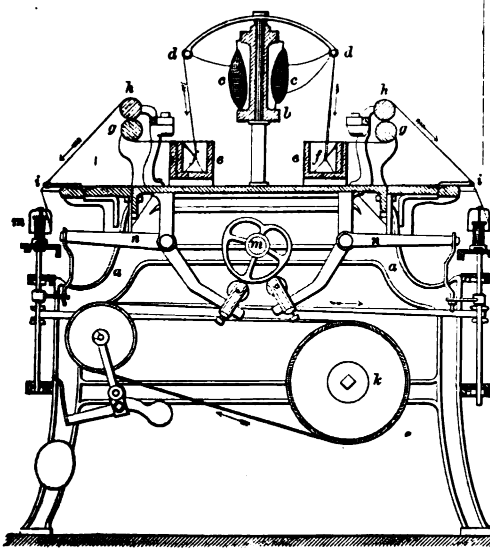
supported along the whole line of the machine, their lower ends turning in oiled steps, and their upper ends in wire eyes. *d d* are glass rods over which the yarn winds as it is unrolled; *e e*, oblong narrow troughs, lined with lead and filled with water, through which the thread passes to moisten it, being drawn through eyes at the bottoms of the forks *f f*, which may be lifted out of the trough. *g g* are smooth rollers of iron, and *h h* rollers of boxwood, between which the thread is pressed. The thread passes from the bobbins *c c* over the rods *d d*, thence downward beneath the forks *f f*, under the rollers *g g*, and upward between them and the rollers *h h*, thence downwardly through eyes *i i* to the bobbins *m m*, by which it is twisted and on which it is wound. The rollers *g* are turned by gearing, and turn the rollers *h* by friction. The spindles are driven from the drum *k* by a band passing over the pulley *l*, weighted to keep the pulleys tense. The bobbins are traversed vertically to wind the thread evenly upon them by a gear on the end of one of the lower roller-shafts, which turns a carrier-wheel engaging a wheel on the shaft carrying the heart-cam *m*; this operates the levers *n n*, raising and lowering the bobbins. See also THREAD-POLISHER.

Fig. 6400.



Thread-Frame.

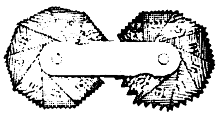
Fig. 6401.



Thread-Frame.

Thread-gage. A gage for determining the number of threads to the inch on screws and taps. It consists of a number of toothed plates turning on a common pivot, so that the serrated edge of each may be applied to the screw until one is found which corresponds therewith. The figures stamped on the plate indicate the number of threads to the inch.

Fig. 6402.



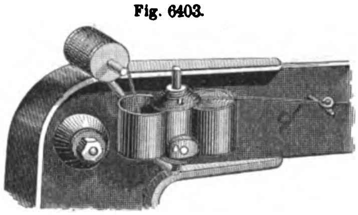
Thread-Gage.

Thread-guide. (*Sewing-machine.*) A loop, eye, or what not, to form a guide for the thread when it changes its direction at points between the spool and the needle eye.

Thread-lace. Lace of linen thread; such as Honiton, and many other kinds.

Thread-oil'er. To lubricate the thread and facilitate its passage through the goods or leather. It

Fig. 6403.



Thread-Oiler.

is placed upon the spool-wire of the machine, and secured by tightening the set-screw *c* in the oiler, which has a wire attached to support the screw, as shown in the cut. The button *a* has a notch at its lower end, by which the thread is conducted through the cup.

Thread-pol'ish-ing Ma-chine'. A machine for imparting the final gloss to thread preparatory to spooling. This is usually effected by passing it between rubbers or rollers.

In Fig. 6404, the thread is conducted from the bobbins *f* over pins *g*, and thence through size-bowls *a* and eyes to the rubber carriages *a' a' a' a'*; these have each a series of projecting pins, between which the thread passes, and are connected with blocks *u' z* caused to reciprocate in vertical guides *w* by cranks on the shaft *b* of the roller which rotates the bobbins. The upper and lower carriages simultaneously move in opposite directions toward and from the center *c'*, and each pair may be disconnected without interference with others in case of breakage of the thread, which is wound upon the reels *l l*.

In the machine (Fig. 6405), the thread, after passing between a pair of sizing-rollers *G H*, is conducted through a guide *d* to a pair of rotary disks connected by a series of parallel bars *F*, which exert a rubbing action; thence through a second guide *e* to another pair of rotary disks connected by similar rubbing-bars, and finally, after passing through a pair of pressing-rollers *I I*, is wound upon reels. *J* is a brush for removing size from the bars *F*. Rollers or rotary brushes may be substituted for these bars. See also THREAD-FRAME.

Thread-wax'er. A bowl of heated shoemaker's wax, through which the thread is conducted in sewing-machines for boots, shoes, and leather.

In the example (Fig. 6406), the thread enters the side of the semicircular trough through the tension-aperture under the depressor, thence passes over the shaft and between the two elastic expressor-disks. The trough is heated by a lamp beneath.

See list under SEWING-MACHINE, Class C, section 2, pages 2108, 2109.

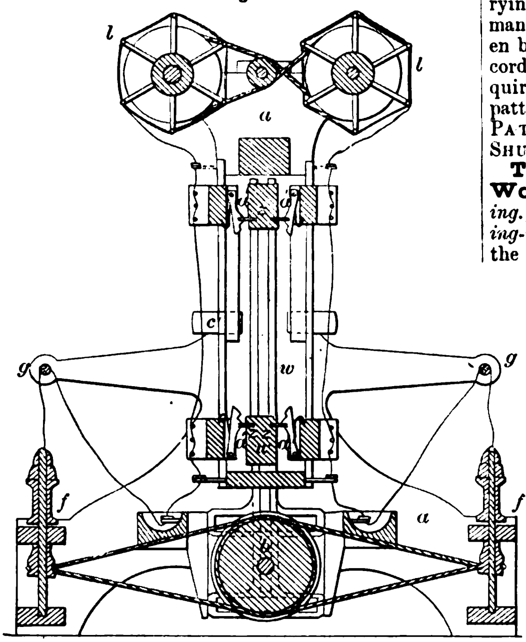
Thread-wind'er. A machine for spooling thread, etc.

In that shown (Fig. 6407), a friction-wheel *C* imparts motion to a small wheel on the axis carrying the spool. The

thread-guide *F L* has an adjustable pivot, by which it is adapted to different sizes of spools and thread, and is traversed, to lay the thread evenly on the spool, by a cam-wheel *R* rotated by a screw-thread on the shaft *B*.

Fig. 6408 is a machine for laying the exterior layers of button-hole twist, etc., on the spool, so as to form various patterns. The spool is placed on a spindle upon the pulley *M*, and part of

Fig. 6404.

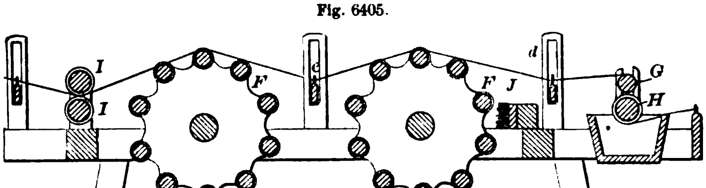


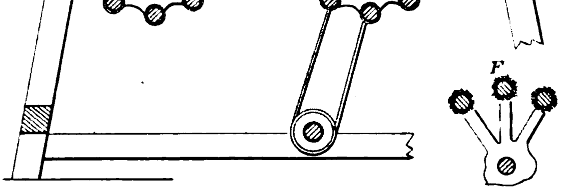
Thread-Polishing Machine.

the thread unwound and passed through the eye of the flyer *F* and the axis of the flyer and its pulley. It is then rewound upon the spool, the pattern formed upon the surface depending upon the angular adjustment of the arm carrying the pulley *M* and the velocity given to the pulley and flyer.

Fig. 6409 is a machine for winding thread for making fancy cassimeres. As the central thread or cord is spun or twisted and wound, the lapping thread of any other color is guided to it by slots in a tube through which the cord is conducted; a sectional pinion on the driving-shaft causes the delivery of the cord to be intermitted as desired, or the cord may be drawn

Fig. 6405.





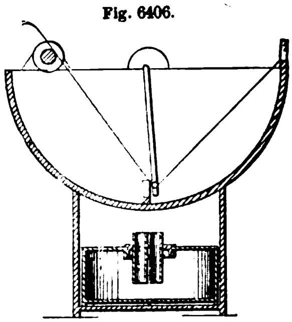
Machine for Polishing and Dressing Thread.

back a short distance from time to time, or the thread-guide may be reciprocated.

Thread-wind'ing Guide. A handle containing a holder for a spool, and having suitable tension-devices, and at one end an eye through which the thread is guided upon a bobbin.

Three-box Loom. (*Weaving.*) One having three shuttle-boxes, from which shuttles carrying yarns of as many colors are driven by the *picker*, according to the requirements of the pattern. See LOOM; PATTERN-CHAIN; SHUTTLE-BOX; etc.

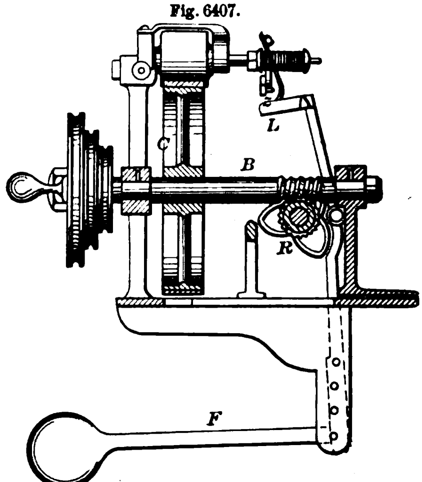
Fig. 6406.



Thread-Waxer for Sewing-Machines.

Three-coat Work. (*Plastering.*) The first is called *pricking-up* on lath; *roughing-in* on brick. The second coat is called *floating;* the third, *set* or *finishing-coat.*

Fig. 6407.



Thread-Winding Machine.

Three-cyl'in-der En'gine. An arrangement of three cylinders working on a common crank-shaft, to overcome the dead-center without a fly-wheel. The eccentrics and valves are so set that steam is admitted to the cylinders in succession, and not simultaneously, by which means the pistons are always in different thirds of their stroke, and two cylinders are always acting effectively.

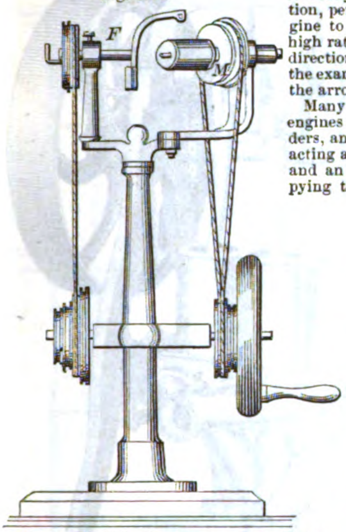
In the drawing (Fig. 6412), the piston in the upper cylinder is at the outboard end, the one at the left at one third of the inboard stroke, and the one on the right at two thirds of the outboard end and exhausting.

Brotherhood's engine (Fig. 6413) has three connected cylinders *a b c* at angles of 120° to each other. Each has a deep but light piston connected to a crank *d*, common to all. One of the connecting-rods has a single eye at the crank end, while the other two are forked at that end, one straddling the other, so that their centers are in the same line. Steam is admitted into the central space *g* through the induction-opening *e*, and exhausted through the opening *f* in line with the crank-shaft. The supply and exhaust are effected by a revolving slide-valve carried around by the crank-shaft. The steam-pressure in the central chamber always exceeds that on the outer end of each

piston, but varies in amount, so that the strain on the connecting-rods and joints is always in one direction, permitting the engine to be run at very high rates of speed. The direction of motion in the example is shown by the arrow.

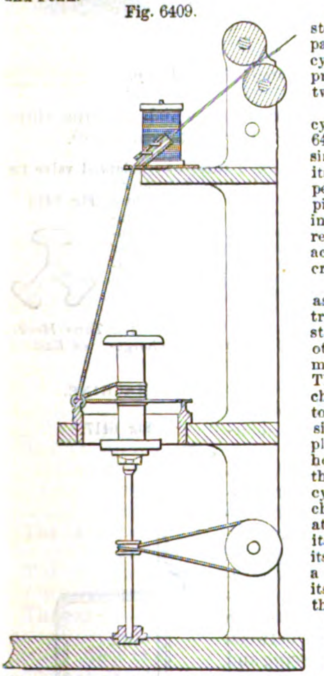
Many marine and river engines have three cylinders, and some have two acting at angles of 120°, and an air-pump occupying the position of a third steam-cylinder. A favorite arrangement with Maudslay and Penn.

Fig. 6408.



Machine for Winding Button-Hole Twist.

Fig. 6409.



Machine for Producing Variegated Thread.

The Baxter canal steam-engine has a pair of high-pressure cylinders and a lower-pressure cylinder between the other two.

In Willans's three-cylinder engine (Fig. 6414), each cylinder is single-acting, receiving its steam upon the upper side only of the piston. The connecting-rods attached directly to the pistons actuate a three-throw crank-shaft.

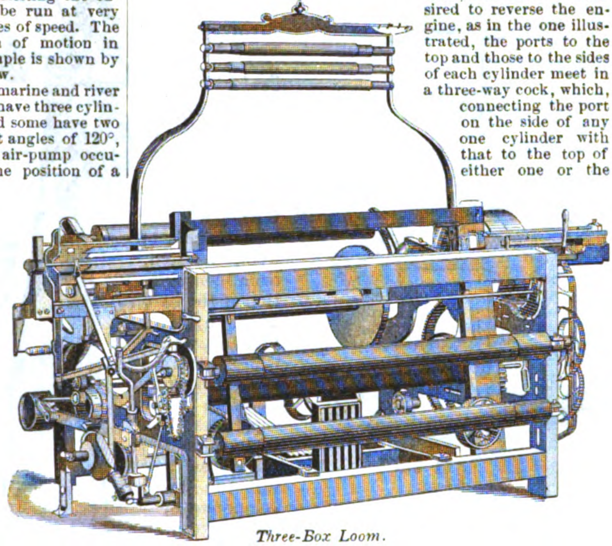
Each piston serves as a steam-valve controlling the supply of steam to one or the other of the two remaining cylinders There is a steam-chamber in each piston and a port in its side. Steam is supplied by means of a hollow rod passing through the top of the cylinder into a steam-chest. When the piston attains three fourths of its downward stroke, its steam-port overlaps a port in the side of its cylinder, and steam then passes to the top of another of the cylinders. When the piston has reached about one half its return stroke, uncovering the port in the side of its cylinder, it allows the steam to escape from the cylinder into which it was previously admitted, into a casing round the crank-shaft, from which the exhaust-steam is taken either to a condenser or to the air, as the case may be.

Fig. 6410.

Thread-Winding Guide.

In an engine which is required to run only one way round, the port in the side of each cylinder passes direct to the top of one of the other cylinders; but where it is desired to reverse the engine, as in the one illustrated, the ports to the top and those to the sides of each cylinder meet in a three-way cock, which, connecting the port on the side of any one cylinder with that to the top of either one or the other of the other cylinders, reverses the engine.

Fig. 6411.



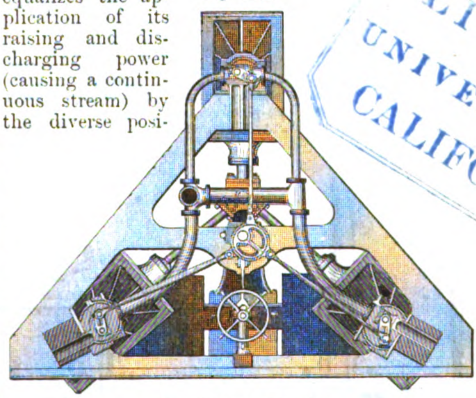
Three-Box Loom.

The equilibrium of the power is maintained by its threefold action.

The lubrication is done through a steam-lubricator on the steam-chest, and the waste oil passing down to the bottom of the casing lubricates the lower ends of the connecting-rods as they pass round.

Three-cyl'in-der Pump. Haskell's three-cylinder pump, having one inlet and outlet common to all the cylinders, equalizes the application of its raising and discharging power (causing a continuous stream) by the diverse position of the three-throw crank to which the pistons are attached.

Fig. 6412.



Three-Cylinder Engine.

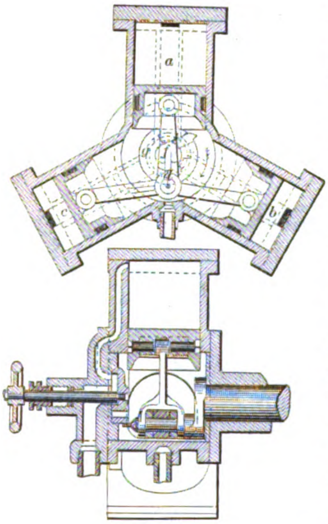
Three-deck'er. (*Nautical.*) A ship with three gun-decks.

Three-head'ed Rail. One having three treads united by webs, set at an angle of 120° with each other.

Three-high Roll. (*Metal-working.*) A rolling-apparatus in which three rollers are arranged in a vertical series, so that the metal may be passed through between the middle and lower roll, and then back between the middle and upper one; rolling it at each passage without changing the direction of motion of the rolls. See Fig. 4416, page 1969.

Three-part Flask. (*Founding.*) One containing a mold which comes off the pattern in three pieces. See *c d e*, Fig. 2010, page 877.

Fig. 6413.



Brotherhood's Three-Cylinder Engine.

Three-pile. (*Fabric.*) A costly thick pile velvet.

Three-ply Car′pet. A carpet made of wool, worsted, or a combination of the two, and having three webs whose warps are interchangeable, so as to allow such ones to be brought to the surface as may suit the development of the pattern. Also known as *triple-ingrain carpet*. See TWO-PLY CARPET.

Three-square File. The ordinary, tapering, hand-saw file of triangular cross section. *r*, Fig. 1965, page 840.

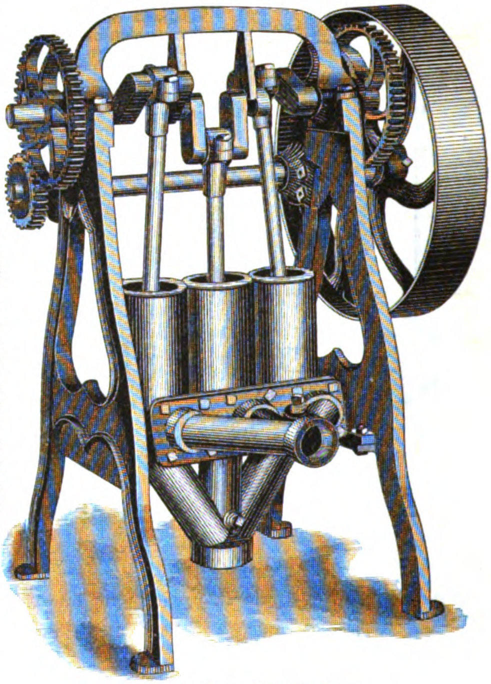
Three-stone Mill. A mill with one middle runner having two faces, which act against two lateral stones. See Fig. 2316, page 1021.

Three-way Cock. One having three positions, directing the fluid in either of three different channels.

In the illustration (Fig. 6417), the plug has a single transverse channel; when the direction of this is vertical, the flow is direct through the delivery-pipe, but when oblique or horizontal, the flow is into an auxiliary tube, which curves upward and then enters the delivery-pipe.

The *four-way cock* is an invention of James Watt. See Fig. 2091, page 912.

Fig. 6415.



Haskell's Three-Cylinder Pump.

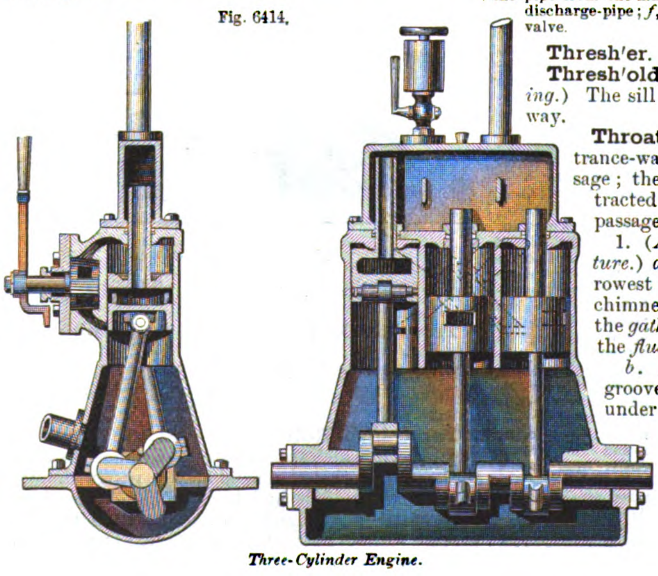
Three-way Valve. One which governs three openings, as a THREE-WAY COCK (which see).

Fig. 6418 is a view of Locke's three-way balanced valve for hydraulic elevators. 1 shows it supplying water; 2, closed; 3, slowly discharging: corresponding to, 1, lifting the cage; 2, holding the cage stationary; 3, allowing the cage to descend gradually. The indented positions at the lower end of the valve and of the tubular downward prolongation into the square chamber are for the purpose of making the openings and closings gradually, so as to make the first flow of water gradual. *a* is the pipe from the main; *c*, pipe to the hoist; *l*, discharge-pipe; *f*, supply-valve; *s*, discharge-valve.

Fig. 6416.

Three-Headed Rail.

Fig. 6414.



Three-Cylinder Engine.

Thresh′er. See THRASHING-MACHINE.

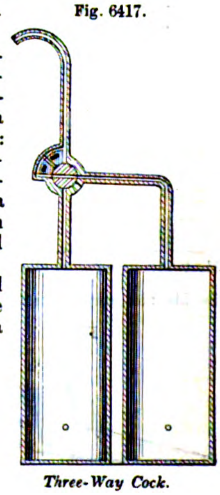
Thresh′old. (*Building.*) The sill of a doorway.

Throat. An entrance-way or passage; the more contracted part of a passage-way, as:

1. (*Architecture.*) *a.* The narrowest part of a chimney, between the *gathering* and the *flue*.

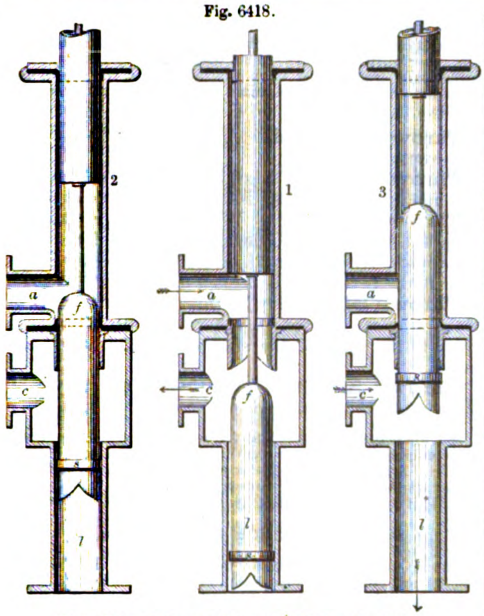
b. A small groove on the under side of a

Fig. 6417.



Three-Way Cock.

Fig. 6418.



Three-Way Balanced Valve for Hydraulic Hoists.

coping or projecting molding. A *gorge.* See GUTTER.

2. (*Shipwrighting.*) The interior angle at the bend of the arms of a knee or compass timber.

3. (*Nautical.*) *a.* The crotch of a gaff where it rests against the mast.

b. The upper front corner of a fore-and-aft sail. The *nock.*

c. The interior angle at the junction of the arm and shank of an anchor.

4. (*Agricultural.*) The entrance-way where grain in the straw passes from the feed-board to the cylinder of a thrashing-machine.

5. (*Wheelwrighting.*) That portion of a spoke just beyond the swell at the junction of the hub, where the spoke is thinner toward its outer side.

6. (*Puddling.*) The narrowed entrance to the neck of the furnace, where the area of flue passage is regulated.

7. The opening in a plane stock through which the shavings pass upward.

8. (*Fortification.*) The narrowed space between the flanks of a bastion at their junction with the curtain, or between the rear ends of the faces of a *redan.* A gorge. See REDAN; BASTION.

Throat-brails. (*Nautical.*) Brails which lead through blocks beneath the jaws of a gaff.

Throat-down'hauls. (*Nautical.*) Ropes for rousing down the throat of a gaff.

Throat-hal'yards. (*Nautical.*) A tackle for lifting the gaff at the throat. The *peak* halyards lifts the other end.

Throat-latch. (*Saddlery.*) The strap which passes under a horse's throat and assists in holding the bridle in place. *Throat-band.*

Throat-strap. (*Saddlery.*) The upper strap of a halter that encircles the horse's throat; also called *jaw* strap.

Throe. A tool for splitting balks of timber into shingles or clapboards. A *frow.*

Thros'tle. 1. (*Cotton.*) The *drawing-frame* of the cotton manufacture. The great invention which succeeded the *spinning-jenny* of Hargreaves. The *drawing-frame* is for attenuating *slivers* of fiber by passing them through consecutive pairs of rollers, each pair in the succession revolving at a higher speed than its predecessor. Leon Paul, by patent of 1738, claimed a mode of spinning by rollers, but the device did not come into use. (See SPINNING.) Richard Arkwright perfected the invention and patented it in 1769.

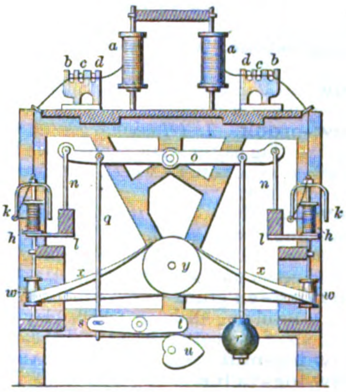
Arkwright's original spinning-frame was fed with rovings which passed between three pairs of rollers of successively increasing speed. The yarns were wound upon bobbins by means of flyers. It was the culmination of several attempts, and possesses the main features of the *throstle* and the *bobbin* and *fly-frame* in function, as well as in the relative positions of parts. See SPINNING, Fig. 5404, page 2271.

The *bobbin* and *fly-frame* is similar in principle to the throstle, and is adapted for giving a partial twist to the sliver as delivered from the carding-machine or the doubling-frame. The slivers in cans are fed to the *coarse* bobbin and fly-frame, where they are reduced and partially twisted so as to give them greater coherence, being elongated say 4½ times. The rovings thus produced are wound on bobbins which are placed on the *creel* of the *fine bobbin* and *fly-frame*, by which they are still farther reduced and twisted.

These rovings on their bobbins are then transferred to the throstle, a transverse vertical section of which is shown in Fig. 6419.

a a are two of the bobbins. The thread, as it is drawn off from these, passes through the drawing-rollers *b c d*, and then to the spindles. Here it is twisted and wound upon the bobbins. The bobbins *h* have no rotatory motion imparted to them,

Fig. 6419.



Throstle.

but simply rest upon the trays *l*, and are dragged round by the thread as it twists itself round them, as the fork or fly *k* revolves much more rapidly than the thread is given out from the drawing-rollers. The up-and-down motion of the bobbins is effected in the following manner: —

The lever *o* turns at its center on a spindle fixed to the framework. At its ends it is connected by the rods *n n* to the trays *l l*, upon which the bobbins rest, and receives an oscillating motion from the heart-shaped cam *u* through the lever *s t* and rod *q*. The cam depresses the one side of the lever, which is pulled down on the other side by the weight *r* as the cam recedes. By this means the trays, and therefore also the bobbins, are moved up and down. The spindles receive their motion from the drum *y* and the belts *x x* passing round the small pulleys *w w*. The speed of the rollers and spindles is proportioned to the required fineness of the yarn. For example, the drum *y* making 600 revolutions per minute, the spindles, whose pulleys are $^1/_6$ of the diameter of the drum, make 3,600 revolutions. There are usually from 75 to 150 spindles on each side of the throstle, and they are set about 3 inches apart, all being driven from the drum *y*, which extends the whole length of the machine.

The specific difference between the action of the *throstle* and the *mule* is that the former has a continuous action, *drawing*, *twisting*, and *winding*; while the *mule* has an alternate action, *drawing* and *twisting*, and then *winding*.

It is thus stated by Tomlinson: —

"The *mule* having made a definite length of yarn, the operation of spinning is suspended while the yarn is being wound up

on bobbins or spindles. In the throstle the yarn is both spun and wound at the same time. The throstle-yarn is smooth and wiry, while the mule-yarn is soft and downy. *Throstle-yarn* is employed for warps of heavy goods, and for making sewing-thread; *mule*-yarn is used for the weft of heavy goods, and for the warp and weft of soft and fine goods." See BOBBIN and FLY-FRAME; DRAWING-FRAME; ROVING; MULE; DOUBLING; JENNY.

The throstle derived its name from the singing or humming which it occasioned. It was also called the *water-frame* from the fact that the machinery in Arkwright's mill, where it was first used, was driven by a water-wheel.

2. A spindle for wool.

Throt'tle. (*Steam.*) A name for the THROTTLE-VALVE (which see).

Throt'tle-le'ver. The handle of the throttle-valve.

Throt'tle-valve. (*Steam-engine.*) A valve which regulates the supply of steam to the cylinder. In the Watt engine it is a disk turning on an axis and occupying in its transverse position the bore of the main steam-pipe.

It is frequently an ordinary conical valve with a stem operated by a screw.

In land engines it is generally connected with the governor.

Through-bolt. (*Machinery.*) A bolt passing entirely through and fastened on opposite sides of the object or objects secured by it, as in 1, 3, 4, 5, Fig. 768.

Through-bridge. One in which the track rests on the lower stringer (Fig. 2702, page 1201) in contradistinction to a *deck*-bridge (*a*, Fig. 3775, page 172), in which the track occupies the upper stringer, the top of the truss.

Through-stone. A bond-stone, extending across the thickness of the wall. A *perbend.*

Throw. (*Machinery.*) The radial reach of a crank, eccentric, or cam.

Throw-crook. 1. (*Husbandry.*) A tool like a brace for twisting hay or straw bands. See Fig. 2448.

2. (*Pottery.*) A potter's wheel. A *thrower.* See THROWING-TABLE.

Throw'ing. 1. A third process in the spinning and combining of silk thread. See THROWN SINGLES.

2. (*Pottery.*) The operation of forming a mass of clay into a vessel on the potter's wheel.

Throw'ing-en'gine. (*Pottery.*) A potter's wheel. A revolving disk on which clay is formed by the hands of the potter, into the shape of a vessel.

Throw'ing-mill. See THROWING-TABLE.

Throw'ing-ta'ble. A revolving, horizontal table on which earthen vessels are shaped by the potter.

Clay ware is *thrown*, *pressed*, or *cast*. In some cases, after being partially dried, it is *turned* to give it smoothness.

The throwing-table consists of a horizontally rotating disk, turned by the foot, an assistant, or by machinery.

Fig. 6420.

Throwing-Table.

A lump of clay prepared by an assistant, called a *baller*, is handed to the *thrower*, who dashes it upon the center of the wheel, and then, with wet hands, commences to work the mass. Pressing it upward, he raises it into a cone, and then flattens it so as to express bubbles. Then, with skillful motions of the hand inside and out, aided by a piece of horn, bone, or porcelain, and called a *rib*, he gives it the shape shown in the figure. The outer surface is worked by a *templet*, and gages projecting horizontally from a post upon the table assist the eye of the workman in giving the required hight to the shoulder and the lip.

Throw'ing-wheel. A potter's wheel. See THROWING-TABLE.

Throw-lathe. A small lathe which is driven by one hand, while the tool is managed by the other.

Thrown. (*Mining.*) When a lode is intersected by a slide, if the undiscovered portion of the lode has apparently been lengthened, it is said to be *thrown up*: if the reverse, it is *thrown down.*

Thrown Silk. A silk thread made of two or more *singles*, twisted together in a direction contrary to the twist of the *singles* of which it is composed.

Thrown Sin'gles. Silk thread, the result of three separate spinning operations.

Silk filaments are twisted to form *singles*. Several of these are combined and twisted together (doubling), forming *dumb singles*. A number of the latter are associated and twisted together (*throwing*), forming *thrown singles.*

This, if single-twisted, is *tram*; if double-twisted, is *organzine*.

If the gum be left in it, it is *hard silk*; if the gum be removed, *soft silk.*

The operation is as follows: the filaments of silk from the bobbin are twisted in one direction, and the *single* thus obtained is wound on a second bobbin. A number of bobbins containing singles are placed in a frame, and their ends, being united, the combined bunch of singles is wound on a bobbin, and from thence on to a reel. From this the bunch of singles is conducted to a rotating flyer, which twists it and delivers it as *thrown* silk on to a bobbin. See DOUBLING.

Thrum. 1. (*Nautical.*) *a.* Coarse untwisted rope, used for mops and for mat-making.

b. A wad of such yarns or a sail passed overboard and hauled into the vicinity of a leak, so as to be drawn thereinto.

c. To insert tufts of hemp or coir in the meshes in making a rope-mat.

2. (*Weaving.*) The ends of the warp or weft threads.

Thrust. 1. (*Mining Engineering.*) The breaking downward of the roof of a gallery, owing to the weight of the superincumbent strata. Opposed to *creep*, which is an upheaval of the gallery floor.

2. (*Husbandry.*) The white whey which last leaves the curd in pressing.

Thrust'ing-screw. The screw of a screw-press; of a cheese-press, for instance.

Thumb-cleat. (*Nautical.*) A small cleat forming a leader to carry the bight of a rope.

Fig. 6421.

Thumb-Nut.

Thumb-nut. One having wings by which it is turned by the thumb and finger to tighten upon its bolt.

Thumb-screw. 1. A screw with a flat-sided head, adapted to be turned by the finger and thumb.

2. An old instrument of torture to break the thumb-joint. A *thumb-kin.*

Thumb-stall. 1. (*Ordnance.*) A stall of buckskin stuffed with hair, which a cannoneer wears on his thumb to cover the vent while the piece is being sponged and loaded.

2. A sailor's thimble used in sail-making.

Thun'der-rod. An old-time name for the lightning-rod, designed to make their houses

"Secure of thunder's crack." — TITUS ANDRONICUS.

Thurl. (*Mining.*) *a.* A short communication between *adits.*

b. A long adit in a coal-pit.

c. To make a breach into former workings or gate-roads.

Thurst. (*Mining.*) The ruins of the incumbent strata after the *pillars* and *stalls* are wrought out.

Thwack'ing-frame. (*Tile-making.*) A table with a curved top, upon which a half-dried pantile is bent to form. The tool by which the upper side is beaten has the shape of the segment of a cylinder, and is called the *thwacker.*

Thwart. (*Nautical.*) One of the transverse planks which keep the sides of a boat asunder, like the beams of a ship, and serve as seats for the rowers. They are spaced about 2 feet 10 inches apart, from center to center, in single-banked boats, and 3 feet in double-banked boats.

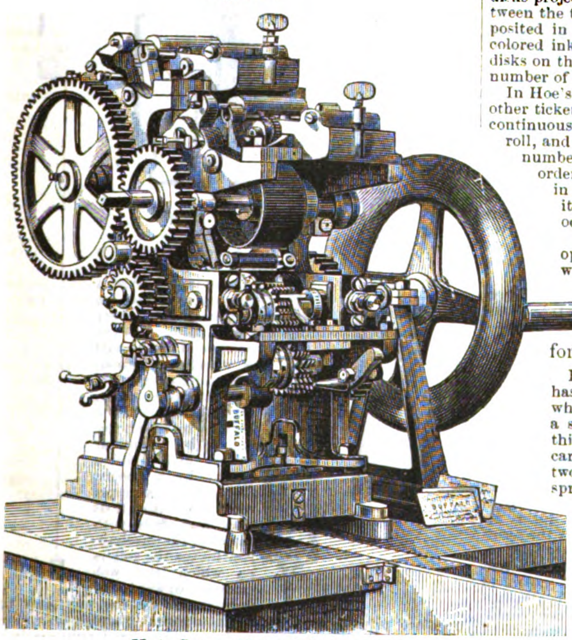
Tib'i-a. (*Music.*) Formerly, a flute; as made of the leg bone of an animal.

Tick. (*Fabric.*) A woven fabric for holding the filling of mattresses and beds. *Ticking; ticken.*

Tick'et. A piece of card, bone, ivory, metal, or what not, printed, impressed, or plain, the equivalent of a sum of money paid for a ride, admission to a concert or other entertainment, etc. One meaning of the Latin *tesseræ.*

Pericles founded the practice of paying for places at theaters; and at Pompeii have been found bone tickets of admission, one side representing the theater, and the reverse having words and figures, some with the place in the theater to which they gave admission engraved upon them. See farther in Fosbroke's "Ency. Antiq.," I. 386, 387.

Fig. 6422.



Hoe's Rotary Ticket-Printing Machine.

Tick'et-hold'er. 1. A device to hold a railway ticket in the hat or to the lappel of the coat; or a tag to a bale or package. See TAG.

2. A contrivance to attach a card or check to a trunk or parcel. See BAGGAGE-CHECK, Fig. 524, page 210.

Tick'et Print'ing and Num'ber-ing Ma-chine'. A machine for printing and consecutively numbering tickets. The first machine of this kind was invented by Edmondson, in England, about 1840, and was designed to remedy the troublesome practice then in use on railways of stamping and tearing each ticket from a book previous to its delivery to the purchaser. This machine imprinted the date and consecutively numbered the tickets, but was imperfect in its inking arrangements, frequently rendering the tickets illegible.

Church and Goddard's machine, introduced subsequently, printed, numbered, cut, counted, and packed the tickets. Pasteboard, cut into strips, is placed in a feed-trough and brought under the prongs of a fork working with an intermittent movement, and passes successively between four pairs of horizontal carrying-rollers, by which it is intermittingly moved forward over a bed carrying the type and the numbering-rollers. At each stop, during the forward progress of the strip, the bed is caused to rise by means of a cam-movement, and print first the denomination of the ticket, and secondly the number; as it falls after each upward movement a self-acting apparatus inks the type. The completed ticket is then severed between a fixed knife and a reciprocating knife attached to the bed, and is delivered into a box provided with a piston by which the tickets are packed.

A counting-apparatus connected with the working parts of the machine is caused to ring a bell when a certain number of tickets (say 100) is completed. The numbering disks are operated in a manner analogous to those employed for paging books.

In another machine the types and numbering-disks are fixed in a metallic frame, which also carries the numbering-disks. The frame is mounted on a rock-shaft, and is rocked by means of a handle to bring the types down on the card and produce an impression; as it is raised again, the unit disk is advanced one figure, and the types are inked by a roller receiving its supply from an inking-table which forms the top of the frame.

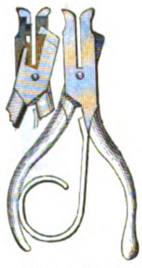
Baranowski's machine (French) has a horizontal shaft, having near each end a disk, carrying a metallic frame of similar curvature to the disk, and on which the type and numbering-disks are arranged radially to the shaft. The type-frame has a slot or opening through which the peripheries of three numbering-disks project. The tickets are automatically fed one by one between the type-frame and a press-roller of india-rubber and deposited in a box. The arrangements are such that different colored inks may be used upon the same ticket. Registering-disks on the same shaft with the numbering-disks indicate the number of tickets printed.

In Hoe's machine for printing and numbering railway and other tickets, the forms are placed on a cylinder which has a continuous rotary movement. The tickets are worked from a roll, and are printed at the rate of 10,000 to 12,000 an hour, numbered, cut, and deposited in a receptacle in regular order, at a single operation. The number may be printed in a different color from the body of the ticket, and it can be changed with great facility. The machine occupies a space of about two feet square.

The Rand and Avery machine is very rapid. It is operated with closed doors, and though shown to the writer, it may not be their wish to have a description published.

Tick'et-punch. A punch used by railway and street car conductors for perforating tickets.

Fig. 6423.



Ticket-Punch.

In the example, the fixed jaw has one longitudinal slot, into which the ticket is inserted, and a second slot at right angles to this, in which the movable jaw carrying the punch works. The two jaws are kept apart by a spring when not in use.

The alarm and registering ticket-punch, now used on street-cars and elsewhere, cuts off and saves a piece of a ticket or a trip slip, and gives an audible notice of the punching. The pieces and the register (if there be one) are the records of the number of passengers, and the bell-alarm calls the attention of the payer to the fact of the punching, enlisting his attention in the service of the company.

See also patents

No. 65,090	No. 79,470	No. 89,828	No. 111,391
68,687	79,498	100,036	115,119
69,019	84,739	101,598	135,549
79,232	86,438	111,345	

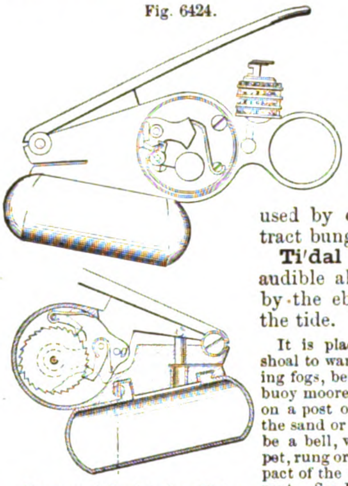
Tick'ing. (*Fabric.*) A closely woven, striped linen or cotton cloth to hold feathers, husks, or other filling for beds or mattresses. It is usually twilled.

Tick'len-burgh. (*Fabric.*) A coarse, mixed linen fabric.

Tick'ler. 1. A book or case containing memoranda.

The memorandum-book of the Middle Ages was the volume which was most read by the owner. Petrarch had a MS. Virgil, with the commentary of Servius. It contains marginal notes in his own hand, and an account of the death of Laura, on a distinct leaf of paper pasted on the wood of the binding.

Fig. 6424.



Alarm and Registering Ticket-Punch.

2. A prong used by coopers to extract bungs from casks.

Ti′dal A-larm′. An audible alarm operated by the ebb and flow of the tide.

It is placed on a spit or shoal to warn off vessels during fogs, being on a vessel or buoy moored to the spot, or on a post or pile driven into the sand or shingle. It may be a bell, whistle, or trumpet, rung or blown by the impact of the passing tidal current. See FOG-ALARM.

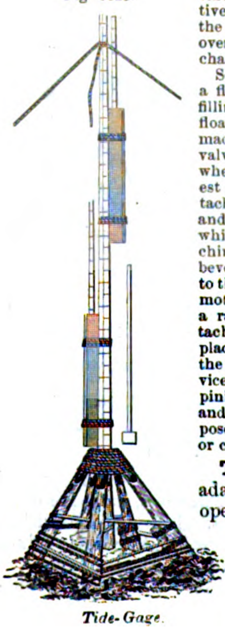
Ti′dal Ba′sin. A dock filled at high tide.

Ti′dal Mo′tor. An arrangement by which the ebb and flow of the tide is utilized as a source of power to move machinery, etc. The idea is not new, and various devices have been invented for accomplishing the object.

A common mode is to place gates at the mouths of inlets which are opened during the flood and closed at the commencement of ebb tide; the head of water thus obtained is used to turn a mill-wheel. Signor Thomassi has proposed to use the rise of the tide as a means of compressing air in a chamber or reservoir, from which the air thus compressed may be conducted to any number of stationary engines, the effective power thus obtained being proportional to the excess of its tension over that of the atmospheric pressure; this may be greater or less in proportion to the relative contents of the chamber into which the water is admitted, and that in which the air is condensed.

By an additional chamber, in which a partial vacuum is produced by the reflux of the tide, a continuous motor is produced, the effective force in this case being equal to the excess of atmospheric pressure over that of the rarefied air in the chamber. See also SLUICE.

Fig. 6425.



Tide-Gage.

Scharit's tidal motor consists of a float, with a screw and valves for filling the float with water. The float consists of a rectangular box made water-tight, and provided with valves for the admission of water when the float has reached its highest point. To the float a nut is attached, which works upon the screw and imparts thereto a rotary motion, which is communicated to the machinery to be driven by means of bevel-gears, one of which is attached to the top of the screw. A continuous motion in one direction is secured by a ratchet and pawl, which are attached to the horizontal shaft that is placed directly over the center of the screw. Modifications of this device have double racks working in pinions for communicating power, and a single rack for the same purpose; another modification has ropes or chains working on pulleys.

Ti′dal Valve. A valve adapted to sluice-ways, which opens to the pressure of the land water when the tide falls, and closes as the tide rises, to prevent the flooding of the land by sea-water. See SLUICE.

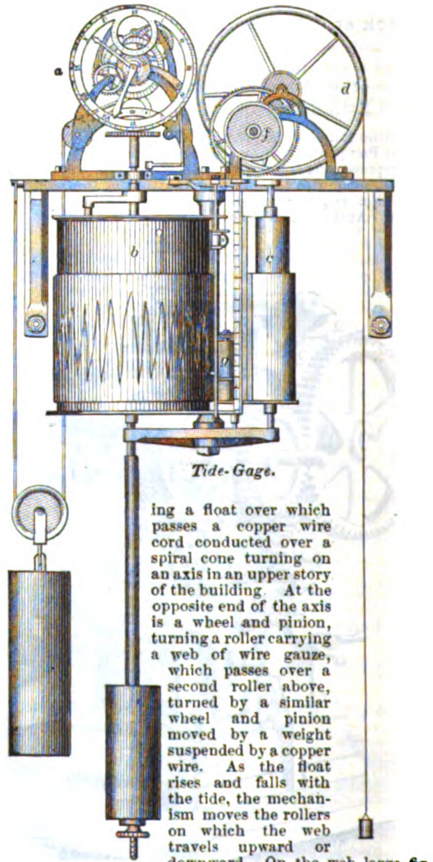
Tide-di′al. See TIDE-GAGE.

Tide-gage. Used in harbors to measure the rise and fall of the tides. A common form consists of a graduated spar, 24 feet long, and having boxes at the side, in which is a float with an elevated stem. The spar is secured to a pier or quay, or is anchored in a frame and secured by guys. The rod is $\frac{3}{4}$ inch in diameter, and is supported by a cork of 3 inches cube. The stem is guided by staples in the spar.

The tide-gage at Sunderland, England, invented by Mr. Meik, engineer of that harbor, is self-registering, and shows to mariners the depth of water on the bar at all stages of the water.

A well is sunk beneath the building containing the apparatus, its bottom being on a level with that of the entrance to the channel. This contains a pipe, open to the water, and containing a float over which passes a copper wire cord conducted over a spiral cone turning on an axis in an upper story of the building. At the opposite end of the axis is a wheel and pinion, turning a roller carrying a web of wire gauze, which passes over a second roller above, turned by a similar wheel and pinion moved by a weight suspended by a copper wire. As the float rises and falls with the tide, the mechanism moves the rollers on which the web travels upward or downward. On the web large figures are painted in a white, transparent varnish on a dark ground, and as it moves up and down, two fixed pointers indicate in feet and half-feet the depth of water on the bar at that time. The figures are visible to a considerable distance at sea, and are strongly illuminated at night.

Fig. 6426.



Tide-Gage.

The self-registering gage is also actuated by a float in a well, which, by means of a cord passing over a wheel, moves a rack carrying a pencil, which traces on a ruled web of paper passing over a drum turned by clock-work a line corresponding to the fluctuations in the hight of the water. The web of paper is of sufficient length to receive the automatic record for fourteen days.

Fig. 6426 illustrates Sir William Thomson's self-registering tide-gage. It consists of a clock a supported on a stand, and which, besides keeping time, actuates the drum b which winds upon itself with a uniform movement a continuous web of paper from the cylinder c. A cord or fine wire passing over the pulley d carries at one end a counterbalanced float-weight e which rises and falls with the tide. A pinion on the end of the shaft of the pulley d engages a gear-wheel on the shaft of the pulley f, from which is suspended a weighted ink-bottle g carrying a

pen. These rise and fall with the movement of the float *f*, though their motion is less in the proportion of the respective diameters of the wheel and pinion. The pen traces a continuous record on the paper in the form of a zigzag line, the angles of which correspond with the hights of high and low water, the horizontal distance between each two angles answering to the intervals of time between two high or low tides.

Tide-gate. The lock-gate of a tidal basin. See SLUICE.

Tide-lock. One situate between the tide-water of a harbor or river and an inclosed basin when their levels vary. It has two pairs of gates. A *guard-lock*.

Tide-me'ter. See TIDE-GAGE.

Tide-mill. A mill driven by a wheel set in motion by the tide.

Mills of this kind were used in Venice as early as 1078, and they were employed in London in 1772.

Generally the water is admitted as the tide rises, through a sluice over which the mill is placed, into a reservoir, turning the wheel in its passage through the sluice. At high tide the sluice-gates are shut until the tide has fallen sufficiently, when they are again opened, and the water again turns the wheel during its outward passage.

The mill may float on the surface of the water, rising and falling with the tide. The flood-gate in this case is arranged to have a simultaneous and equal rise and fall, so as to maintain a uniform head of water.

Dr. Gregory enumerates four different arrangements of tide-mills: —

1. The water-wheel may turn one way when the tide flows, and the other way when it ebbs.
2. The wheel may turn in a constant direction, in either course of the tide.
3. The water-wheel may rise and fall, as the tide ebbs and flows.
4. The axle of the wheel may be fixed, the wheel receiving the influx and efflux of the water, being more or less submerged according to the state of the tide. The former is the preferable arrangement. See also TIDE-WHEEL.

Tide-wheel. A wheel turned by the ebb and flow of the tide, and employed as a motor for driving machinery, etc.

The most remarkable variations in the tide are at Chepstow, where the rise of spring tides is about 60 feet; at Bristol it is 40 feet; in Mount St. Michael's Bay it is 46 feet; in the Bay of Fundy and on the coast of Nova Scotia it is about 60 feet; whilst in the Northern Atlantic it is on the average from 10 to 12 feet; at St. Helena only 3 feet; and on the shores of the islands of the Pacific it is barely perceptible.

Where the rise is so extreme, it is produced by the contraction of the sides of the river or estuary, as the Bristol Channel, for instance, or a convergence to one point of wide stretches of coast, as at the Bay of Fundy.

In some cases the phenomenon of the *bore* is produced, which is defined by Colonel Emery as being a peculiar undulation, which announces the arrival of the flood tide in many rivers. It consists of two, three, or sometimes four waves, very short, and succeeding one another rapidly, which bar the whole river, and ascend it to a great distance; they often break upon the crown, and upset everything they meet in their course, and are accompanied by a fearful noise. In the Severn, the bore is stated to be of almost daily occurrence, and sometimes even to attain a hight of 9 feet; in the Dordogne it rises from 5 to 6 feet, and travels at the rate of about 5 miles in 34 minutes; in the Seine it does not exceed 3 feet; in the Thames it only exists in a rudimentary state; whilst in the Hoogly, at Calcutta, it rises about 5 feet, and is transmitted at the rate of about 17½ miles per hour; and in the Menga the rise is said to be 12 feet.

The tide-wheel at East Greenwich on the Thames is, or was, a breast-wheel raised and lowered with the tide, so as to always have a submergence of four feet water. The buckets are divided into four steps, so as to prevent any jerking or irregular motion. The wheel turns both with the flowing and ebbing of the tide, having a sluice-gate and tail-gate on each side, one pair being opened when the other pair is closed.

Dryden's is an undershot-wheel, each float being set at an equal angle with the radius drawn from it to the center. The bottoms of the buckets have narrow openings to admit air as they rise from the water, so that they may not have to overcome atmospheric pressure.

A species of wheel like the sails of a windmill may be employed, having a vane or float so arranged that it will always turn the same face toward the current, and its axis always rotate in the same direction. See CURRENT-WHEEL.

The turbine is also employed, but is adapted to work with one flow only.

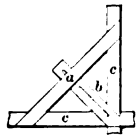
Gwynne's double-acting balanced pressure-wheel is intended to produce a continuous movement both with the ebb and flow; the buckets are arranged to present a direct surface to the passage of the water in either direction, and the wheel turns on a vertical spindle in a casing through which the water flows

Tie. 1. (*Architecture.*) A beam or rod which secures parts together and is subjected to a tensile strain; as a *tie-beam*, which forms the base of the triangle in a roof-truss and withstands the outward thrust of the rafters. See ROOF; TRUSS; KING-POST; QUEEN-POST; TIE-BEAM; RAFTER; etc.

It is the opposite of a *strut* or *straining-piece*, which acts to keep objects apart, and is subject to a compressing force; such as a COLLAR-BEAM, or STRAINING-BEAM (which see).

An angle tie or brace is a framing on the inner side of an angle, for the purpose of tying the work together. Fig. 6427 represents the framing of the external angle of a building.

Fig. 6427.



Angle-Tie.

a, angle or diagonal tie.
b, dragon-piece.
c c, wall-plates.

2. (*Railway Engineering.*) A piece of timber laid transversely of the track and held down by *ballasting*, serving to retain in place the rails, which are spiked to it.

3. (*Nautical.*) *a.* A mooring-bridle.

b. A *lashing.*

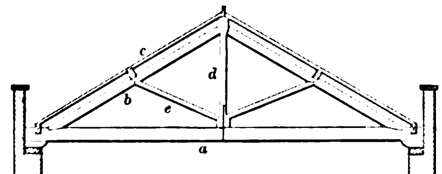
4. A band-fastening for bale-straps. See BALE-TIE, Fig. 540, page 218.

5. (*Mining.*) A support for the roof, attached to a rib.

Tie-beam. (*Carpentry.*) A horizontal timber in a frame connecting posts, and secured to them by a joint, or by mortise, tenon, and pin.

In a roof-truss the king or queen posts are planted upon it, and are strapped thereto. The feet of the *principal rafters* are stepped into the tie-beam which withstands the outward thrust. In dwellings the tie-beams support the ceiling of the room below.

Fig. 6428.



Tie-Beam, etc.

a, tie-beam. *b*, principal rafter. *c*, common rafter. *d*, king-post. *e*, strut.

Tier. 1. (*Nautical.*) *a.* A range of *fakes* of a cable or hawser. A *fake* is a single coil in a tier.

b. Cable tier. A place below decks where the cable is coiled.

c. A row or rank, as of vessels alongside a wharf, or moored alongside each other in a stream.

2. (*Music.*) A row of pipes in an organ.

Tie-rod. A rod acting as a tie in a truss or other structure.

Tier-saw. One for cutting curved faces to bricks for arches and round pillars.

Tier-shot. Grape-shot in regular tiers divided by disks.

Tie-strap. (*Saddlery.*) A long strap having a buckle and chape on one end, used as an extra strap to a bridle for tying.

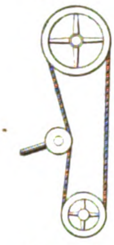
Tie-wall. A transverse wall in the hollow spandril of an arch, at right angles to the spandril wall.

Tif'fa-ny. A thin silk gauze.

Tige. (Fr. *tige.*) A stem or stalk. A pin at the base of the breech in the Thouvenin system of fire-arms, for expanding the base of the ball; an anvil or support for the cap or primer in a central-fire cartridge.

Ti'ger. (*Sugar.*) A tank having a perforated bottom, through which the molasses escapes.

Fig. 6429.



Tightening-Pulley.

Tight'en-ing-pul'ley. One which rests against the band in order to tighten it, to increase its frictional adhesion to the pulleys over which it runs.

Til'bur-y. An open carriage on two wheels. A form of *gig.*

Tile. 1. A thin slab of baked clay.

It was used in great quantity in ancient Mesopotamia among that wonderful people that has passed utterly away, leaving mural remains indicating that it was the most densely populated region of antiquity.

In that country the common mode of keeping records of national and historical events was by stamping inscriptions upon tiles of clay, which were baked after the impression was made Mr Layard, in the course of his excavations at Nineveh, found a large number of these records, some of which were written with such minute characters that a microscope was required to decipher them. He believed that they were read by a magnifying lens, one of which, made of rock crystal, he found among the ruins of the palace of Nimroud.

These tiles are stored away in such order that they were evidently records, but a commoner description of tile furnished the material for many of their structures, sometimes in conjunction or alternation with brick, from which it differed more in form and proportions than in any essential respect.

The tiles of Assyria and China lead the way, so far as the history of this art is concerned, for the Egyptian system was not favorable to the existence of tiles, even in rainless Upper Egypt. While the bricks of Babylon were some burnt and some adobes, the bricks of Egypt were universally adobes, or merely sun-dried, and this does not suit a thin tile, however well it may answer for a thick brick. The references to tiles in Holy Writ are not infrequent. We read of tiles in Ezekiel and in the Gospel of Luke, where the sick man was let down through the tiles. Tiles were also common in Rome at that day.

The art of glazing tiles came from China, and before the introduction westward of this Chinese art, neither bricks, tiles, nor earthenware was glazed, but in cases where it was necessary to render their earthen vessels water-proof, they were daubed with pitch, wax, tallow, or other resistant. See POTTERY.

The vitreous glazes passed from China to India, and spread from thence after the conquest of the latter country by Mahmoud of Ghuzna, the bogy of the warrior episode, in Moore's "Paradise and the Peri." His conquest, wherein, as Moore says, he

> "Choked up with the glittering wrecks
> Of golden shrines the sacred waters,"

occurred A. D. 1000, about the time that Gerbert of Auvergne, the schoolmaster of Rheims, was introducing the civilization of the Spanish Saracens into France and Italy.

The passion for glazed tiles extended from India and Ispahan to Spain, from the thirteenth to the sixteenth centuries.

The palace of the Alhambra at Granada, the residence of the Moorish kings, was built in 1280, and many of the rooms are ornamented with glazed tiles.

The tomb of Sultan Mohammed Khoda-Bendeh, at Sultanich in Persia, was also built in the thirteenth century, and is ornamented on the cupola and minarets with a green glazed tile, and on the architrave with a dark blue tile.

The painted mosque of Gour, in India, now in ruins, was built in 1475, and derives its name from the profusion of glazed tiles which adorned it.

In Ispahan, the domes and mosques are covered with green and blue tiles; and the caravanserai at Mayar, near Ispahan, built in 1580 by the mother of Shah Abbas, is inlaid with green tiles.

The art of glazing tiles passed from Spain to Italy, which soon became celebrated for the taste and execution of its works in that line. Raffaello himself made designs for the paintings in *terra invitriata.*

The art spread to Holland, and long abode there. Delft was its headquarters; and the Dutch tiles, which some of us can recollect as lining the capacious fireplaces of old mansions, have been studied by many thousands besides the excellent Doddridge, who there learned Scripture history.

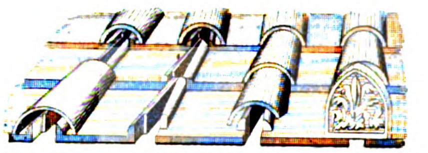
The glazing of delft-ware is given under POTTERY (which see). Under the same caption will also be found a description of the mode of making porcelain, which is closely allied to our present subject.

Rome was originally roofed with shingles; tiles of baked clay were introduced about the time of the war with Pyrrhus.

Tiles of marble were used in Greece about the time of Pausanias, 620 B. C. The temples of Jupiter at Olympias, of Athenæ at Athens (the Parthenon), were thus covered.

Tiles of bronze, gilt, were also used in some cases. The lower edges of the joint tiles were protected and ornamented by *frontons.* The edges of the flat tiles were turned up and covered by semi-cylindrical joint tiles, termed *imbrices.*

Fig. 6430.

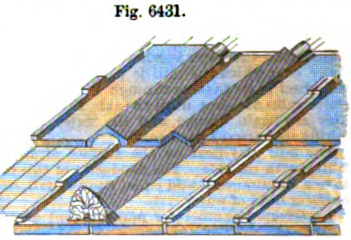


Roman Tiles.

The Greek and Roman tiles were made of marble, and have been imitated in clay.

Flat tiles with raised edges extend from rafter to rafter, the upper end having a rib that enters a groove formed on the under side of the tile placed above it. After these are laid, the joints above the rafters are covered with other tiles, each formed like the half of the frustum of a hollow cone, so that they are able to lap upon each other, their edges lying snugly to flat tiles of the roof. The end of these ridge-tiles was terminated by an ornament.

Fig. 6431.



Greek Tiles.

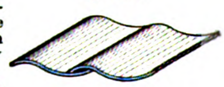
Tiles, both flat and curved, were in great demand in Roman architecture. Roofs were covered with the flat and curved tiles alternating. Tiles two feet square with a foot at each angle were used to line the thermæ, so that an air space between them and the wall should prevent the absorption of the water by the latter.

Tiles are extensively used in Europe for various purposes,— roofs, gutters, pavements, drains, house siding, lining flues, and furnaces, etc. They assume many forms; some have a local character, others are made in imitation of the antique.

Plain tiles are usually made ⅝ inch in thickness, 10½ inches long, 6¼ wide. They weigh from 2 to 2½ pounds each, and expose about one half to the weather. 740 tiles cover 100 superficial feet. They are hung upon the lath by two oak pins, inserted into holes made by the molder.

Plain tiles are now made with grooves and fillets on the edges, so that they are laid without overlapping very far, the grooves leading the water. This is economical of tiles, and saves half of the weight, but is subject to leak in drifting rains, and to injury by hard frosts.

Fig. 6432.



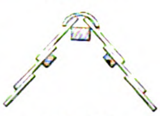
Pan-Tiles.

Pan-tiles, first used in Flanders, have a wavy surface, lapping under and being overlapped by the adjacent tiles of the same rank. They are made 14½×10½; expose 10 inches to the weather; weigh from 5 to 5¼ pounds each; 170 cover 100 superficial feet.

Crown, ridge, hip, and *valley* tiles are semi-cylindrical, or segments of cylinders used for the purposes indicated.

A *gutter*-tile has been introduced in England, forming the lower course, being nailed to the lower sheathing board or lath.

Fig 6433.



Ridge-Tile.

Fig. 6434.

Gutter-Tiles.

Siding-tiles are used as a substitute for weather boarding. Holes are made in them when molding, and they are secured to the lath by flat-headed nails. The *gage,* or exposed face, is sometimes indented, to represent courses of brick. Fine mortar is introduced between them when they rest upon each other.

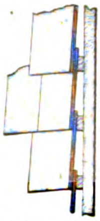
Siding-tiles are sometimes called *weather-tiles* and *mathematical tiles;* these names are derived from their exposure or markings. They are variously formed, having curved or crenated edges, and various ornaments either raised or encaustic.

Modifications of the pan-tile are shown in the examples *a b* (Fig. 6436), the edges being turned up and down respectively. *c d e* are modifications of the ridge-tile, in which the gutter and ridge are placed alternately.

f g show modes of securing. The former is molded with a

lug, which catches above the lath of the roof to hold itself in position. *g* shows a tile molded with two lugs, by which it engages the tiles of the courses above and below.

Fig. 6435.



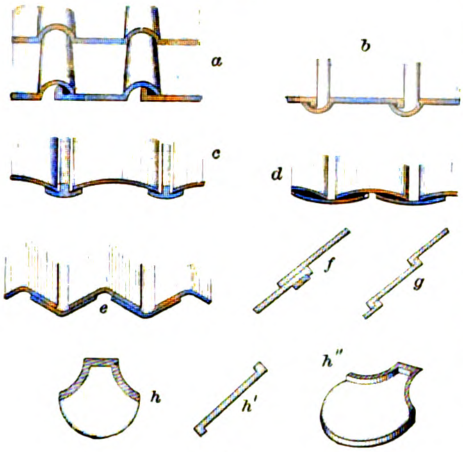
Siding-Tiles.

h h' h'' are elevation, section, and perspective views of a tile exposing a semicircular face to the weather. The semicircular portion has a drop-flange which catches over the re-entering curves of the upper part, these curves having upturned flanges for that purpose.

The glazed tiles are inferior to slate, as they imbibe about $1/7$ their weight of water, and tend to rot the lath on which they are laid. Good slate only imbibes $1/200$ part of its weight, and is nearly water-proof.

The *tile* is somewhat celebrated in an artistic sense, as forming the cover of the basket of keepsakes placed by a nurse upon the tomb of a Corinthian maiden. Being placed over an acanthus root, the basket became inclosed by the foliage, which turned gracefully over when it met the tile, and suggested to Callimachus the Corinthian capital. Such is the story, and it is pretty enough to believe upon a moderate amount of evidence.

Fig. 6436.



Tiles.

Encaustic tiles; ornamental tiles in which the colors are burned in. See page 801.

Galvanized iron tiles have been introduced in France. They are shaped like pan-tiles, so that each laps upon its neighbor in the course, as well as the lapping of each course upon the one beneath it.

The metal being thin, the tiles are easily cut to fit a sloping line of roof, corners, etc.; and they are fastened by a single nail of galvanized iron, with which is used a small leaden washer, to render the nail-hole perfectly tight.

2. (*Brass-founding.*) The cover of a brass furnace. Now made of iron, but formerly a flat tile. See BRASS-CASTING.

3. (*Metallurgy.*) A clay cover for a melting-pot.

Tile-creas'ing. (*Masonry.*) A row of tiles laid along the top of a wall, projecting beyond the face; or each face, if both are exposed. A row of bricks laid *header* fashion is laid above, and is called a *cope*. This is *plain* tile-creasing. A double row laid so as to break joint is double tile-creasing.

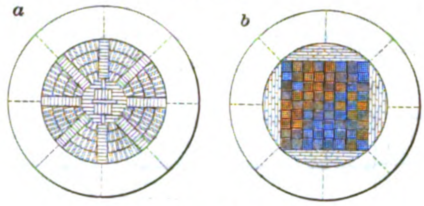
Tile-drain. One made of baked earthenware.

Til'er. A tile-kiln.

Tile-kiln. A form of kiln adapted to *burning* tiles.

A good form of tile-kiln, as used in Staffordshire, England, is shown in the accompanying figure. On the bottom of the oven are first placed 2,000 bricks, as shown at *a*, which is a plan of the oven as seen when eight courses of brick are laid edgewise. The eight rows, with twelve bricks in each, as seen in the plan, cover a space left in continuation of flues from the eight fire-holes. The bricks in the first seven courses are so placed as to leave a flue of an average width of 4 inches. The dotted lines show the position of the fire-holes. Upon these bricks are placed 7,000 tiles, forming a square, the spaces between the

Fig. 6437.



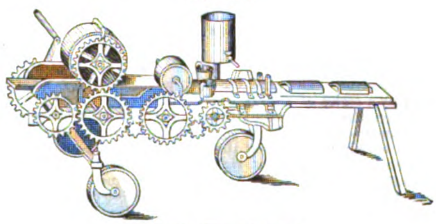
Tile-Kiln.

a, plan of brick courses. *b*, plan of tile courses.

tiles and the curved sides of the oven being filled up with bricks, as seen in the figure. *b* is a plan of the oven as seen when the first course of tiles are placed upon the bricks, seen in the figure *a*. The tiles are placed in bunches of twelve, and laid alternately cross and lengthwise; the nib on each tile spaces it from its neighbor and supports it in vertical position. The spacing of the bricks and tiles allows the circulation of the heat between them, and the circular oven is found well adapted to secure uniformity of heat.

The kiln is protected on the windward side, to prevent uneven urging of the fires. The oven being *set*, the doorway is bricked up and daubed, the fires kindled and kept burning, moderately at first, and then more freely. The usual time for firing is thirty-eight hours, and the consumption four tons of coal for a kiln of the size described. Three days are then allowed for cooling, and they are afterward taken out of the kiln. Those tiles which are to be made of a grayish color are thus treated. It having been ascertained that the tiles are burnt enough, and while still red-hot, a quantity of small fagots of green alder with the leaves on is introduced into each flue. The flue-holes are then well secured, and the holes in the roof each stopped with a paving tile, and the whole surface is covered with four or five inches of sand, on which a quantity of water is thrown, to prevent the smoke from escaping anywhere. It is this smoke which gives the gray color to the tiles, both internally and externally. The kiln is then left closed for a week, when the sand is taken off the top, the door and roof-holes are opened, as also the flue-holes, and the charcoal produced by the fagots taken out. Forty-eight hours after, the kiln is cool enough to allow of the tiles being taken out, and the kiln charged again. Whenever any of the tiles are to be glazed, they are varnished after they are *baked;* the glaze being put on, the tiles are put in a potter's oven till the composition begins to run. The glaze is generally made from what are called lead ashes, being lead melted and stirred with a ladle till it is reduced to ashes or dross, which is then sifted, and the refuse ground on a stone and resifted. This is mixed with pounded calcined flints. A glaze of manganese is also sometimes employed, which gives a smoke-brown color. Iron filings produce black; copper slag, green; smalt, blue. The tile being wetted, the composition is laid on from a sieve.

Fig. 6438.



Hunt's Tile-Machine.

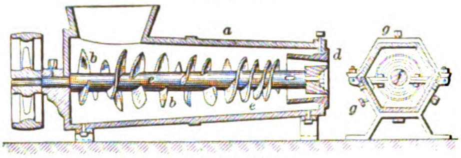
Tile-lay'ing Plow. A mole-plow invented by J. Fowler, Jr., England, about 1850, in which the mole was made to draw in a succession of drain-tiles strung upon a rope. See MOLE-PLOW, Fig. 3207, page 1469.

Tile-ma-chine'. Drain-tiles are either molded flat and bent around a former to the proper shape, or are made at once of a curved form by pressing the clay through a *dod* or mold of the required form. The latter plan is now usual.

Hunt's machine (Fig. 6438) has two iron cylinders, around which webs of cloth revolve, whereby the clay is pressed into a slab of proper thickness without adhering to the cylinders. It is then carried between two vertical rollers, which impart a

semi-cylindrical or other required shape, after which the tiles are polished and finished by passing through three iron molds of horseshoe form, being at the same time moistened by the dripping of water from a tank above, and finally conducted off upon an endless web.

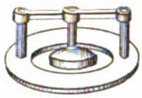
Fig. 6439.



Tile-Machine.

In more recent machines, the tiles are generally formed at one operation, by pressing. A charge of clay sufficient to form a number of tiles is placed in a cylinder and subjected to the action of a piston, which forces it out as a continuous tube through the *dod* (Fig. 6440), after which it is cut into lengths by a wire.

Fig. 6440.

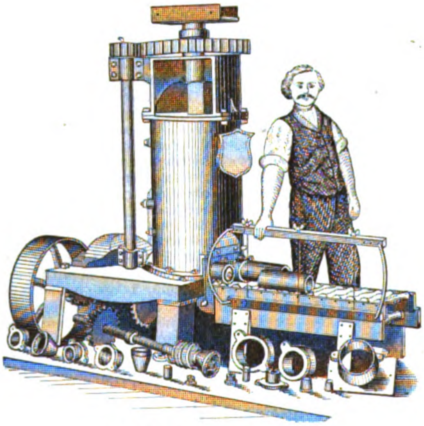


Dod.

The most modern machines generally employ a screw, which serves at the same time to mix the clay and force it through the mold; the process of feeding and molding is thus rendered continuous, no time being lost in charging the cylinder. See also Fig. 1746, page 741.

Tiffany's (Fig. 6441) consists of a vertical pug-mill containing rotary curved knives and a screw-follower for forcing the clay through the dies, an assortment of which are shown at the base of the apparatus.

Fig. 6441.



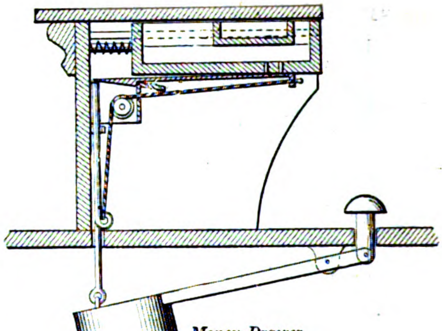
Tiffany's Tile-Machine.

The pipe, on issuing from the dies, is carried forward by a series of rollers having hollowed surfaces, and is cut into lengths by a rocking-frame provided with cross wires. In another machine, the clay is forced through the dies by two plungers working in boxes at the base of the pug-mill, and reciprocated by cranks set at right angles to each other on the same shaft; two sets of dies are employed; one plunger being retracted to allow its box to receive a supply of clay, while the other is engaged in forcing the clay through its die.

Till. A money-drawer in a counter or desk.

Fig. 6442 shows a shop-counter till, which is opened by pressure of the foot on a knob, which lifts a weighted lever and allows a spring to throw the door open. When the foot is withdrawn, the weight pulls the drawer shut.

Fig. 6442.



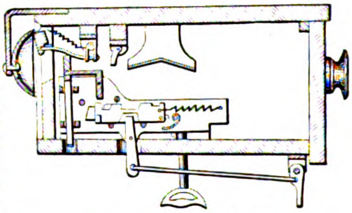
Money-Drawer.

Till-a-larm'. An attachment to drawers, especially to money or till drawers, to announce the surreptitious opening of the same. Some are simple, and are so attached as to strike an alarm whenever the drawer is opened, and consist of a bell and a spring hammer, the latter being tripped by the contact of a stud on the opening drawer. Other devices are more complicated, and only sound the alarm when the drawer is opened by one unacquainted with the specific devices which throw the alarm out of operation.

There are many patents on till-alarms, some of which have complicated locks and secret devices, which cannot be briefly explained within the limits assigned to this subject.

Fig. 6443 has a vertically sliding bolt, employed in connection with a series of notched tumblers, together with springs and catches, and with a catch-rod and plate, all so arranged that when the till is opened an alarm will be sounded upon the bell. By a secret trigger beneath the drawer, the bolt is withdrawn and the alarm-mechanism is undisturbed as the till is opened.

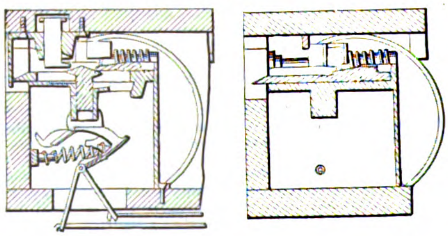
Fig. 6443.

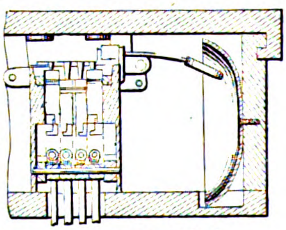


Purrington's Till-Alarm.

Fig. 6444 is a till-alarm and lock. When the till is closed, the outer bolts which rest on the tumblers are raised above the upper surface of the frame, while the central bolts which rest upon the other tumblers extend within the frame and in front of the cross-piece at the rear of the same. If, while the parts are in this position, an unauthorized person undertakes to open the till, the rear cross-piece is brought in contact with the central bolts, which will prevent its farther movement, while the drawer moves forward until the flange is brought against the lug, which prevents farther movement of the till. If the till be now moved back, the alarm is sounded. See also Fig. 129, page 57.

Fig. 6444.





Till Alarm and Lock.

Till'er. 1. A transverse handle at the upper end of a *pit* saw.

2. The handle of a cross-bow.

3. (*Nautical.*) The lever on the head of a rudder, and by which the latter is turned.

Rudders with tillers are shown in paintings of Edfou, Egypt.

Till'er-rope. (*Nautical.*) That connecting the head of the tiller with the drum of the steering-wheel.

Fig. 6445.

Tiller.

Till'er-wheel. More properly termed *steering*-wheel, as it does not always act upon the rudder through the intervention of a tiller, which is a bar or lever projecting

Fig. 6446.

Tiller.

from the rudder-head or rudder-post. See STEERING-WHEEL.

Sometimes called a "pilot" wheel, as that functionary has it in charge in the ordinary steamboating on our rivers.

Till-lock. One adapted to money-drawers of counters. See TILL-ALARM.

Tilt. 1. (*Vehicle.*) *a.* A wagon-cover, usually of canvas on wooden bows.

b. The temporary cover for an artillery-carriage, corresponding to our *paulin* or *tarpaulin*, is called a *tilt* in the British service.

2. (*Nautical.*) An awning over the stern sheets of an open boat, supported by stanchions on the gunwale.

3. (*Machinery.*) A TILT-HAMMER (which see).

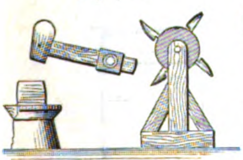
Tilt'ed Steel. Blistered steel heated in a furnace and subjected to the action of a tilt-hammer, which strikes about 700 blows per minute, and increases the solidity and tenacity of the metal.

Tilt-ham'mer. The word *tilt* is derived from a root which means a lifting or up-and-down motion, which is descriptive of the action of the hammer.

The hammer-stock is pivoted as a lever of the first or third order, and is acted upon by a *wiper-wheel*, whose cams or cogs tilt the hammer and then allow it to drop upon the bloom on the anvil.

Its particular use is in compacting the balls of iron as they come from the puddling-furnace, and driving out the dross with which the iron is associated when in the form of *pig*, and some of which is removed by the reverberating flames of

Fig. 6447.



Tilt-Hammer.

the furnace. It is also used in heavy forging.

In the first-mentioned use, the *squeezer* has to some extent superseded it; and in the latter line, the atmospheric and steam hammers — especially the latter — have entirely dispensed with the *tilt* motion when very heavy forgings are under treatment. See STEAM-HAMMER; STEEL-PRESS; FORGING.

A number of other power-hammers are reciprocated in vertical lines by other means than piston and cylinder. A list will be found under HAMMER.

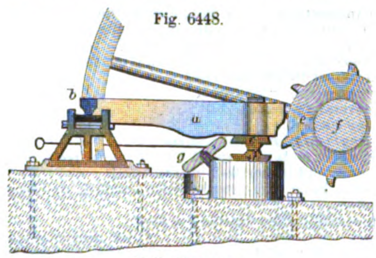
The ordinary tilt-hammer (Fig. 6448) has a cast-iron helve *a* supported at the end *b* on plummer-blocks, fixed upon wooden beams to ease the jar. The head *c* is of wrought-iron, faced with steel, passes through an eye in the helve, and is secured by a key. The base of the anvil is of cast-iron, and the *pane d* of wrought-iron, faced with steel. The head is raised by a series of cams upon a cast-iron collar *e*, called the *cam-ring bag*, fixed on the shaft *f*, which is provided with a heavy fly-wheel.

The hammer has usually a drop of 16 to 24 inches, and strikes 75 to 100 blows per minute. When not in use it is propped up by the support *g*. See TRIP-HAMMER; STRIKER; STEAM-HAMMER. See list under HAMMER.

The cushioned hammer shown in Fig. 6449 (Butterfield's patent) is made of iron, except the helve. The anvil and anvil-block are cast-iron, made separate and adjustable. The latter has a separate foundation, independent of that of the main bed.

The balanced helve swings upon two hardened adjustable steel centers, and is put in motion by the use of a broad adjustable steel eccentric operating in connection with the working-beam and rubber cushions, the length of stroke being governed by the adjustable eccentric; the force and power of the blow is greatly influenced by the reactive and united action of the cushions, which so far absorb the jar that a person holding his

Fig. 6448.



Tilt-Hammer.

hand upon the working parts, when under the most rapid and violent motion, cannot identify the strokes of the hammer.

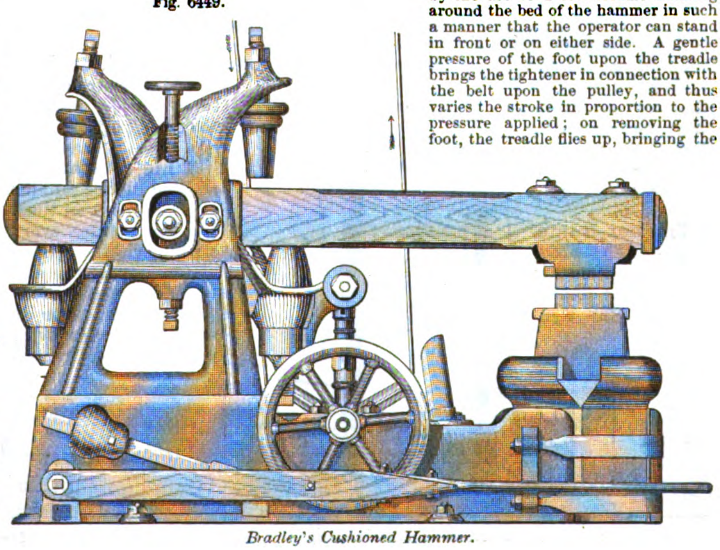
The cushions do the double work of relieving the frame from jar and giving force and power to the blow.

Tension can be given each cushion by raising or lowering the set-screws in the upper and lower sockets of the working-beam; the helve is placed in position and adjusted to any stroke or sized die by the use of set-screws where the same is attached to the frame; the husk is also adjusted to the helve in the same manner.

The object of raising or lowering the husk is to enable the operator to use different thicknesses of dies, or adjust it to the same dies after grinding, etc.

The power is applied and regulated by the use of a foot-treadle running around the bed of the hammer in such a manner that the operator can stand in front or on either side. A gentle pressure of the foot upon the treadle brings the tightener in connection with the belt upon the pulley, and thus varies the stroke in proportion to the pressure applied; on removing the foot, the treadle flies up, bringing the

Fig. 6449.



Bradley's Cushioned Hammer.

brake upon the balance-wheel, stopping it instantly, leaving the hammer up, as it cannot stop with the dies closed.

Tilt'ing-fil'let. (*Roofing.*) The strip, $2\frac{1}{2} \times \frac{3}{4}$ inch, and chamfered to an edge, laid down around the edge of a roof where the edges of the shingles or slates abut upon a wall. The object is to avoid leakage at the arris. An *arris-fillet.*

Tilt-mill. (*Metal.*) A building where a *tilt-hammer* is used.

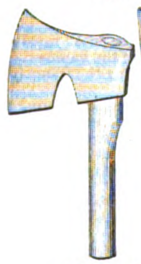
Tilt-roof. A round-topped roof, shaped like a *tilt* or wagon-cover.

Tim'ber. 1. (*Carpentry.*) A piece of wood in a frame. See BEAM; GIRDER; BRACE; TIE; JOIST; POST; PLATE; PURLIN; STRUT; etc. See list under CARPENTRY.

2. (*Shipbuilding.*) One of the curved frames which form the ribs of a ship. They are built up of several pieces: the *floor-timbers* are between the *keel* and *keelson*, and the outward and upward extension-pieces are *futtocks*, first, second, third, etc. The portions extending above the deck-level are the *top* timbers. See FRAME, Fig. 2093.

Cant timbers are placed obliquely on the keel.
Filling-timbers are to fill up between the frames.
Knuckle-timbers are the foremost in the bow.
Fashion-pieces, the hindmost in the quarter.
Each timber-frame comprises: —
The *cross-piece*, or half-floor.
The several *futtocks*.
The *top timber*.
The *lengthening-piece* (if necessary).
Their upper ends are capped by the *rough-tree rail*.
The lower end is mortised into the keel.
The *skin*, inner and outer, is bolted, nailed, or tree-nailed to the timbers.
Each course on the outside is a *strake*.
Thick *strakes* are *wales*.
To the channels (*chain-wales*) the *shrouds* and *back-stays* are connected.

Fig. 6450.



Timberer's Axe.

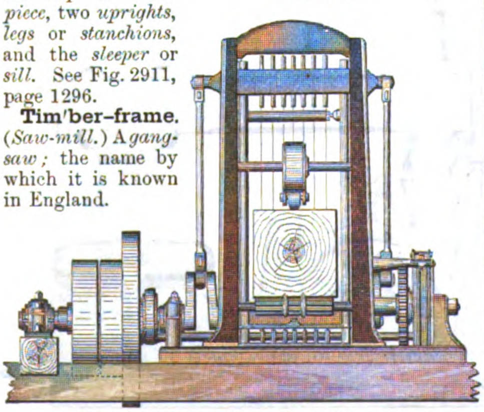
Tim'ber and Room. (*Shipbuilding.*) The width of a timber and a space. Also called *room* and *space*, or *berth* and *space*.

Tim'ber-bridge. See WOODEN BRIDGE; also list under BRIDGE.

Tim'ber-er's Axe. (*Mining.*) An axe or hatchet of the mine-carpenter, used in chopping to length and notching the timbers which support the roof and sides of the gallery or drift. A set of timbers consists of the *cap* or *head-piece*, two *uprights*, *legs* or *stanchions*, and the *sleeper* or *sill*. See Fig. 2911, page 1296.

Tim'ber-frame. (*Saw-mill.*) A *gang-saw*; the name by which it is known in England.

Fig. 6451.



Worssam's Timber-Frame (End Elevation).

Worssam's (Figs. 6451, 6452) comprises an iron sole-plate bolted to a timber framing and carrying upright standards. It has a swing-frame carrying a gang of saws and reciprocated by two connecting-rods, which vibrate outside of the main standards by the action of a double-throw crank-shaft. The timber is propelled to the saw on rollers, top-pressure rollers being provided to keep it well down. The ends of the timber are supported and guided by carriages running on rails back and front of the machine. See also Plate LIV., page 2042; Fig. 2157, page 942.

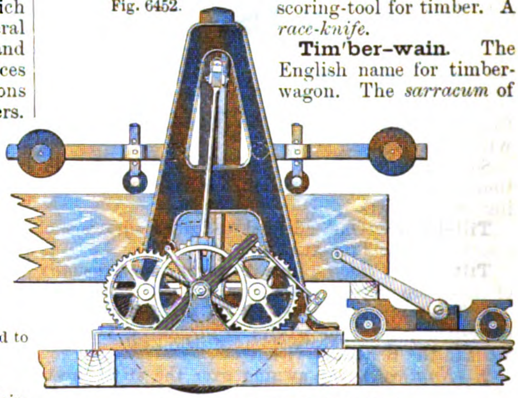
Tim'ber-head. (*Shipbuilding.*) So much of a frame-timber as rises above the deck.

Tim'ber-hitch. (*Nautical.*) The end of a rope is taken round a spar, led under and over the standing part, and passed two or three turns round its own part, making a jamming-eye.

Tim'ber-scribe. A scoring-tool for timber. A *race-knife*.

Tim'ber-wain. The English name for timber-wagon. The *sarracum* of Juvenal. Shown on the Trajan column.

Fig. 6452.



Timber-Frame (Side Elevation).

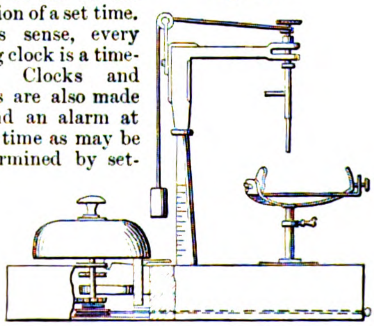
Tim'bre. Fr. (*Music.*) The *quality* of tone distinguishing voices, instruments, and stops, irrespective of *pitch* or intensity.

All the notes of a given stop of an organ have of necessity the same *timbre*, but in pitch they range throughout the extent of the chromatic scale. Corresponding notes, of *stops pitched in unison*, such as the *open diapason*, *dulciana*, *trumpet*, *bassoon*, *cremona*, *vox-humana*, have the same pitch, but each differs from the others in *timbre*; the *quality* of the tone is different. This difference is attained in various ways. Some of the pipes have wooden mouth-pieces, others metallic mouth-pieces, reed pipes, reeds of varying qualities, tubes of varying proportions and shapes, to imitate the peculiar sounds of the various instruments after which they are named, as *flute*, *trumpet*, *bassoon*, *oboe*, etc.

Tim'brel. A drum or tambourine used in ancient times. We read of it in Exodus and Job. Miriam sang, danced, and played on the timbrel when she took her part in the grand antiphonal by the Red Sea. See TAMBOURINE; TABRET.

Time-a-larm'. An audible notice at the expiration of a set time. In this sense, every striking clock is a time-alarm. Clocks and watches are also made to sound an alarm at such a time as may be predetermined by set-

Fig. 6453.



Time-Alarm.

ting the machinery therefor. (See ALARM-CLOCK.) The term is, however, specifically applied to a device to waken sleepers; in some cases it goes so far as to fire a pistol, strike a match, light a candle, and upset the bed, or empty a pitcher of water into the face of the sleeper. Strange how much trouble some people will take not to rest easy!

In Fig. 6453, the weight is elevated by coiling its supporting cord upon the shaft, and is raised so high that when the shaft is connected to the spindle of the minute-hand, the required time shall elapse before the weight descends sufficiently to depress the detent of the alarm. A scale on the post indicates the hight to raise the weight.

Time-ball. A ball on a pole, dropped by electricity at a prescribed instant of time. An *electric time-ball.* It is used especially in maritime cities to give time to the officers of the ships in port.

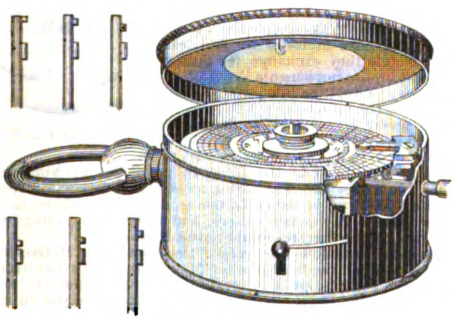
Time-can'dle. One in which the size and quality of the material and the wick are so regulated that a certain length will burn in a given time. Candles colored or indented at certain intervals so as to mark time were patented in England in 1859.

In Asser's Life of Alfred the Great it is stated that the king had for his daily use six tapers, each 12 inches long and containing 12 dwts. of wax, and divided into 12 parts or inches, of which three would burn in one hour. To prevent flaring and irregular consumption, he shielded the light by thin plates of horn, making a lantern. See LANTERN.

Time-de-tect'or. An instrument for recording the time at which a watchman may be present at different stations on his beat.

It is a kind of large strong watch, which is carried by the watchman, and is provided with several keys, differing some-

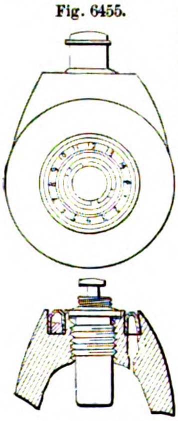
Fig. 6454.

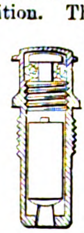


Time-Detector.

what from each other, and each adapted to operate a marker appropriate to itself alone, and which leaves an imprint on its own particular circle of the dial; one of these keys is secured at each station to be visited, and that one must be employed in order to leave the proper record, it not being accessible to the watchman at any other point.

Fig. 6455.





Time and Percussion Fuse for Explosive Shells.

Time-fuse. A fuse which can be so arranged as to explode a charge at a certain determinate interval after the time of its ignition. This is usually effected either by cutting out or off a portion of the fuse or by employing compositions of which given lengths burn at different rates.

Fig. 6455 shows a "Borman" fuse, which at the discharging point is in contact with a chamber containing quick powder, and communicating with the interior charge of the shell. See also FUSE, Fig. 2132, and pages 928, 929.

Time-keep'er. (*Horology.*) A watch or clock. See HOROLOGICAL INSTRUMENTS, list, pages 1123, 1124.

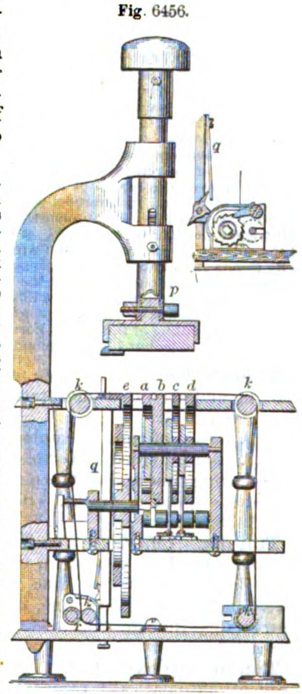
Time-lock. A lock having clock-work attached, which, when wound up, prevents the bolt being withdrawn when locked, until a certain interval of time has elapsed, even by means of the proper key. Various devices may be employed for this purpose; in one, a circular stop-plate rests against the end of the bolt and resists its withdrawal until pushed away by the movement of the train at the end of the time to which it was wound up. See ALARM-CLOCK, page 57.

Ti-men'o-guy. (*Nautical.*) A rope made fast to an anchor when stowed, to keep ropes from fouling on it.

Time'piece. An instrument for indicating time. See CLOCK; WATCH; CHRONOMETER; CLEPSYDRA; HOUR-GLASS; DIAL. See list under HOROLOGICAL INSTRUMENTS, page 1123.

Time-print'ing Ma-chine'. An apparatus for imprinting on a letter, dispatch, or other document the time at which it was sent, received, filed, etc. Adapted for use in telegraphic or other offices where numerous records of this kind have to be made.

Fig. 6456.



Hinchman's Time-Printing Apparatus.

Fig. 6456 is a stamping-apparatus which automatically records the time of each impression made upon it. It comprises a clock provided with a minute-wheel having 60 teeth, which, through the medium of a lever having at one end a spring nib which has a limited freedom of movement in one direction, acts upon a ratchet-wheel also having 60 teeth, and borne upon the same shaft with the plain wheel *e* on which the minutes are engraved. A pin on this wheel at the expiration of each hour strikes a pawl-lever, which rotates a wheel *a*, having the hours engraved on its periphery; to this is affixed a wheel *b* having 24 divisions, 12 marked A. M. and 12 marked P. M. *c* is a wheel numbered from 1 to 31, corresponding to days, and *d* a wheel having the months engraved on its circumference; these two wheels are adjusted by hand. An endless ribbon passes over the faces of the wheels *a b c d e* around rollers *k k k k*, and is inked by contact with the inking-roller *r*. Impressions are made by the hand-stamp *p*, which at the same time depresses a pawl-rod *q* that engages a ratchet-wheel *s*, causing the lower left-hand roller to rotate and feed the ribbon.

In this device the clock-work only acts upon the printing mechanism for an instant in each minute, so that no shock is communicated to the former in the act of stamping.

In another machine a time-piece, provided with minute, hour, and calendar wheels, having raised figures and letters on their edges, arranged in line side by side, and operated from the time-piece by a pawl and armature lever of a magnet, is combined with a suitable inking and spring-plate device, so that the time and date may be at any time printed, either by a hand-pad or by the action of a second electro-magnet.

In a third machine by the same inventor, the type-dials are

concentrically arranged in a horizontal plane, and are operated by bevel-gears connected with the main shaft. Each revolution of the minute-dial moves the hour-dial one space, while one revolution of the latter moves the vertically arranged meridian-wheel and the disk indicating the day of the month each one space, and the latter in turn moves the month-disk. When the platen is depressed to make an impression, and the rotation of the shaft is suspended, the clock-movement winds up a spring within one of the cog-wheels connecting said shaft with that of the clock, which spring, as the shaft is released, communicates to it its lost motion.

Tim′er. A watch which has a seconds-hand, revolving once in a minute, and a counting hand which records minutes. It has a projecting pin which, when pressed, causes the hand to *fly back* to zero, and remain there till the pressure is removed. A form of *stop*-watch, keeping not actual time, but the time between events, such as the starting and arrival time in a race.

Time-sig′nal. A means of indicating the local time at an observatory to observers at one or several distant points.

Dropping a ball (*time-ball*) at a fixed hour, 1 o'clock, P. M., or mean noon daily, has long been in use in maritime cities and observatories. This serves as a means of regulating or ascertaining the rate of clocks or chronometers at all points where the falling of the ball is visible.

The electro-magnetic telegraph has been used for operating time-signals at much greater distances; thus, the Greenwich time is indicated at Liverpool and other cities in England by the dropping of a ball by means of an electric circuit operated from Greenwich, the circuit being automatically closed at one o'clock. The ball is dropped through the intervention of a series of levers, to one of which, acting as a detent, the armature of an electro-magnet, made so by the closing of the circuit, is attached. When this is attracted by closing the circuit, the detent is withdrawn and the ball falls.

By galvanometers placed in the circuits of the time wire to Liverpool, and the return wire, it was ascertained that the time elapsing between the receipt of the current in London and the discharge of the ball in Liverpool was $^{11}/_{30}$ of a second; of this $^{2}/_{30}$ were occupied by the automatic circuit-closer, $^{4}/_{30}$ by the ball-trigger mechanism, leaving $^{5}/_{30}$ of a second for the passage of the current by the underground wire.

By means of an improved arrangement devised by Mr. Varley for connecting the observatory at the Cape of Good Hope with time-balls at Simonstown and Port Elizabeth, the time elapsing between the passage of the current at Capetown and that announcing the falling of the ball at Port Elizabeth, 500 miles distant, is found to be but $^{1}/_{18}$ of a second.

Time-ta′ble. 1. A table giving the times of starting and arrival at each station of the daily trains on a given road.

2. A record of time of employés.

3. A board divided by vertical and horizontal lines representing time and distance respectively, and used to denote speed of trains. See SPEED-RECORDER, Fig. 5373, etc.

Tim′ing. (*Machinery.*) The regulation of the parts of a machine so that all the motions shall take place in due order and time. This may be illustrated in the sewing-machine, in which the stroke of the needle, the shuttle, and the feed take place necessarily in an exact sequence.

Tim′ing-ap′pa-ra′tus. (*Railway.*) An apparatus for automatically recording the rate of speed of railway-trains.

An endless screw on the axle of a car through the medium of a worm-wheel and connecting-rods causes a pencil-point to traverse back and forth across a strip of paper winding over a drum moved by clock-work. The paper is ruled with transverse lines corresponding to minutes, and the rate of speed is indicated by the number of lines which the pencil-mark crosses during its passage from one side of the strip to the other. Thus at the rate of 15 miles an hour, the diagonal pencil-line will cross four of the ruled lines; at 20 miles, three; and so on. When the train is stopped, the pencil-mark will be directly across the paper, parallel to the ruled lines. See SPEED-REGISTER; SPEED-RECORDER; etc.

Tim′pa-no. A drum. See TYMPANO.

Tim-whis′key. A heavy, lumbering, low-wheeled carriage.

Tin. Equivalent, 59; symbol, Sn. (*stannum*); specific gravity, 7.29; fusing-point, 442° Fah. A malleable, fusible, soft, white, lustrous metal, not readily corroded by atmospheric influences.

The bichloride is used as a mordant.

Tin forms an ingredient in most of the white alloys, such as solders, Britannia metal, pewter. See ALLOY.

Iron plate is tinned to prevent its oxidation, and the tin plate — as it is then called — is used for numerous purposes in and about the house, from the roof and eave-spouting to the culinary vessels in the kitchen.

Kassiteros (Gr.) is the ancient Sanscrit word *Kastira: Zinn*, in German; *den*, in Icelandic; *tin*, in English; *tenn*, in Swedish: answering to the Malay and Javanese *timah*. The names of articles of commerce become widely distributed; as the Sanscrit *'sarkara* and *kanda*, whence our *sugar* and *candy*. The old German word *glessum*, amber, has become the modern *glass*: the latter resembles the former very closely.

"Through the intercourse which the Phœnicians, by means of their factories on the Persian Gulf, maintained with the east coast of India, the Sanscrit word *kastira*, expressing a most useful product of Further India, and still existing among the old Aramaic idioms in the Arabian word *kasdir*, became known to the Greeks even before Albion and the British Cassiterides had been visited." — HUMBOLDT.

The position of the *Cassiterides*, or "Tin" islands, referred to by Herodotus, Book III. Chap. 115, was kept secret by the Phœnicians, who had been dealing with the Celtic natives of Cornwall and Ireland for many centuries, introducing among them many of the weapons and implements which are found in their barrows and bogs. Strabo, Polybius, and Diodorus, each has his guess as to the geographical position of the islands. The trading for tin seems to have been conducted at St. Michael's mound in Cornwall, to which place it was carried in carts across the sands when the channel was dry at low tide.

A rude, smelted block of tin was found some years since at Ladock, near Truro, Cornwall, supposed to have been smelted at the time when the Phœnicians traded with ancient Cornubia, and is in the Truro Museum. It is about 2 feet 11 inches long, 11 inches broad, and 3 inches thick.

Fig. 6457.

Phœnician Pig-Tin.

Strabo says: "The people live by their cattle, and have mines of tin and lead; these metals they exchange for pottery, salt, and bronze implements."

Ptolemy, Pliny, Solinus, and P. Mela referred to the islands.

The metal is believed to have been brought to the Mediterranean, from the Malay islands to India and Arabia, in early times.

Tin is mentioned in the Bible in the books of Numbers, Isaiah, and Ezekiel. The latter mentions it as coming from Tarshish to Tyre, probably Tartessus, now Cadiz, where there was a famous Phœnician colony, and where the trading-vessels from the Cassiterides would naturally call.

Tin is first mentioned as among the spoil of the Midianites, 1452 B. C., when the five kings of Midian and the recalcitrant Balaam were slain. Gold, silver, brass (? copper), iron, tin, and lead were among the spoils, and the tribes also received an accession of 32,000 young females.

The tin was probably obtained from the intercourse of the Midianites with Phœnicians. The sources of supply from the Indian Archipelago were not then opened to the Mediterranean countries.

Tinning was practiced by the Romans. Pliny says: —

"Stannum illitum æneis vasis."

Dripping-pans have been found at Herculaneum plated with silver.

The tin of commerce is derived from the native oxide, which is found in Cornwall, Malacca, the island of Banca, Germany, Bohemia, Hungary, Australia, Chili, and Mexico.

Five kinds of metallic tin are found in the market, known as Banca, Straits, English, Spanish, and Australian. The first, derived from the island where it is produced, is the purest and best. Straits tin comes from Singapore, Borneo, and other places adjacent to the Malayan peninsula, and ranks second. The English tin ranks third; the better qualities, however, which are retained for home consumption, equalling the Banca. Spanish tin comes from Mexico and South America; it is badly refined, and commands a less price than either of the others. The provinces of New South Wales and Queensland, Australia, now furnish immense quantities.

The tin of Cornwall is principally derived from the peroxide; the tin stone is found in veins associated with copper ores in granite and slate rocks, in which case it is called *mine tin*. It is also met with as an alluvial deposit mixed with rounded pebbles, and is termed *stream tin*. When occurring in reniform masses or wedge-shaped pieces with concentric bands, giving it a ligneous appearance, it is termed *wood tin*.

The ore is broken with a hammer into pieces about the size of a man's fist, crushed in a stamp-mill, and then undergoes a number of washing and separating processes depending on its quality and condition, such as *buddling*, *tossing* or *tozing*, *chim-*

ming, *dilluing*, *vanning*, *jigging*, *trunking*, *framing* or *racking*, and *tying*, the latter being generally performed after roasting.

The ore having been thus prepared is roasted in a reverberatory furnace to get rid of the sulphur and arsenic. The latter is collected in chambers and resublimed to form the white arsenic of commerce. The calcined ore is then washed to remove the impurities. If it contain copper pyrites, it is exposed for some time to the atmosphere and again washed, in order that the oxygen may convert the pyrites into a soluble sulphate. If copper be present, the calcined ore may be treated with dilute sulphuric acid, which dissolves the copper without attacking the tin.

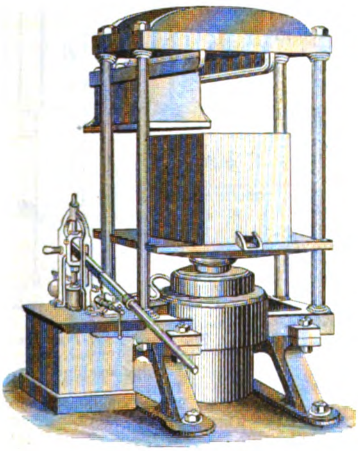
After washing, the ore is called *black tin*, and is ready for smelting. This process is conducted in a reverberatory furnace, with common pit-coal, anthracite or other carbonaceous substance being mixed with the ore to produce an ordinary quality of metal; but if very pure metal is desired, a blast-furnace, with charcoal for fuel, is used. In the former case the ore, mixed with about $^1/_5$ its weight of powdered coal or anthracite, and a little slaked lime or fluor spar, serving as a flux for the silica present, is placed upon the floor of the furnace and slightly sprinkled with water. During the first six or eight hours the doors of the furnace are closed, and the heat gradually increased. The door is then opened, and the fused mass worked with a long iron paddle to separate the slag.

The molten metal is then drawn off by removing a clay plug from the tap-hole, and flows into a basin. The slags are divided into three classes, one of which is thrown aside, a second restamped and worked, and the third smelted with the succeeding charge. The tin thus produced is refined, by liquation, or slow fusion in a reverberatory furnace, the dross floating on the surface while the tin is drawn off; billets of green wood are then lowered into the molten metal and allowed to remain for some three hours; these cause the lighter remaining impurities to rise in the form of a scum to the surface, the heavier ones subsiding toward the bottom. Three strata are thus formed: the upper, being most pure, is termed refined; the lowest most impure, and the middle medium. Each is ladled out into iron molds, forming what is known as *block-tin*. The refined is used principally for tin-plate.

The *blowing-house* is often employed, where charcoal is cheap, for producing a fine quality of tin. In this the ore is smelted in a blast-furnace, and the metal refined by poling with green sticks of wood.

Grain-tin is prepared by plunging blocks of tin into a bath

Fig. 6458.



Tincture-Press.

of molten tin, and when they have assumed a brittle crystaling texture, they are broken with a hammer; or, after being heated nearly to the fusing-point, they are allowed to fall from a considerable hight; they are thus broken up into elongated grains.

Tin Can. The ordinary name for the cans of tinned iron now so widely used.

One of the great improvements in this branch of business was the tin can of Masury, in 1859, in which he made a portion of the cover of very thin metal, which could be readily cut through with a knife. 10,000,000 of these cans are made yearly, 10,000 being used daily by the Borden condensed milk company. The invention is largely used in the paint trade, as it enables paints to be put up in liquid form, ready for use, thereby saving the painters time and trouble in mixing paint. See CAN-SOLDERING MACHINE, and other titles under SHEET-METAL. For list, see PLUMBING AND SHEET-METAL WORK, page 1750.

Tin-clip'pings. See TIN-SCRAP.

Tinct'ure-press. An apparatus for thoroughly extracting the active principles of plants, etc., by submitting them to compression.

The example is worked by hydraulic power. The ram of the press lifts the table which supports the box in which the infused mass is contained. The platen is above the press, and is stationary during the operation of pressing, but is moved out of the way when filling and emptying the box.

Tine. A term properly applied to a prong which pierces, as in forks, whether for culinary or table use, or such as are adapted for hay or manure. It must not be confounded with *tooth*, as in the harrow, or the cylinder of a thrashing-machine, etc.; the action is different. The stirrers of other cultivators are known as *shovels*, *shares*, or *teeth*, according to form and action.

Tin-foil. Very thin sheet-tin; often alloyed.

Tin-fur'nace. Tin-ore is broken into pieces with small hammers, and the pieces of spar thrown aside. The ore is then crushed between rollers, *jigged*, to separate the tin-stone from the refuse, then stamped and washed.

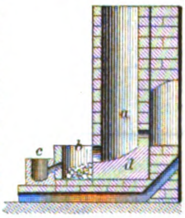
The crushed and washed ore is calcined in furnaces, to get rid of arsenic and other volatile impurities. It is then mixed with powdered culm or anthracite coal, and put in another furnace. The heat expels other impurities, the earthy matters float, and the metal is drawn off at a tap-hole.

In the subsequent refining process, the remaining impurities are gradually eliminated, and the refined tin is cast in granite molds in blocks of 300 pounds each. This is *block-tin*.

Grain-tin is obtained by granulating molten tin in water, from a second melting of blocks of a superior quality of metal.

Fig. 6459 represents the furnace used at Altenberg, Saxony, for smelting roasted tin-ores. It is of granite, about 10 feet high. *a* is the shaft; *b*, the fore-hearth; *d*, the bottom stone; and *c*, an iron caldron for receiving the metal; a tuyere enters through *b*. The ore, mixed with coke, coal, or charcoal, and slag from former smeltings, is placed in *a*; the reduced tin collects first on the fore-hearth *b* and runs thence to *c*. In this state it contains iron and arsenic, from which it is purified by liquation; the pure tin, fusing more readily, oozes out and leaves a more infusible alloy behind.

Fig. 6459.



Tin-Furnace.

Tin-glass. The glass-maker's name for *bismuth*.

Tin-glaze. (*Pottery.*) An opaque glaze, or enamel, having oxide of tin as a basis, used upon majolica ware and other fine pottery.

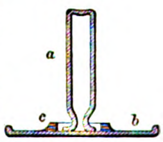
Tin-glazes are found upon ancient Egyptian and Persian articles. The process appears to have been introduced into Europe by the Saracens; tin-glazed tiles manufactured about 1300 A. D. being found in the Alhambra. They also made very beautiful wares, known as Hispano-Moresque, recognizable by the peculiar metallic luster of their surface. These were imitated by the Italians in the well-known majolica ware. The earlier specimens of this have a lead glaze, and are termed half or "mezza majolica." Toward the close of the fifteenth century the Italians became possessed of the secret of making tin-glazes, and soon surpassed the work of their predecessors the Moors.

Tink'er. (*Ordnance.*) A small mortar on the end of a staff. See Fig. 1365.

Tink'er's-dam. A wall of dough raised around a place which a plumber desires to flood with a coat of solder. The material can be but once used; being consequently thrown away as worthless, it has passed into a proverb, usually involving the wrong spelling of the otherwise innocent word "dam."

An electrophorus may be thus formed. A vial *a*, previously heated, is upset upon a circular plate *b* with a turned-over edge. A circular dam of dough *c* is raised

Fig. 6460.



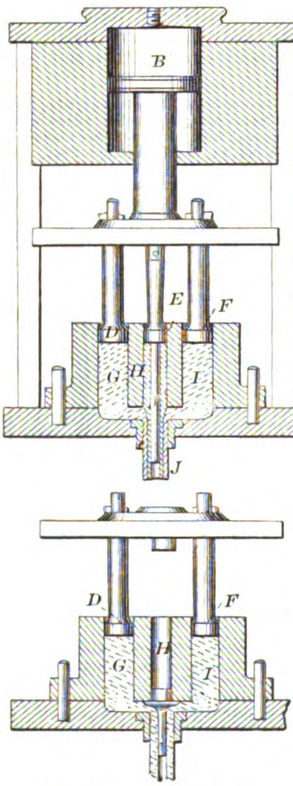
Tinker's-Dam.

around the lip, forming a wall to hold the soft solder which holds the insulator-handle to the plate.

Tin-lined Pipe. Lead pipe is lined with tin in order to prevent the formation of deleterious salts by the action of the water on the lead. Although the action of pure water upon metallic lead when there is no access of air to the pipe is so slight as to be uninjurious, yet it is found in practice that, owing to various causes, all water used for domestic purposes containing air and more or less mineral impurities, the water after its passage through lead pipes is found to become charged to a greater or less extent with the poisonous salts of lead. Tin is much less subject to be thus acted on, and its salts are comparatively innocuous.

The earliest attempt to remedy this evil by lining the tin pipe with lead appears to be found in Alderson's English patent of January 26, 1804.

Fig. 6461.



Machine for Making Tin-Lined Lead-Pipe.

In this the lead was cast around a core or mandrel in a two-part mold, the mandrel was then withdrawn and replaced by a smaller one, around which the fused tin was poured. A reversal of the process was provided for, the tin lining being first cast, and the lead afterward poured around it. The compound pipe was afterward lengthened by being drawn out upon a mandrel. A method of drawing out the tin lining upon a mandrel, inserting it in a larger leaden tube, and drawing out the two together, is also specified.

The first specified methods are still generally followed, various improvements having been made in the details.

In Fig. 6461, the piston *B* of a hydraulic press serves to operate the central plunger *E* and the annular plunger *D F*. The former forces out the tin contained in the central cylinder *H*, and the latter the lead in the annular cylinder *G I*. *J* is the mandrel. The machine admits of being arranged for making pipes all of one metal, as in the lower portion of the figure.

In Fig. 6462, two or more cylinders *H H*, *K K* are employed. The hollow ingot of tin *B B* is placed on a mandrel and forced through the central opening previously made to receive it in the ingot of lead *A*. The pressure unites the two together, and the compound pipe is forced through a die and passes out through the opening *E*.

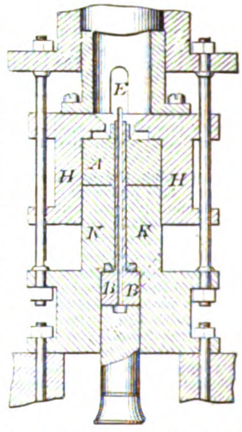
In Fig 6463, the tin is cast around the mandrel *e*, and is protected by a tube from the heated lead when the latter is poured into the cylinder *a a*. By a motion of the plunger *b b* or cylinder *a a*, either of which may be the working part, the two metals are forced through a die at the bottom of the cylinder and united together.

Tin-liq'uor. A dyer's solution of tin, digested in hydrochloric and nitric acids, with an addition of salt.

Tin'man's-punch. A punch or swage for sheet-metal workers' use. The plunger in the machine illustrated is worked by treadle. See also PUNCH; SHEET-METAL; STAMPING-MACHINE.

Tin'man's-shears. Hand-shears from 4 to 9 inches in length; the ends of the handles are bent toward each other, so as to meet when closed; also known as *snips*. The bench-shears are 18 inches or more in length, and one handle is bent down, forming a square tang, which is inserted through a hole in the bench; the other operates the movable blade. See SHEARS, Figs. 4928, 4929.

Fig. 6462.



Machine for Making Tin-Lined Lead-Pipe.

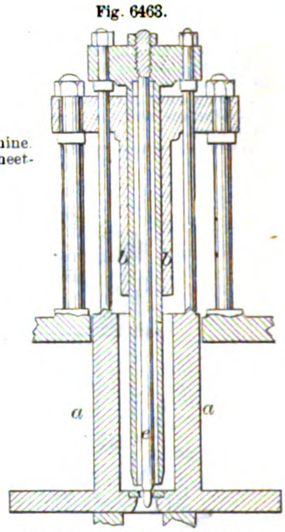
Tin'man's-sol'der. Ordinary or fine tin solder is composed of 2 tin, 1 lead, and melts at about 360° Fah.

Plumbers' solder consists of 1 tin, 3 lead, melting at about 500° Fah. See SOLDER; ALLOYS.

Tin'man's Tools. See under the following heads: —

Anvil.
Autogeneous soldering.
Bat.
Beak-iron.
Copper bit.
Creasing-tool.
Die.
Double-seaming tool.
Flanging and wiring machine.
Grooving-machine for sheet-metal.
Grozing-iron.
Latterkin.
Mallet.
Planishing-hammer.
Punch.
Raising-hammer.
Riveting-hammer.
Riveting-set.
Roof-seaming machine.
Seaming-machine.
Seaming-tools.
Seam-set.
Setting-punch.
Shears.
Sheet-metal folder.
Sheet-metal press.
Sheet-metal shears.
Snarling-iron.
Snip.
Solder.
Soldering-furnace.
Soldering-machine.
Soldering-tools.
Spinning-metal.
Stake.
Stamping-machine.
Striking-up press.
Swage.
Swaging-machine.
Teest.
Tinner's folding-machine.
Tinner's stove.

Fig. 6463.



Tin-Lined Lead-Pipe Machine.

Tin'ner's Fold'ing-ma-chine'. One in which the sheet-metal, cut to the required shape and size, is laid upon the bed-piece, held by a lever, and bent up against the *former* by a folder. The sides of the pan are operated upon consecutively.

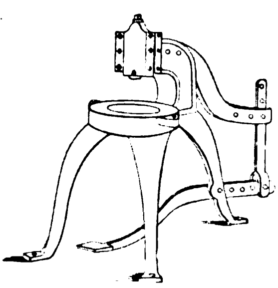
Tin'ner's Stove. A sheet-metal stove used by tinmen for heating the soldering-tools. See Figs. 5293, 5294.

Tin'ning. The art of coating other metals with tin.

The Romans employed tin (*stannum*) for lining vessels of copper in which were cooked articles which would corrode the copper. The practice is cited by Pliny, Columella, Palladius, and others. Silver was previously used for this purpose, and afterward a pewter (*argentarium*), lead and tin. The tinned

vessels were known as *vasa stannea*. The pure tin was preferred, and the mixture of lead considered an adulteration, as we understand the passage of Pliny. Galen refers to the same mode and kind of adulteration.

Fig. 6464.



Tinman's Punch.

The process seems to have been by immersion, as at present practiced.

Hollow ware is tinned inside, having been first thoroughly cleaned and heated, by pouring grain tin into the vessel and turning and rolling it about so as to bring it in contact with every part. Powdered rosin is used in the bath to prevent the formation of an oxide, and the surface of the ware is rubbed with cloth or tow to aid the process. In *cold tinning* an amalgam of tin and mercury is applied to the metal, the mercury being afterward driven off.

Bridle-bits, stirrups, and other small articles are tinned by immersion.

See also the following: —

By simple immersion. Dissolve 17½ ounces ammonial alum in 12 pounds boiling water, and when dissolved add 1 ounce protochloride of tin. The articles to be coated are well cleaned, and then immersed in this liquid until they are sufficiently white. The ammoniacal salts last a long time, but the tin salt requires occasional renewal.

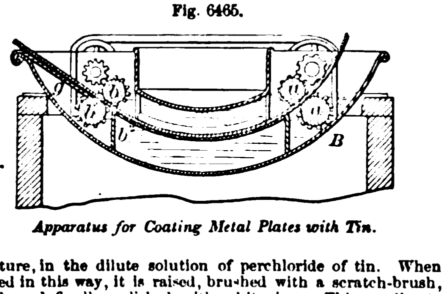
By contact with another metal in a suitable liquid. Dissolve 10½ ounces bitartrate of potassa in 17½ parts water, and add ½ ounce protochloride of tin, and boil it a few minutes. The articles to be coated are immersed in a solution, in contact with a piece of zinc of proportionate size.

By the battery. Dissolve 11 ounces pyrophosphate of potassa or soda in 17½ pounds water, and then add 4½ ounces protochloride of tin, and operate by the battery process with an anode of tin. See also TIN-PLATE.

Wegler gives the following method: —

A solution of perchloride of tin is first prepared by passing washed chlorine gas into a concentrated aqueous solution of tin salt, and expelling the excess of chlorine by gently warming it, then diluting it with eight to ten times its volume of water, and filtering it, if necessary. The article, well pickled in dilute sulphuric acid, and polished with sand and a steel scratch-brush, and rinsed with water, is loosely wound with a zinc wire, and immersed for ten or fifteen minutes, at the ordinary temperature, in the dilute solution of perchloride of tin. When tinned in this way, it is raised, brushed with a scratch-brush, dried, and finally polished with whitening. This applies to tinning cast-iron, wrought-iron, steel, copper, brass, lead, and zinc.

Fig. 6465.



Apparatus for Coating Metal Plates with Tin.

In Butterworth's apparatus (Fig 6465), the sheet of metal to be tinned is drawn through the bath contained in the melting-pan *B*, being fed down the guide-plate *g* and drawn forward by the rollers *b b′ a a*. A curved apron b^2 supports the sheet while passing through the bath.

The following is M. Heeren's process for giving iron wire the appearance of silver by a thin film of tin: the iron wire is first placed in hydrochloric acid, in which is suspended a piece of zinc. It is afterward placed in contact with a strip of zinc in a bath of two parts tartaric acid dissolved in 100 parts of water, to which are added three parts of tin salt and three parts of soda. The wire should remain about two hours in this bath, and then be removed, and made bright by polishing, or drawing through a polishing-iron. By this galvanic method of tinning, wire which has been wound in a spiral, or iron of other shape, can be made quite white, which is an advantage over most other methods, where the wire is tinned in the fire and then drawn through a drawing-plate.

Tin-plate. Iron-plate coated with tin by dipping it into a molten bath of the latter metal.

The art of tinning plate-iron seems to have been invented in Bohemia, was carried from thence into Saxony, 1620, and other parts of Germany, whence the rest of Europe was supplied until near the end of the seventeenth century. The art was introduced into England by Yarranton about 1675.

The iron used is *charcoal iron*, rolled into sheets of various thickness, according to the grade and size of the plates, which are cut into rectangular pieces of the required sizes.

The processes are as follows: —

Scaling. The plate is bent so as to enable it to stand when placed on edge, and is then pickled in a trough containing dilute hydrochloric acid. The bent plates being laid on the floor in a row, a rod is placed under them, and they are thus lifted and placed in a furnace, where they are heated to redness. The scale then drops off; after removal and cooling, the plate is beaten smooth on a cast-iron anvil. Cold rolling between hard, polished rollers confers smoothness and elasticity.

Pickling. The plates are immersed in a bath of acidulated bran-water, at about 100° Fah., for 12 hours, standing half the time on one edge and half on the opposite one. They are then transferred to a bath of dilute sulphuric acid (100° Fah.), which makes them bright. This is followed by a bath of clean water and scouring with hemp and sand.

Tinning. The series of pots in which the dipping is performed is placed in a brick structure which rises above the floor of the factory, and at which the workmen stand. This structure is called the *stow*, and contains the furnace which heats the pots. These cast-iron pots are arranged in a row, and are five in number, — the *tin-pot*, *wash-pot*, *grease-pot*, *pan*, and *list-pot*.

The *tin-pot* contains about 500 pounds of block and grain tin, on which floats 4 inches of tallow, to prevent oxidation. Alongside it is a grease-pot.

The *wash-pot* is nearly full of the best grain-tin, and has a partition to prevent the dross from gathering at that part where the last dip is given to the plates.

The *grease-pot* contains lard or tallow free from salt.

The *pan* has a grating at bottom, and no fire *under* it.

The *list-pot* has only ¼ inch depth of tin in it.

The operation is as follows: —

300 plates previously dipped in a grease-pot are placed one by one in the *tin-pot* (No. 1), in a vertical position, and left for an hour or two, the heat being as great as possible without burning the grease. They are then taken out by tongs and placed on an iron rack to drain.

The plates are then placed in the larger division of the *wash-pot* (No. 2), which melts off the superfluous tin acquired in No. 1; being taken out, a few at a time, from No. 2, they are taken up singly by a pair of tongs, swept on each side by a hempen brush, to make the layer equable and remove drip, and receive a final dip in the clean side of the *wash-pot*, by which the marks of the brush are erased.

Each plate, after its final dip in metallic bath, is plunged in the *grease-pot* (No. 3), which is so hot as to remove superfluous metal, allowing it to drain off and collect in the bottom of the pot. The plates stand singly in the grease-pot, being separated by pins, and as the pot holds but five, a boy is continually removing the one which has been longest in the grease.

As the boy takes the plates from the *grease-pot* (No. 3), he places them on edge in the cold pans (No. 4) to drain off the grease and cool.

The *list-pot* (No 5) is employed for melting off the *list* or selvage of tin which has accumulated at the edge of each plate as it stood vertically in the *wash-pot* and *grease-pot* (Nos. 2 and 3). The *list*, being thus melted, is detached by a smart tap with a stick.

The grease is cleaned from the warm plates by rubbing with dry bran. The plates are then boxed. Trade custom has prescribed the grades, weights, and sizes, which are indicated by certain marks on the boxes, as shown in the following table: —

Names.	Sizes.	No. in a Box.	Weight in a Box.	Box-Marks.
	Inches.		Pounds.	
Common, No. 1	13¾ × 10	225	112	CI
Common, No. 2	13¼ × 9¾	225	105	CII
Common, No. 3	12¾ × 9½	225	100	CIII
Cross, No. 1..........	13¾ × 10	225	140	XI
Two cross, No. 1	13¾ × 10	225	161	XXI
Three cross, No. 1.....	13¾ × 10	225	182	XXXI
Four cross, No. 1......	13¾ × 10	225	203	XXXXI
Common doubles......	16¾ × 12½	100	77	CD
Cross doubles..........	16¾ × 12½	100	126	XD
Two-cross doubles.....	16¾ × 12½	100	147	XXD
Three-cross doubles....	16¾ × 12½	100	168	XXXD
Four-cross doubles	16¾ × 12½	100	189	XXXXD
Common small doubles.	15 × 11	200	168	CSD
Cross small doubles....	15 × 11	200	189	XSD
Two-cross doubles.....	15 × 11	200	210	XXSD
Three-cross doubles....	15 × 11	200	231	XXXSD
Four-cross doubles.....	15 × 11	200	252	XXXXSD
Wasters, common, No. 1	13¾ × 10	225	112	WCI
Wasters, cross, No. 1 ..	13¾ × 10	225	140	WXI

The process in Pittsburg is as follows: —

The sheets, cut into the desired sizes, are "pickled" by immersion in a bath of dilute sulphuric acid for 10 to 20 minutes. They are then annealed for from 6 to 7 hours; then rolled cold, to give them a surface polish. This operation hardens the iron, so that the plates are again annealed, with greater care and at a lower temperature, for 6 or 7 hours. The plates are then again pickled in an acid bath for some 10 minutes, to remove the scale of oxide, washed in water to remove the acid, and then plunged for a few moments into a bath of palm-oil or melted tallow. The plates are then put, 40 or 50 at a time, in a tin bath, where they remain about 15 minutes. On leaving this, the plates are plunged into a second tin bath, on leaving which they have the dross brushed off, and go to the third tin bath; from that they go into a tallow or oil bath, from which they are drawn by passing between rolls, which smooths them. They are then rubbed with shorts, or bran and leather, to clean them, sorted and boxed, each box of I. C. plate, containing 112 pounds, or 112 plates, the plates having a gage of about No. 30, and weighing one pound each; I. X. brand weighs 140 pounds to the 112 sheets.

Tin-pot. The first of the set of baths in which sheet-iron is dipped for tinning.

It is a rectangular cast-iron vessel holding about 500 pounds of block and grain tin, and heated by a furnace, which envelops the sides and bottom. The molten tin is covered with a layer of tallow four inches thick, to prevent oxidation.

The other baths or pans are the *wash-pot*, *grease-pot*, *pan*, and *list-pot*. See TIN-PLATE.

Tin-saw. (*Bricklaying.*) A saw used by bricklayers for cutting kerfs in bricks in order to render them more readily dressed by the axe which hews them into shape for the skew or gaged work, dome, or niche for which they are destined.

Tin-scrap. Clippings or scraps made in the manufacture of tin-ware. It consists of iron plate, partially alloyed, and also coated, with tin, the amount of the latter varying from three to five per cent. In inferior wares the tin is itself debased with lead.

In the manufacture of tin-ware it is said that 6 per cent of the whole of the plates employed disappears in the form of scraps. The trade in sardine-boxes produced at Nantes, in 1869, nearly 400 tons of scrap; Birmingham produces about 20 tons per week, and Paris 50 to 60 tons per month. The tin-scrap of New York is estimated at 30 tons per day. A small quantity of these scraps has always been used in various ways, such as fluxing lead ores, and the addition of a small proportion to the pig-iron intended for steam-cylinders.

The following plans for the recovery of the tin have been proposed: —

a. Edward Schunk (English) patented, in 1848, three processes: the first involving the use of sulphide of sodium; the second, of soda, lye, and litharge; and the third, of a solution of chromate of potash and caustic soda. He preferred the first, as most perfectly liberating the tin, and for other reasons. The alkaline process is said not to extract the tin completely.

b. James Higgin, in 1854, patented a treatment of the scraps with muriatic acid and water, mixed with a substance, such as nitrate of soda, to liberate chlorine, and facilitate the solution, from which the tin was subsequently precipitated with powdered chalk; ammonia is stated to be obtained as a by-product.

c. Charles Frederick Claus patented in 1859 the use of a solution of sulphide of calcium, containing sulphur in excess. He recommended alkali waste and gas waste. From the solution bisulphide of tin is precipitated by means of muriatic acid, and converted to oxide, and finally to metallic tin.

d. Alexander Parkes, in the same year, employed mercury, forming a tin amalgam, which was subsequently retorted. The use of mercury is prejudicial to health.

e. The same person, in 1858, recommended concentrated oil of vitriol.

f. J. M. Patterson, of New Jersey, patented, in 1863, the use of a bath of melted lead, to form an alloy with the tin, which, suitable proportions of tin being added, may be used as solder.

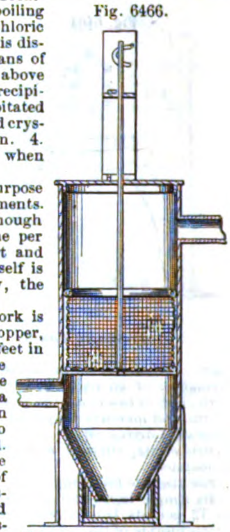
g. Mr. Everett, of New York, in 1865, proposed to use tin-scraps in smelting galena.

h. Sturdevant and Harmon, New York, propose to melt off the tin from the scraps by means of hot air and steam in a cylindrical retort with a perforated, inverted conical bottom.

i. Ott's method consists in the solution of the tin and lead of the scraps in muriatic, with a slight admixture of nitric acid, the precipitation of the lead from this solution by means of sulphuric acid, and the final precipitation of the metallic tin by means of spelter. The iron scraps are washed first in water, then in a weak alkaline solution, then again in water, after which they are barreled and sent to the puddling-furnaces.

The subject has been treated by M. Kuenzel in the "Bergund Uttannannische Zeitung." The mode employed by him comprises four chief operations: 1. Treatment of the scraps by means of boiling in water acidulated with hydrochloric and nitric acid, until all the tin is dissolved. 2. Precipitation by means of zinc of the tin contained in the above solution and washing of the precipitate. 3. Solution of the precipitated solution in hydrochloric acid, and crystallization of the chloride of tin. 4. Utilization of the iron scraps when despoiled of the tin.

Fig. 6466.



Harmon and Sturdevant's Apparatus for Removing Tin from Sheet-Metal.

Most inventions for this purpose have failed in one of the requirements. Either the iron is not left pure enough to be marketable (less than one per cent of tin makes it cold-short and worthless), or the tin-product itself is not in salable form, or, finally, the process is not cheap.

A process pursued in New York is about as follows: A cylinder of copper, glass lined, is provided, some 6 feet in diameter and 5 feet long, capable of holding 1,000 pounds of the scrap. This is arranged upon a shaft so that it can be revolved in a glass-lined tank filled almost to the brim with hydrochloric acid. When the acid has dissolved the tin, the cylinder is lifted out of the tank and lowered into a cistern of water, where it is revolved a few minutes and then transferred to a second tank of water, and turned a few times to wash away all the acid; after this it is rotated for a little while in a fourth tank, containing a weak solution of silicate of soda, to remove traces of acid and prevent the iron from rusting. The tin is dissolved in the first tank of acid, which soon becomes saturated. It is now drawn off into another tank, and the tin is separated by putting in zinc, for which the acid has a greater affinity than for tin. The chloride of zinc thus formed is useful for other purposes, and the tin remains pure. The whole time thus required to treat a charge is but little over an hour.

Tin'sel. 1. A shining thin metallic plate. *Foil.* Somewhat allied to tinsel is the *metallic dust*, the invention of John Hautsch, of Nuremberg, 1595–1670.

2. (*Fabric.*) A cloth composed of silk and silver. A material with a superficial sheen and but little sterling value.

Cloth overlaid with foil.

Tin-tack. A tack dipped in melted tin.

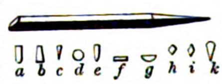
Tint'ed Pa'per. Paper with moderate depth of color.

Tints are grades of color, and are made by the addition of white pigment to all color, or of water to a water color, subduing the energy of the color.

Tin'tin-nab'u-lum. A musical instrument of percussion, consisting of a number of bells suspended in a frame.

Tint-tool. (*Engraving.*) A graver for cutting the lines employed in forming tints. They are of various sizes, according to the character of the work and the depth of tint to be produced.

Fig. 6467.

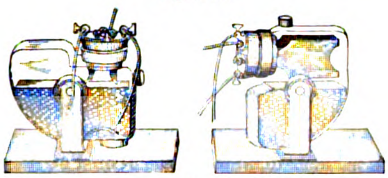


Gravers' and Tint Tools.

a, round-edge graver.
b, square-edge graver.
c, knife-edge graver.
d, round graver.
e, graver.
f, flat graver.
g, half-round graver.
h, square graver.
i, lozenge-graver.
k, tint-tool.

Tip. 1. (*Gilding.*) A tool made of camel's hair, and used by the gilder in transferring gold-leaf from the *cushion* to the sized surface of the work. The ends of a number of camel's hairs are secured by their buts between two cards, which are glued together, thus making a broad, flat, and very elastic brush. This is laid upon a piece of gold-leaf, which adheres to it slightly, and is thereby removed. See GILDING.

Fig. 6468.

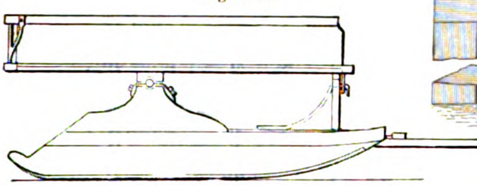


Tip-Battery.

2. (*Hat-making.*) A circular piece of scale or paste board pasted on the inside of a hat crown to stiffen it.

3. (*Shoemaking.*) A protecting cap at the toe end of a shoe.

Fig. 6469.



Tip-Sled.

4. The nozzle of a gas-burner.

5. A ferrule ; as the tip of a bayonet scabbard.

6. The rubbish of a quarry.

Tip-bat′ter-y. (*Electro-Magnetism.*) A battery in which the vessel turns on a horizontal pivot, so that the pairs of plates may be immersed in or raised clear of the liquid in the trough by tilting.

Tip-pa′per. A variety of paper of a rigid quality, made for lining the *tips* or insides of hat-crowns.

Tip′pet. 1. (*Wear.*) A fur or cloth covering for the neck and shoulders, worn over the dress.

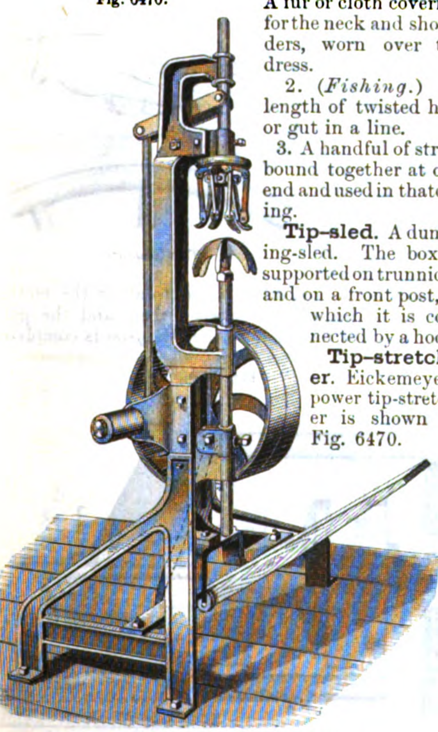
2. (*Fishing.*) A length of twisted hair or gut in a line.

3. A handful of straw bound together at one end and used in thatching.

Tip-sled. A dumping-sled. The box is supported on trunnions and on a front post, to which it is connected by a hook.

Tip-stretch′er. Eickemeyer's power tip-stretcher is shown in Fig. 6470.

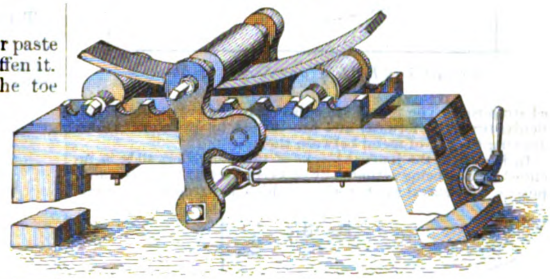
Fig. 6470.



Eickemeyer's Tip-Stretcher.

The *star* upon which the hat-body is placed is connected with the treadle, and is raised up when the treadle is depressed. This star is screwed upon the sliding spindle, and may be exchanged for another star of a different size. Above the star are the adjustable *stretching-fingers*, which can be set by a hand-wheel to stretch the hat-body more or less. The stretching-fingers are attached to another sliding spindle, which is caused to move up and down in rapid succession by the walking-beam on the upper end of the frame, which receives its motion from a crank on the short shaft of the machine. A loose and tight pulley on

Fig 6471.



Tire-Bender.

the same shaft are driven from any suitable pulley, and give motion to the reciprocating stretching-fingers.

The hat-body is kept as hot as steam will make it, and placed upon the star while the machine is in motion, and by the depression of the treadle is brought up in contact with the stretching-fingers. Every time these fingers come down the hat-body is stretched a certain amount; and as the fingers retreat, the body is slightly turned on the star by the operator, who pushes the hat-body up and turns it a little every time the fingers leave it, and the hat is stretched from 100 to 120 times a minute.

Tire. 1. (*Vehicle.*) An iron band around the fellies of a wheel.

The circular continuous tire is of American origin. In Europe tires were, until lately, generally made in sections arranged to break joint with the fellies.

The rim-tire is expanded by heating, and then shrunk on so as to tightly compress the wheel, and bolted ; in the sectional tire, bolts only are relied on to hold the parts together. Steel railway-tires are always of the former kind.

Theocritus, the Greek poet, describes the chariot-maker bending a slat rived from the limb of a wild fig-tree and rendered pliable by roasting in the fire, "in order to form the circumference of a wheel." The same agent, fire, was used in early times to supple the planks of vessels. See WOOD-BENDING.

India-rubber wheel-tires are used for the purpose of decreasing the jar on the vehicle, and as a means of increasing the tractive adherence.

In the Thomson road steamer a thick rubber tire, capable of yielding to the inequalities of the ground, and protected by an endless band of steel slats, is employed.

In 1852, a patent was granted to Marcus Davis in England, for forming locomotive tires of a soft material, covered with india-rubber protected by an exterior sheet of steel. In the same year Thomas Allan obtained a patent for encircling wheels with an outer tire of vulcanized india-rubber, solid or tubular, or other elastic substance. The advantages of this arrangement for road locomotives were particularly set forth. At the same time Mr. Dunlop patented a tire of annealed cast-iron, grooved to receive an india-rubber band. Various other patents followed, embracing india-rubber as a material to be used in constructing tires.

A source of trouble with continuous tires on wooden wheels is the shrinkage of the timber, particularly when green, rendering cutting and resetting the tires necessary. To obviate this it is recommended to use only seasoned timbers for the fellies, and soak them in boiling linseed-oil. See also TIRE-BENDER ; TIRE-SHRINKER.

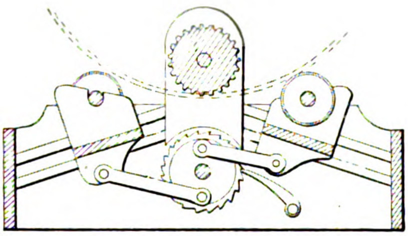
2. (*Railway.*) The rim of a driving-wheel, shrunk on to the other portion.

Tire′balle. (*Surgical.*) The bullet-forceps.

Tire-bend′er. A device for bending tires to a uniform circular curve.

That illustrated (Fig. 6471) has two lower rollers, which may be placed at various distances apart, in a bed-plate having semicircular grooves to receive their journals, and an upper roller journaled in a swing-frame, adjustable by a screw-thread-

Fig. 6472.

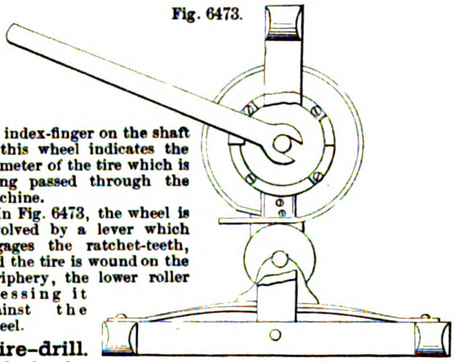


Gettemy's Tire-Bending and Shrinking Machine.

ed strap-rod. The rollers are adjusted to the curve of the particular tire to be formed, and are turned by levers or cranks, drawing the bar of metal between them.

In Fig. 6472, the journal-blocks of the end rollers slide in inclined guides, being actuated by links connecting them to crank-pins on the central ratchet-wheel, which is turned by a lever.

Fig. 6473.



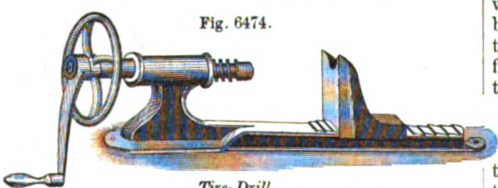
Ballow's Tire-Bending Machine.

An index-finger on the shaft of this wheel indicates the diameter of the tire which is being passed through the machine.

In Fig. 6473, the wheel is revolved by a lever which engages the ratchet-teeth, and the tire is wound on the periphery, the lower roller pressing it against the wheel.

Tire-drill. A device for drilling the bolt-holes in tires. It is secured to the bench, and has a ratchet-clamp for holding one side of the tire, the other being passed over a suitable post or stud. The drill-holder has a screw-thread on its periphery, works in a box, and is advanced by turning a crank.

Fig. 6474.



Tire-Drill.

Tire′fond. (*Surgical.*) An instrument used to elevate the piece of bone sawed off by the trephine.

Tire-heat′er. A furnace in which a tire is expanded by heat so as to tightly embrace the circle of fellies, or the rim of the wheel on which it shrinks in cooling.

In Fig. 6476, the tires are laid horizontally in an annular fire-space, and a cover containing escape-flues may be let down upon it to preserve the workmen from the heat and carry off the smoke.

In Fig. 6477, the tires are placed upon edge in the annular case, which is turned upon rollers above the fire.

Tire-meas′ur-er. An instrument for measuring the circumference of wheels and the length of the developed tires, invented by Wray of Springfield, Ohio, are shown in Fig. 6478. It differs from the ordinary tire-circle in having a supplementary hand *b* attached to the pointer *a*, which is fixed, while the hand *b*

Fig. 6475.

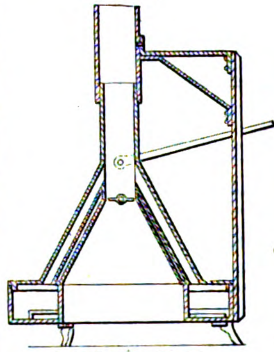
Tirefond.

may be set so as to allow for the desired lap in welding.

Tire-press. A machine for driving the wrought-iron or steel tire on to the rim of a driving-wheel.

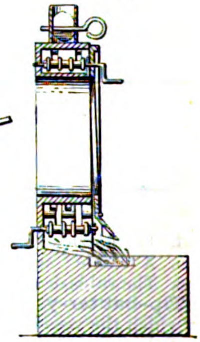
Fig. 6479 shows an application of the hydraulic press to this purpose. The tire is turned to a tight fit; the bars *a a* are fitted with slots or openings, that they may be brought nearer or put farther from the center, and the pieces *b b b b* can be changed for the larger wheels. There is an opening in the plate *c* to admit the axle, and by short temporary rails the wheels can be rolled into position.

Fig. 6476.



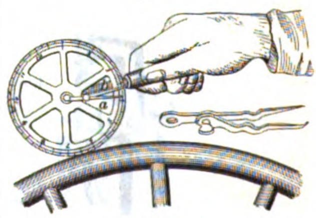
Stroud's Tire-Heater.

Fig. 6477.



Pierce's Tire-Heater.

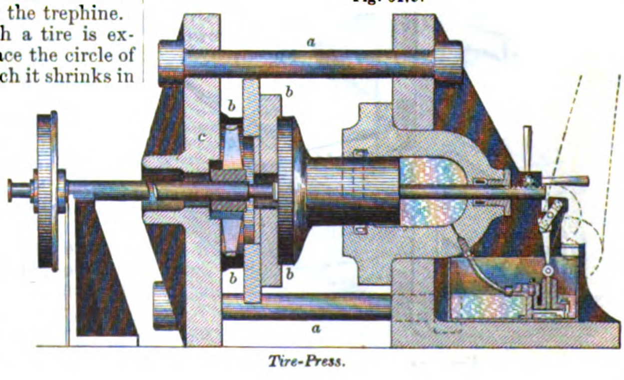
Fig. 6478.



Tire-Measurer.

Tire-roll′er. A form of rolling-mill for tires in which the rolls between which the work is performed are made to overhang their bearings and be movable from or to each other, so as to allow the endless tire to be introduced between them and the parts then brought together, so that the *pass* is complete.

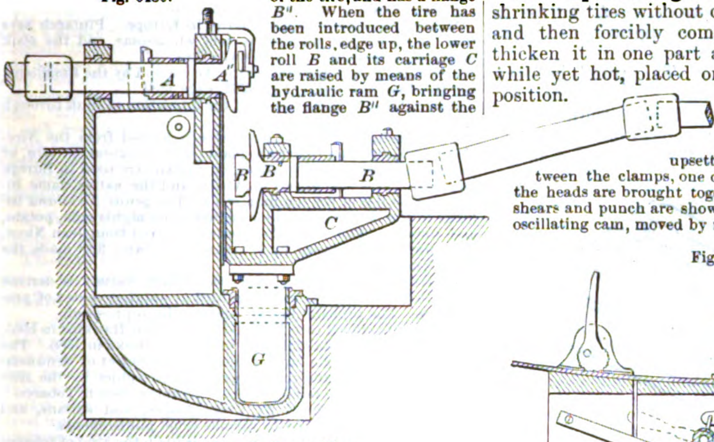
Fig. 6479.



Tire-Press.

The parts are shown open in the figure. *A* is the roll to operate on the inner side of the tire, and has a flange *A*″. *B* is the roll to operate on the outside of the tire, and has a flange *B*″. When the tire has been introduced between the rolls, edge up, the lower roll *B* and its carriage *C* are raised by means of the hydraulic ram *G*, bringing the flange *B*″ against the end of the roll, and the flange *A*″ against the end of the roll *B*, confining the tire, and bringing the required pressure to bear upon it.

Fig. 6480.

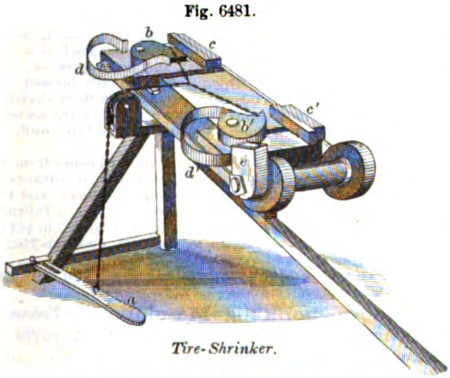


Vickers's Mill for Rolling Railway-Tires.

Tire-shrink′er. A device for shortening tires when they have become loose from the shrinkage of the wheel.

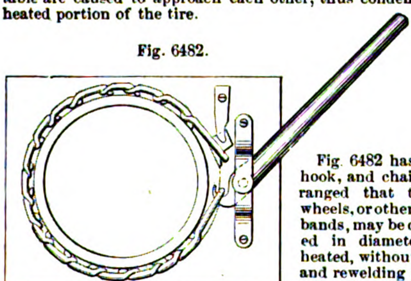
By depressing the treadle *a*, the cams *b b*′ are drawn away from the blocks *c c*′; the heated part of the tire is then inserted, and the treadle released, when the springs *d d*′ act to throw out the cams clamping the tire between them and the blocks. By depressing a lever, inserted in the socket *e*, the two ends of the table are caused to approach each other, thus condensing the heated portion of the tire.

Fig. 6481.



Tire-Shrinker.

Fig. 6482.



Weitman's Tire-Shrinker.

Fig. 6482 has a lever, hook, and chain so arranged that tires for wheels, or other metallic bands, may be contracted in diameter while heated, without cutting and rewelding them.

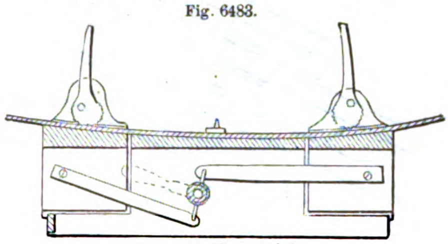
In Fig. 6483, the tire is clamped to the moving end blocks of the frame by corrugated cams, with its convex side resting upon the curved central plate. The end blocks are then approached, to reduce the tire in length.

Tire-tete. (*Surgical.*) An instrument for extracting the head of the fetus. A *crochet.*

Tire-up-set′ting Ma-chine′. A machine for shrinking tires without cutting. The tire is heated and then forcibly compressed endwise, so as to thicken it in one part and shorten it. It is then, while yet hot, placed on the wheel and shrunk in position.

Fig. 6484 is a machine for *upsetting*, *cutting*, and punching tires. The upper figure shows the upsetter; the heater tire is placed between the clamps, one of which is on a sliding head; as the heads are brought together the tire is shortened. The shears and punch are shown beneath, being operated by an oscillating cam, moved by rack, pinion, and lever.

Fig. 6483.



Jackson's Tire-Shrinker.

T-ir′on. A kind of angle-iron having a flat flange and a web like the letter T, by which it is called. See ANGLE-IRON.

Ti′sar. (*Glass.*) The fireplace at the side of and heating the *carquaise* or annealing arch of the plate-glass manufacture.

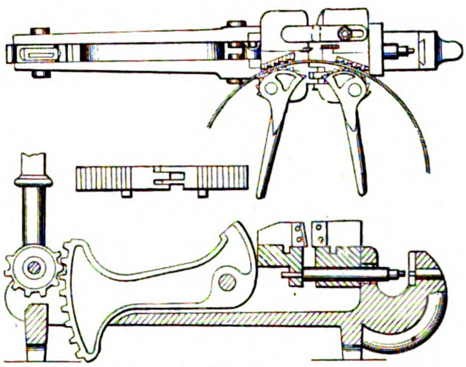
Tis′sue. (*Fabric.*) *a.* A very fine transparent silk stuff used for veils; white or colored.

It was formerly interwoven with gold or silver threads and embossed with figures.

"In their glittering *tissues* bear imblazed
Holy memorials." — MILTON.

"A robe of *tissue* stiff with golden wire." — DRYDEN.

Fig. 6484.



Machine for Upsetting, Punching, and Cutting Tires.

b. Cloth interwoven with gold.

Tis′sue-pa′per. A very thin gauze-like paper made of several sizes, and used for the protection of engravings, for wrapping fine and delicate articles.

Tracing paper is a good grade of tissue, rendered more transparent by treatment with oil or varnish.

Ti-ta′ni-um. Equivalent, 25; symbol, Ti.; fusible under the blow-pipe. Has a deep blue color, and is used in coloring porcelains and enamels. Discovered by Gregor in 1791. Its ore is called *menachanite*, from Menachan, in Cornwall, where it was first found.

Ti′tho-nom′e-ter. An instrument for noting the *tithonic* or chemical effect of the rays of light. See ACTINOMETER.

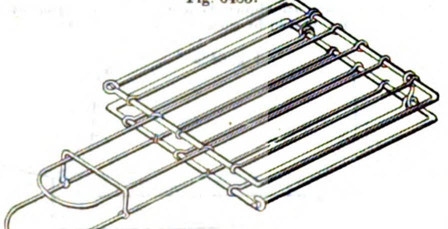
Ti-thon′o-type. (*Photography.*) A process in which a cast is obtained from an original phototype-plate.

Ti′tle. 1. (*Bookbinding.*) The panel between bands, used for the book's name.

2. (*Printing.*) *a.* The name of a book on the first page.

b. The *running-title* is at the head of a page, and consists of the name of the book or the subject of the page.

Fig. 6485.



Broiler or Toaster.

T-joint. The union of one pipe or plate rectangularly with another, resembling the letter **T**.

Toast′er. A fork or cage to bread or meat while toasting. Fig. 6485 is a toaster or broiler.

Toast′ing-fork. A three or four pronged fork to hold a slice of bread while toasting.

Toast-rack. A small rack of wire to hold toast on edge on the table.

Toat. The handle of a bench-plane.

To-bac′co. A plant indigenous to America, and used in various forms, — smoking, chewing, snuffing, — from the northwest coast to Patagonia.

The name is probably derived from *tabaco*, a forked tube through which the fumes were inhaled into the nostrils. The island of Tobago is said to have been so named by Colon from a supposed resemblance to this shape, — "Y." The Caribs are said to have called it *kohiha*. Roger Pane, the friar who accompanied Christopher Colon in his second voyage, gives it as *cogiaba*, its Hispaniolan name, otherwise spelt *cohiba*. It was known as *petun* in Brazil; *piecelt* in Mexico, or, according to other authorities, *yetl; yoli* in other places.

All the present modes of using the tobacco plant originated in America.

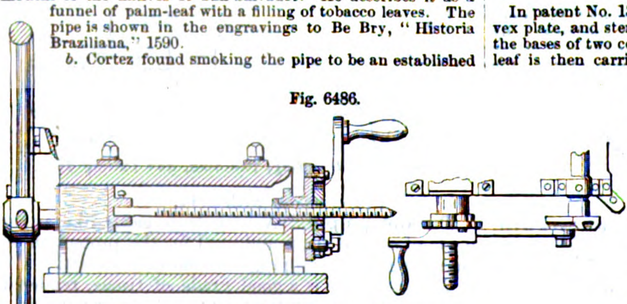
a. Columbus noticed that the natives of the West India islands used the leaves in rolls, — cigars. The Aztecs had cigar tubes, and also used nostril tubes of tortoise-shell for inhaling the smoke. The Mexicans and North American Indians used pipes.

Ovideo speaks in 1526 of the inhaling of the smoke through the forked nostril tube by the Indians of Hispaniola.

Lobel, in his "History of Plants," 1576, gives an engraving of a rolled tube of tobacco (a cigar) as seen by Colon in the mouths of the natives of San Salvador. He describes it as a funnel of palm-leaf with a filling of tobacco leaves. The pipe is shown in the engravings to Be Bry, "Historia Braziliana," 1590.

b. Cortez found smoking the pipe to be an established custom in Mexico. Bernal Diaz relates that Montezuma had his pipe brought in great state by the ladies of his court after he had dined, and washed his mouth with scented water.

Fig. 6486.



"Fine-Cut" Tobacco-Machine.

In the city of Mexico, tobacco-pipes of various forms and grotesque shapes are dug up from time to time.

"The mound-builders were inveterate smokers." — SQUIER; DAVIS.

c. When the Spaniards landed in Paraguay, in 1503, the chewing natives "spurted the juice toward them."

Pizarro found tobacco-chewers in Peru.

Masticatories were used anciently in Europe. Plutarch says that the chewing of mallows is very wholesome, and the stalk of asphodel very luscious. See also TEA.

d. Snuffing was practiced by the Aztecs and by the Brazilians. See Brazilian snuff-mill, Fig. 5262, page 2232.

Roger Pane, in 1494, speaks of the inhalation of snuff through tubes.

The principal tobacco of commerce is derived from the *Nicotiana tabacum*, the American plant; the *Nicotiana persica*, or Persian tobacco, and *N. rustica*, or Syrian, are used in Europe and Asia. It is also grown in Africa, and the native name indicates that it is of the common stock. The genus *Nicotiana* belongs to the *Solanaceæ*, which includes the nightshade, potato, and tomato. The name *Nicotiana* is derived from Jean Nicot, the minister of France in Portugal, 1660, who first made the plant known in France.

It has been conjectured that the Asiatic variety is derived from China, which has been regarded as another center of production. The probabilities are against the supposition.

It was introduced into England by Sir John Hawkins in 1565, and by Sir Walter Raleigh and Sir Francis Drake in 1586. The practice was made the butt of the wits, the object of denunciation by the clergy, and the subject of a pamphlet by the silly King James I., who published his "Counterblaste to Tobacco." Its use was condemned by kings, popes, and sultans, and smokers were condemned to various cruel punishments.

The manufacture of tobacco depends upon the kind of tobacco and the article required. Cigars are made of the best, which is grown on soils peculiarly adapted to produce the delicate flavor; a portion of the northwest of the island of Cuba is the best of all. The Connecticut Valley, some parts of Virginia, a few counties in Ohio and Kentucky, near Cincinnati and Maysville, respectively, are noted regions. Of the foreign regions we are not well informed: The *Manilla* and *Hungarian* are noted. Tobacco is packed in hogsheads for sale and shipment, and the different processes commence when it reaches the factory.

Chewing-tobacco is put up in ropes, plugs, knots, and various other forms. The shapes and flavors are matters of taste, and the latter becomes a fashion; comparatively little of the leaf is used in its natural state. Plug-tobacco is steamed to soften it, stemmed, bundled, dipped in a hot solution of licorice and molasses, sunned, dried, flavored, and then made up into bundles of the required weight, — pound, half-pound, or two-ounce, as the case may be. Each bundle is wrapped in a leaf; pressed in sheet-iron *shapes*; turned, and again pressed; then packed in boxes or tubs, in which they are finally pressed.

For smoking, the tobacco is granulated in a mill or shaved in a fine-cutting machine; stems are ground up with the leaves in the poorer qualities, but these are usually made into snuff.

See CIGAR; SNUFF; TOBACCO-PIPE; etc.

The culture of the poppy at Patna is under license from the English, the whole produce being contracted for in advance, at rates varying with the quality. It flowers in January and February, and the capsule is hacked by a serrated tool in February and March. The opium is rolled into balls, wrapped in poppy-petals, packed in chests, carried to Calcutta, and exported to poison the Chinese — and others.

It has been known to the Chinese only about two centuries, even as a medical prescription.

To-bac′co-book′ing Ma-chine′. (*Tobacco.*) A machine which arranges the smoothed leaves of tobacco into symmetrical piles.

In patent No. 133,420, the leaf is fed in upon a pointed convex plate, and stemmed by two shear-cutting disks attached to the bases of two conical rollers, one of which is adjustable. The leaf is then carried by an endless apron down around and pressed upon the booking-roller, which is suspended by the said elastic apron and held up against an adjustable roller. The apron is strained properly by a weighted concave roller. A suspended guard-plate insures the passage of the leaf to the booking-roller, and a knife-cleaner removes the gum from the cutting-disks. See also TOBACCO SHEETING-MACHINE.

To-bac′co-cur′ing. Done, in the first place, in sheds or tobacco-barns. The leaf is very succulent, and requires care and favorable weather. The fine flavor is developed in curing; mildew spoils it, and unfavorable conditions spot and discolor, impairing quality and appearance. Artificial heat is applied in some stages.

To-bac′co-cut′ter. 1. A machine for shaving tobacco-leaves into shreds for chewing or smoking:

the former is known as *fine-cut* in this country; the latter is the usual form of smoking-tobacco in Europe, where the granulated tobacco is (or was) not preferred.

Fig. 6486 is a *fine-cut* machine, in which the leaves are driven along a square trough by a plunger, which is moved by a screw, a certain distance between each cut of the knife.

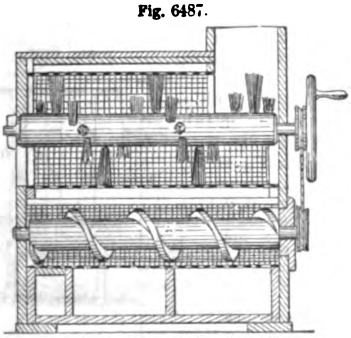
In Spencer's machine, patent 75,805, the stock is carried forward upon an endless apron, and compressed between the upper and lower cylindrical rollers and the inclined, smooth, metallic sides. The knives are carried in contact with an emery-wheel at each revolution. The emery-wheel rotates at high speed within a case which is filled with steam, and has a longitudinal aperture allowing the contact of the knives and wheel, and also the passage of steam to moisten the knives and prevent the accumulation of hard gum thereon.

2. A knife for cutting plug-tobacco into smaller pieces. See TOBACCO-KNIFE.

To-bac'co Gran'u-lat-ing-ma-chine'. A machine for grinding tobacco-leaves, to fit them for smoking or making into cigarettes.

Fig. 6487 is a machine to facilitate the manufacture of kinnikinick and cigarette tobacco. The tobacco-scraps from which such tobacco is manufactured are thrown into a hopper, whence they pass into the upper sieve, through which the tobacco which is broken up by the spiral brush is forced, while that portion which is not broken up is carried out at the end of the sieve, together with whatever pieces of wood and other hard substances may have been introduced with the scraps. The fine particles of tobacco and dust pass into and are separated by a lower sieve containing an agitating screw.

Fig. 6487.



Tobacco Granulating-Machine.

In patent No. 62,811, the circular closed box contains a sieve revolving by a crank above the box-lid. This sieve has triangular holes, and has teeth projecting upward between pins on the lower side of the cross-bar of the yielding head.

Patent No. 48,680 describes a corrugated beater-roller, which is made to revolve within a vibrating vessel whose sides are composed of wire-cloth on a mesh of like character, so that the tobacco is broken up and delivered in small pieces through the meshes of the wire-cloth into a box below.

Patent No. 133,136 has rotary shear-blades, spirally arranged, which work against stationary shear-blades, cutting the tobacco in shreds, after which a vibrating sieve separates the granulated from the uncut portion.

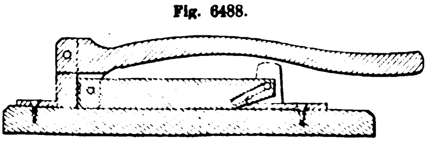
To-bac'co-grat'er. A machine for grinding tobacco into small pieces suitable for smoking in pipes.

In one form, the circular closed box contains a sieve revolving by a crank above the box-lid. This sieve has triangular holes, and has teeth projecting upward between pins on the lower side of the cross-bar of the yielding head.

See also TOBACCO-GRANULATING MACHINE.

To-bac'co-knife. A knife for cutting plug-tobacco into pieces convenient for the pocket. It is usually a sort of guillotine knife worked by a lever, and cutting downward on to a wooden bed.

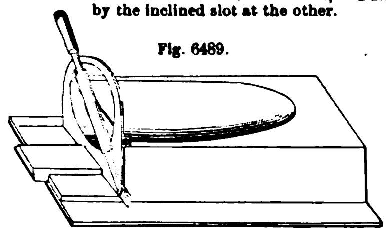
Fig. 6488.



Tobacco-Knife.

In the figure, the knife has a draw cut, being pivoted to the side arm of the lever at one end, and directed by the inclined slot at the other.

Fig. 6489.



Tobacco-Cutter.

2. Fig. 6489 is adapted for cutting leaf-tobacco for smoking.

To-bac'co-pack'ing Ma-chine'. One for making up tobacco into packages, or into shape for packing.

In patent No. 143,545, the material is fed into an endless band-carrying trough, passing under two rollers, which leave the tobacco of a uniform depth. Two knives or combs are pressed down into the tobacco. One holds back the layer of tobacco, the other divides and drives forward a charge, forces it beneath a plate, and leaves it there. A plunger now descends and pushes forward the charge of measured tobacco into a receiver, which has already been automatically provided with a sheet of printed foil and a wrapper from a printing-press arranged at one side. One set of folding-knives then folds one end of the package, which is repressed and completed in another receiver by an additional plunger and another set of folding-knives.

To-bac'co-pa'per. Paper made for envelopes for cigarettes, to avoid the flavor of burning cotton or linen. Corn-husk is better than either. Rice-paper is also used.

To-bac'co-pipe. The materials which have been employed for making pipes are numerous, from the primitive corn-cob, which is deservedly a favorite, up to the precious and highly ornamented meerschaum. The invention of the pipe, if of nothing else, must be conceded to the Indians. Ancient specimens, buried in the soil, have been found in most parts of North America. So highly was the pipe prized by them, that the red pipe-stone quarry of the Coteau des Prairies was esteemed a sort of sacred neutral ground, where men of all tribes and kindreds might unmolested supply themselves with the precious deposit.

Clay, in its various forms, still maintains a pre-eminence, and is used nearly all over the globe for making pipes, the commoner kinds varying in price from 50 cents to $ 1.20 per gross. Those of porcelain are manufactured in Germany, the finer kinds being ornamented by painting, which is in some cases of a very artistic order, commanding a high price.

Red-clay pipes, with wide mouths, are made in Turkey and Algeria. Some are ornamented by stamping, and others are gilded with arabesque designs. The stems are of cherry or jessamine, with amber mouth-pieces, and the whole affair is often elaborately ornamented.

The hookah, or nargileh, has a very large bowl, generally provided with a water-chamber, and may have several long flexible tubes, so as to accommodate a number of smokers at the same time.

These are made in Turkey and Algeria, and often have richly carved bowls of solid silver.

The so-called "brier-root" pipes should be, as their name imports, made from the root of the brier, which is peculiarly incombustible and enduring, but in fact many other species of wood are employed. These are manufactured in Germany and France, particularly in the latter country, where St. Claude, in the Jura, has a monopoly of the commoner kinds. The more expensive carved varieties are made in Paris, and sometimes have a lining of meerschaum.

MEERSCHAUM (which see) is found in Moravia and Spain, but the best is found in Asia Minor, which is the principal source of supply. In 1869, over 3,000 boxes of this material, valued at 345,000 florins, were imported into Trieste from Asia Minor. The manufacture and carving of meerschaum-pipes is principally carried on at Vienna and at Ruhla in Saxe-Cobourg-Gotha. The value of the product at these two places has been estimated at $ 2,000,000 annually. Large numbers are now made in France, conspicuous for the taste and elegance displayed in their carving. Those made of magnesite from the department De Gard are highly esteemed.

The bowls of meerschaums are prepared by first soaking in tallow, then in wax, and finally carving and polishing. Large quantities — it is said, about half of those now sold — are made from the waste. This is ground to a fine powder and boiled with linseed oil and alum, and when the mass is sufficiently cohesive it is cast in molds, carefully dried, carved, and polished, in the same manner as is the original material.

Amber, which has become so favorite a material for mouthpieces, was brought from the Baltic in the time of Herodotus, 450 B. C.

The ordinary clay tobacco-pipe — which, by the by, has so long a stem that it is called in the slang of the pothouse, a "yard of clay" — is made by hand by a series of processes. The clay is reduced to a plastic condition by pounding with a heavy wooden bar. A workman takes two lumps of clay, of the size of an average apple, and after kneading, rolls them on a table with the palms of his hands till they assume proximately the shape of a pipe, — two clay tadpoles with large heads and very long tails. These are placed in a row and are taken in hand by another workman, who takes a fine steel rod in his left hand, and seizing a "tadpole," draws its long slender tail on to the rod, the fine touch of the right-hand fingers indicating the position of the rod and preventing the protrusion of the wire on either side. The spitted "tadpole" is then laid in the lower half of the metallic pipe-mold; the upper part is then brought down and pressed.

The pipe, being removed, goes to the hands of the finisher, who with a sharp steel instrument smooths the rough clay about the bowl, and cuts away the fins or sharp edges of clay that entered in the parting crack of the mold. The stem is then smoothed and the mouthpiece cut even. The steel wire being withdrawn, the stem is blown through, to insure that it shall not be a "blind" passage.

Thence to the kiln. One set of hands will make 4½ gross per day.

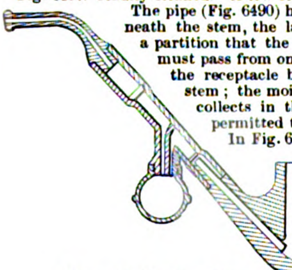
The pipes are baked in a peculiar kiln, being arranged in crucibles or seggars, each of which has six horizontal ledges running around its interior. Upon these ledges rest the bowls of the pipes, while the stems lean against the central pillar. The top is covered in with a dome, and the crucible contains about 50 gross.

Broseley, in Shropshire, on the banks of the Severn, has been for centuries a chief seat of the clay-pipe manufacture in England, pipes still extant bearing the date 1687, and the names of Richard Legg and John Legg on the bowls. Many of this family still follow the profession of pipe-makers in the quiet little old town. The collection of "broseleys" has been pursued by some ardent spirits with all the zeal which numismatists devote to their favorite subject, and the progressive alterations in form, and the various marks placed upon them by the old manufacturers, have been noted with a fidelity which might have brought renown to the observers had their talents been devoted to the examination of palæozoic remains.

The celebrated French Marshal Oudinot was a great collector of pipes; not by any means, however, of "broseleys," of which it is probable he never heard, but of rich and rare specimens.

Many devices have been contrived for collecting the oily matter, containing nicotine, by which pipes become fouled after being some time in use, and enabling them to be readily cleaned. A few of these are illustrated.

Fig. 6490.



Pipe with Nicotine Cup.

The pipe (Fig. 6490) has a receptacle for oil beneath the stem, the latter being so divided by a partition that the smoke from the tobacco must pass from one portion of the stem into the receptacle before again entering the stem; the moisture from the upper end collects in the receptacle and is not permitted to enter the bowl.

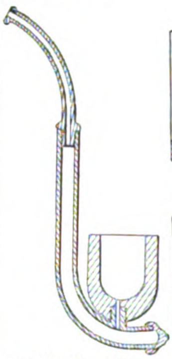
In Fig. 6491, the stem is a metallic tube; the lower part screws into the bottom of the bowl, and is provided with a cap; by unscrewing this and the mouthpiece, it may be cleansed.

To-bac'co-plug Ma-chine'. One for adjusting and compacting the leaves into layers of the required form and thickness.

In Fig. 6492, the tobacco is pressed between series of rollers into troughs running on flange-rollers. A large wheel rotating in a transverse direction shifts the troughs on to a series of rollers rotating in the opposite direction, by which they are carried back to the starting end. An inclined knife removes the tobacco from the troughs when sufficiently pressed.

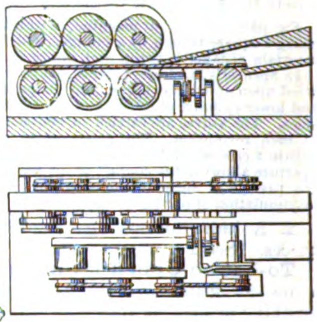
In patent No. 141,562, the tobacco-leaves are laid in a trough, which is placed between two adjustable guide-bars, the leaves resting upon a plate having slots, and beneath another plate having knives, which sink through the layer of tobacco into the said slots, dividing it into plugs. A traversing roller, having shoulders to rest upon the sides of the box, gives the desired

Fig. 6491.



Metallic-Stem Pipe.

Fig. 6492.



Plug-Tobacco Machine.

pressure, being placed in vertically movable bearings in a horizontally moving carriage.

See also patent No. 92,462.

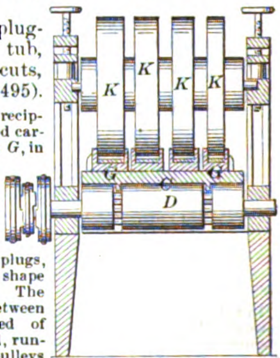
To-bac'co-press. These are of several kinds:

1. For pressing granulated tobacco into bags, pockets, or boxes, for convenience of package.

2. For pressing plug-tobacco into shape; the leaves, having been booked and wrapped, are pressed flat, so as to lie compactly in the box or tub (Figs. 6493, 6494).

3. For pressing plug-tobacco in the box or tub, to compact the rolls, cuts, plugs, or twists (Fig. 6495).

Fig. 6493.



Plug-Tobacco Press.

In Fig. 6493, the bed *C* reciprocates on the roller *D*, and carries the removable troughs *G*, in which the tobacco is laid to be pressed into the shape of flat plugs by passing under the rollers *K K*.

Fig. 6494 is for making up the leaf-tobacco into plugs, which are pressed into shape and cut off to a length. The sheeted tobacco is fed between revolving aprons, formed of transverse strips of wood, running over corrugated pulleys and slides. A piercer is automatically forced into the plug end at the time it is cut by a guillotine-knife. The rest is then tilted, which raises the edge of the tobacco for removal. The counting is done by revolving numbered disks operated by the main shaft.

Fig. 6495 is for packing boxes or tubs. The box receives a charge of tobacco and a follower at each stroke of the reciprocating plunger; the wad is delivered at the open bottom of the trunk, being pressed by the frictional contact with the sides thereof. The trunk has clamp-bands, and either of two trunks may be brought in connection with the plunger.

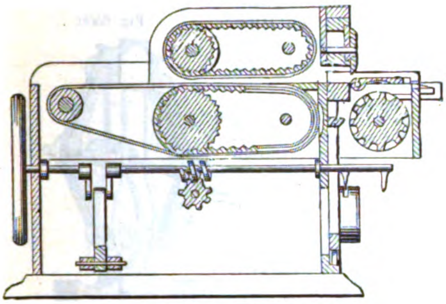
To-bac'co-roll'ing Ma-chine'. One for rolling into shape a bundle of leaves to form a filling for a cigar. See patent No. 103,255.

To-bac'co-sheet'ing Ma-chine'. Sheeting tobacco consists in laying the leaves out smoothly in sheets. This is done by passing the leaves between rollers which flatten them, devices acting in concert with the rollers to draw out the wrinkles. Sometimes the shape of the rollers has this effect; revolving brushes are used, acting obliquely to the direction of motion of the leaf.

In sheeting tobacco it is sometimes laid in symmetrical piles known as *books*: the operation being known as *sheeting* and *booking*. Tobacco is also *sheeted* and *stripped*, the operation laying the broad portions of the leaf flat, and separating them from or flattening the stem, as the case may be.

Such a machine is one (United States patent, No. 137,170) in which the elastic portion of the rolls presses the leaf without

Fig. 6494.



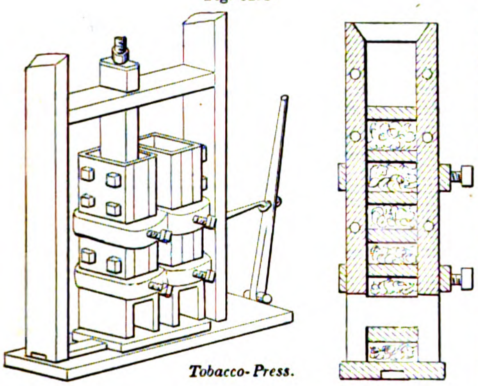
Plug-Tobacco Pressing-Machine.

injury to it, while a middle metallic portion flattens the stem. The stem is afterward sheared off.

See also TOBACCO-STRIPPING MACHINE; TOBACCO-BOOKING MACHINE.

Another application of the sheeting-machine is in laying the leaves in layers to form flat plugs; or in laying them of an

Fig. 6495.



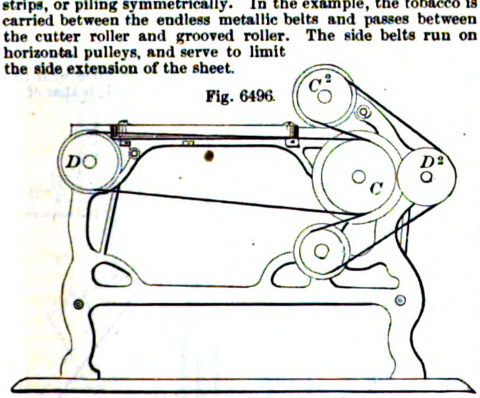
Tobacco-Press.

even thickness to be carried to a device which makes them up into twists or twisted plugs.

Another form of tobacco-sheeting machine smooths the leaf, and then cuts it into strips for cigar-wrappers. Such is Fig 6496.

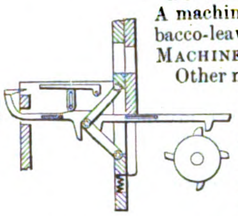
It smooths out tobacco-leaves into flat sheets for cutting into strips, or piling symmetrically. In the example, the tobacco is carried between the endless metallic belts and passes between the cutter roller and grooved roller. The side belts run on horizontal pulleys, and serve to limit the side extension of the sheet.

Fig. 6496.



Tobacco Sheeting and Pressing Machine.

The tobacco-leaves are fed in at the left of the machine, as shown; are carried along past the guide-edge *L*, and pass between the endless metallic belts which run over the rollers *C D* and C^2 D^2 respectively. These belts consist of endless parallel brass ribbons, and the roller *C* has circular knives which cut the leaves into strips for cigar-wrappers.



To-bac′co-stem′ming Ma-chine′. A machine for removing the stems of tobacco-leaves. See TOBACCO-STRIPPING MACHINE.

Other machines depend upon crushing the stem. See also patent No. 68,597, machine for breaking stems of tobacco.

To-bac′co-stop′per. A little plug for condensing the burning tobacco in the bowl of the pipe.

To-bac′co-strip′ping Ma-chine′. (*Tobacco.*) A machine for tearing or cutting out the main stems or stalks of tobacco-leaves. Also called *stemming.*

In patent No. 145,699, the tobacco-leaf is fed between two rollers having cutting-disks to remove the stems; then passes along, carried by two pairs of endless belts between four other pairs of rollers, when revolving brushes or scrapers loosen the leaf, and it passes on to a fan which automatically deposits the two portions of the stripped leaf in piles.

In patent No. 156,608, the strippers are pivoted upon the frame, and their long arms are connected by a screw, whereby the inner edges of the scrapers may be adjusted to the rolls at will, and held with a yielding pressure.

In patent No. 146,540, the leaves are fed to the separating-cutters, and are delivered upon one side of the machine by means of a pair of endless bands, so arranged over their rolls that when the leaves are divested of their stems they are pressed and smoothed.

In patent No. 141,563, the leaves are passed between rollers having alternate flat and concave surfaces to crush the stems; then between another pair of rollers having knives and brushes, whereby the flattened stems are cut into narrow strips, and the leaf is brushed. Guides prevent the leaf from adhering to the pressing-rollers, and scrapers clean the cutting-rollers.

See also patent No. 122,816, and Fig. 6496.

To-bac′co-wheel. A machine by which leaves of tobacco are twisted into a cord. It resembles the hay-band machine, or machine for twisting hempen yarns.

To′bine. A stout twilled silk.

Tod-stove. (*Qu.* from *tod*, a branch or bush.) A box-stove adapted for burning small and round wood, brush, limbs, and the like.

A six-plate stove for bar-rooms and country stores.

Toe. 1. (*Machinery.*) *a.* The lower end of a vertical shaft, as a mill-spindle, which rests in a *step*, or *ink*.

b. An arm on the valve-lifting rod of a steam-engine. A cam or lifter strikes the toe and operates the valve; such toes are known respectively as *steam-toes* and *exhaust-toes.*

2. A projection from the foot-piece of an object, to give it a broader bearing and greater stability.

3. A barb, stud, or projection, on a lock-bolt.

Toe-calk. A prong or barb on the toe of a horse's shoe, to prevent slipping on ice or frozen ground.

Toed. (*Carpentry.*) A brace, strut, or stay is said to be *toed* when it is secured by nails driven in obliquely and attaching it to the beam, sill, or joist.

Tog′gle. 1. (*Nautical.*) A short wooden pin, or double cone of wood, firmly fixed in a loop at the end of a rope. By passing the toggle through the eye or bight of another rope, a junction is easily formed and quickly disengaged. It is useful in bending flags for signals, or it is attached to the end of a line to afford a firm hold for the fingers, as in the gunner's lanyard. It is also used in flensing whales, in which a hole is cut in the blubber, the eye of a purchase-strap being passed through and toggled.

Fig. 6497.

Toggle.

2. (*Machinery.*) Two rods or plates, hinged together, and employed to transmit a varying force by lateral pressure upon the hinge, which is called the *knuckle*, or knee,

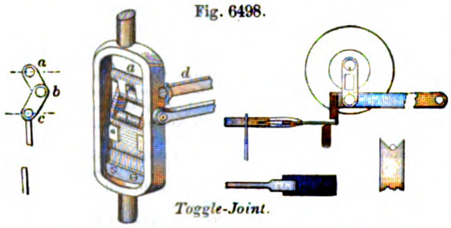
form obvious analogies. See TOGGLE-JOINT; TOGGLE-PRESS.

Tog′gle-joint. An elbow-joint. A joint formed by two pieces articulating endways, as the human knee. It is much used in presses: the Stanhope printing-press, and some hay-presses, are instances. See HAY-PRESS, and many other instances under Presses. See list of Presses, page 1784. See also TOGGLE-PRESS.

Fig. 6498 illustrates the toggle-joint, frequently used in place of the screw, in presses.

The two parts *a c* are jointed together at *b*. The part *a* is jointed to the upper part of the press, and *c* to the upper end of

Fig. 6498.



Toggle-Joint.

the follower. When the links *a c* form an angle with each other, the follower is in raised position, but when straightened, by depressing a lever *d* connected to the point *b* by a crank-arm, they operate with great power to depress the follower.

Tog′gle-press. One in which the platen is moved by the flexion or extension of two bars which unite to form a knee-joint.

This form of press has especial value for many purposes, as the motion of the platen is more rapid at the time when the toggle-bars are starting from the point of their greatest flexion, and, as they straighten out, the power increases and rate diminishes as the point of ultimate pressure on the bale is approached.

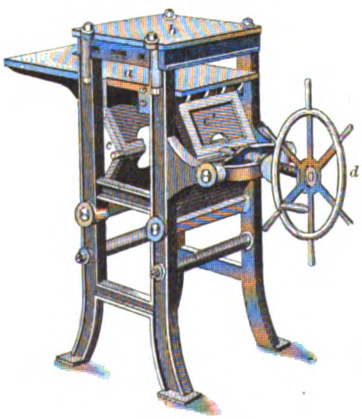
1. (*Printing.*) *a.* A form of press which succeeded the screw used universally until late in the eighteenth century.

One of the most familiar forms of this order of presses is to be found in the Stanhope printing-press, in which the platen is depressed by a toggle and raised by springs. The movement is variously known as a *knuckle*, *knee*, or *elbow* movement. See STANHOPE PRINTING-PRESS, page 1796.

b. A press for making electrotype molds from forms of type.

The platen *a* has a projecting table upon which the form and mold are adjusted to each other, and being pushed beneath the fixed head *b* the platen is raised and the impression made by two pairs of toggle-jointed leaves *c c′* operated by a screw and crank wheel *d*.

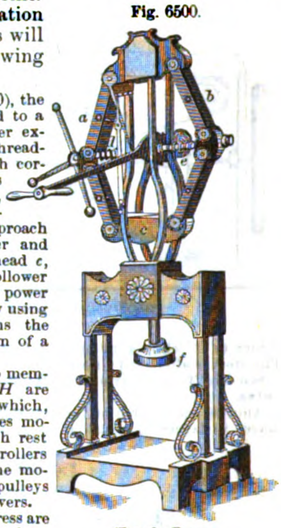
Fig. 6499.



Toggle-Press.

2. (*Baling.*) A cotton or hay press operating by the action of a toggle-joint. The mode of presentation of the toggle varies, as will be seen in the following examples: —

Fig. 6500.



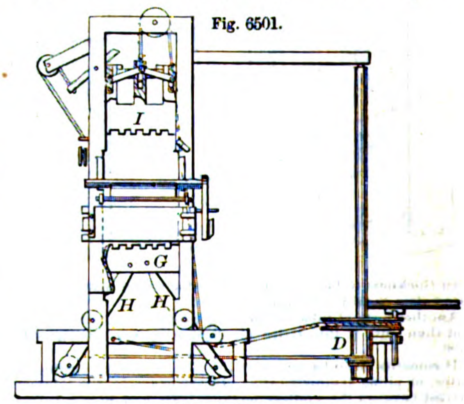
Toggle-Press.

In that shown (Fig. 6500), the two toggles *a b* are pivoted to a cross-head *c* at their lower extremities; two oppositely threaded screws *d e* work through corresponding hollow screws at the joints of the toggles, and are turned by a hand-wheel, causing them to approach or recede from each other and raise or lower the cross-head *c*, to which the stem of the follower *f* is connected. If greater power be desired, it is obtained by using the lever *g*, which turns the screws through the medium of a pawl and ratchet-wheel.

In another form, the two members of the toggle *H H* are knuckled into the follower, which, in the illustration, receives motion from two levers which rest by their moving fulcrum rollers on a horizontal beam. The motive cord is passed around pulleys in the lower ends of the levers.

The conditions of this press are the inversion of those of the last. In the former, power on the knee separated the hip and ankle, if the parallel may be allowed, as it may; in the latter case (Fig 6501), the hip and ankle are

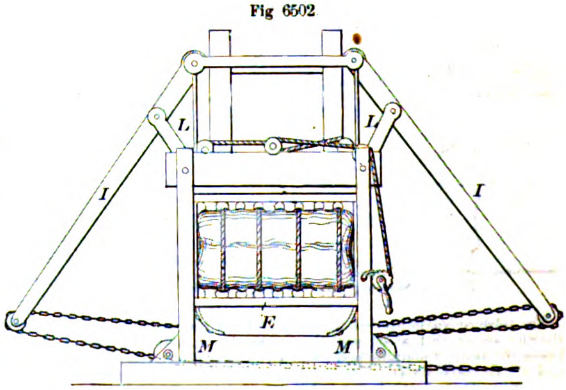
Fig. 6501.



Toggle-Press.

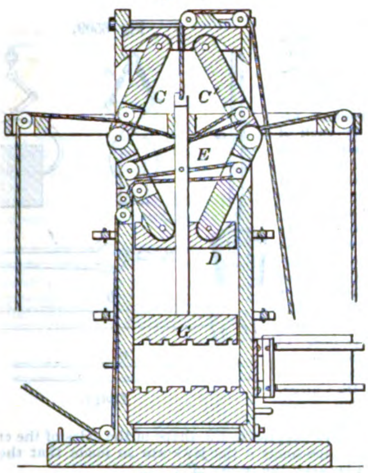
drawn together by the rope and pulleys, and the knee with its follower *G* is elevated. The illustration, Fig. 6501, is that of a

Fig 6502.



Overhead Toggle-Press.

Fig. 6503.



Toggle-Press.

beater-press, in which the upper weighted follower *I* is dropped repeatedly upon the stuff in the box, until a certain degree of compactness is attained. Then, the follower *I* being locked in its down position, the bale receives its ultimate pressure from the ascending follower *G*, operated by the toggle *H H*, through the medium of pulleys *c*, rope, and winding-shaft *D*. See also BEATER-PRESS; BALING-PRESS.

In another form (Fig. 6502), the platen *E* is raised by suspension rods *M M* dependent from the ends of levers *I I* which are constituted toggles by means of the rolling fulcrums *L L* which are hinged to the frame. They are operated by chains which pass around rollers at their lower ends and others in the frame.

In Fig. 6503, the toggle-levers *C C'* are operated by cords serving to depress the slide *D* to which the platen-rod *E* is attached. The follower *G* has a long stem *E*, by means of which it may be raised when used as a beater. When the beating operation has progressed as far as desirable, the platen-rod *E* is attached to the slide *D* by a pin, and the toggles are brought into requisition to complete the baling.

In still another form (Fig. 6504), the toggle is double acting, pressing upon two followers *a a* which act within their respective boxes. The action is simultaneous in the boxes. Each toggle consists of a main beam *b* and a rolling fulcrum *c*; the adjacent ends of the beams *b b* are simultaneously depressed by the rope which is rove through the pulleys on the levers and the standard *d* respectively.

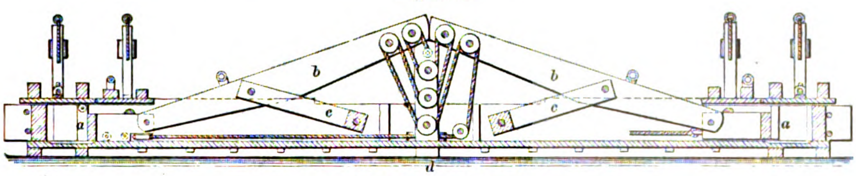
Toi-li-net′. (*Fabric.*) *a.* A kind of German quilting.

b. A fabric of silk and cotton warp and woolen weft.

To′ken. 1. (*Mining.*) A piece of leather with a distinct mark for each hewer, one of which he sends up with each corf or tube.

2. (*Printing.*) *a.* Ten and a half quires, or 250 sheets, of paper printed on both sides.

Fig. 6504.



Double-Headed Toggle-Press.

b. In some cases, ten quires of paper.

3. A coined medal or piece of metal, intended for currency and issued by a private party.

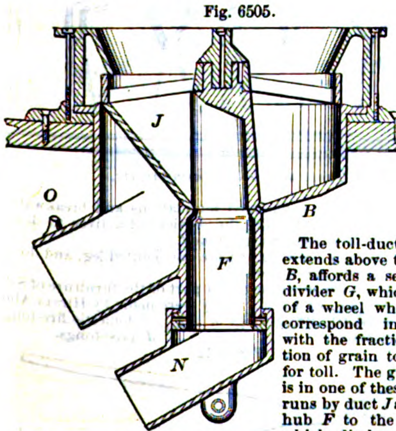
To′ken-sheet. (*Printing.*) The last sheet of a token.

Toll-bar. A gate or bar placed across a road to stop animals and vehicles till toll be paid.

Toll-col-lect′or. 1. A counter at a turnstile or gate to indicate the number of persons passing. See TURNSTILE.

2. A device attached to the feed of a grain-mill to subtract the toll.

Fig. 6505.



Toll-Collector for Grist-Mills.

The toll-duct *F*, which extends above the bottom *B*, affords a seat for the divider *G*, which consists of a wheel whose spokes correspond in number with the fraction or portion of grain to be taken for toll. The grain which is in one of these divisions runs by duct *J* and hollow hub *F* to the chute *N*, which discharges it separately from the remainder of the grain, which passes by spout *O* to the stones. There are several other forms.

Toll-dish. A vessel of given capacity for taking the toll or proportion of grain ground on shares. A *toll-hop*.

Toll-gate. A turnpike gate at which toll is collected.

Toll-house. The residence of the toll-taker at a turnpike-gate.

Tom′a-hawk. An Indian hatchet.

Fig. 6506.

Tomahawk.

Indians are supplied with tomahawks by the governments and traders with whom they deal, and their tastes are ministered unto in the attachment of a pipe to the poll. A hole is drilled through the bottom of the bowl and the poll of the axe, to meet one passing through the length of the handle. A heavy, clumsy pipe and a light, effective little axe. A combination of tastes, — blood and smoke.

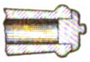
Tom′bak; Tom′bac. (Malay, *Tambaga*, copper.) An East Indian alloy for cheap jewelry. Copper, 16; tin, 1; zinc, 1. Red tombak: copper, 11; zinc, 1. Arsenic is added to make *white tombak*.

There are a number of other varieties, the constituents and proportions of some of which are given: —

	Copper.	Zinc.	Lead.	Tin.
Tombak for making gilt articles	82	18	1.5	3
Tombak for making gilt articles	82	18	3	1
Tombak for making gilt articles	82.3	17.5	..	0.2
French tombak for sword-handles, etc.	80	17	..	3
Yellow tombak of Paris, for gilt ornaments	85.3	14.7	..	..
Tombak for the same purpose, from Hanover	86	14	..	..
Tombak of the Okar, near Goslar, in the Hartz	85	15	..	Trace.
Chrysochalk	90	7.9	1.6	..
Red tombak, from Paris	92	8	..	..
Red tombak, from Vienna	97.8	2.2	..	..

Tom'pi-on. (From a French word meaning a plug or stopper.) 1. (*Ordnance.*) *a.* A plug fitted to the bore of a gun at the muzzle, to protect it from injury by the weather.

Fig. 6507.



Tompion.

b. The iron bottom of a charge of grape-shot.

2. (*Lithography.*) The inking-pad of the lithographic printer. *Tompon.*

3. (*Music.*) The plug in a flute or organ-pipe, which is adjusted toward or from the mouth-piece to modulate the tone.

The pitch of the note is determined by the length of the pipe beyond the mouth-piece, and the tompion of the organ pipe allows this distance to be regulated to tune the pipe. The stopping of an organ pipe by a *tompion* lowers the pitch one octave; in effect doubling the length of the pipe. See PIPE; PITCH.

Tom'pon. The inking-pad of the lithographic printer.

Tom-tom. The form of *kettle-drum* used by the Chinese, Hindoos, and Cingalese. The bowl is of sonorous bronze, and the head is of parchment. It is usually beaten by the hand, and resembles the *darabooka* of ancient and modern Egypt, which is in use under allied names throughout the Arabic tribes. The *tom-tom* is, however, placed on the ground, while the *darabooka* has a handle by which it is grasped by the *left* hand, being played by the *right* hand. The *darabooka* is thus a connecting link between the *drum* proper and the *tambourine.* It is perhaps more generally called *tam-tam.*

The *tom-tom* is the original kettle-drum, and in some shape is found among most nations, savage and comparatively civilized.

Ton. In America the usual ton is 2,000 pounds avoirdupois, — 20 cwt. of 100 pounds each.

In the Eastern States, 2,240 pounds — 20 cwt. of 112 pounds each — is usual with coal, and perhaps some other things. This is the *long ton.*

The mining ton of Cornwall is 21 cwt. of 112 lbs. Tin is sold in Cornwall by the 1,000 lbs.

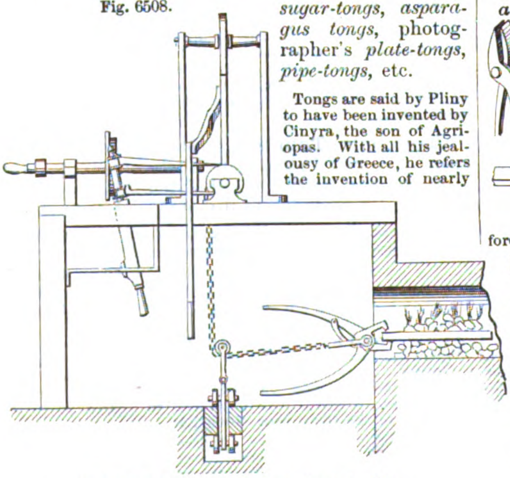
Toned Pa'per. Tinted paper. The glaring white taken off by a creamy tint.

Tong. The catch to a buckle. See TONGUE.

Tong-kang. (*Nautical.*) A Malay or Chinese boat of a certain kind.

Tongs. A tool consisting of two parts joined by a pivot, and used for grasping objects; generally those that are hot, as *blacksmith's tongs* (*h*, Fig. 6511), *crucible-tongs*, and *fire-tongs*: the term is not confined to such, however; e. g. *sugar-tongs, asparagus tongs*, photographer's *plate-tongs*, *pipe-tongs*, etc.

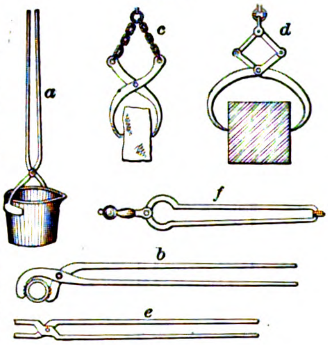
Fig. 6508.



Apparatus for Drawing Iron from the Fire.

Tongs are said by Pliny to have been invented by Cinyra, the son of Agriopas. With all his jealousy of Greece, he refers the invention of nearly all the known tools of his time to the Greeks, with an occasional notice of a protest being entered by the Egyptians and Phœnicians. The latter will seem very reasonable to us who read of the progress attained by each of these nations as recorded in Scripture history, and on the monuments of the former.

Fig. 6509.



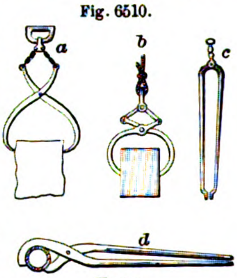
Tongs.

The ancient fire-irons were the *fire-fork*, two-pronged; *fir-scovel* (Anglo-Saxon) or *fire-sholve* of the sixteenth century; and *Fyr-tang* of the Anglo-Saxons; the *tenalea, tenecula*, of Du Cange.

Crucible tongs (*a*, Fig. 6509) have curved plates adapted to the shape of the sides of the crucible.

In the pipe-tongs *b* the jaws are so made that the pipe is grasped between the recess of one jaw and the end of the other. The leverage on the short jaw makes a very tight pinch. See Figs. 3747-49, 3753.

Fig. 6510.



Tongs.

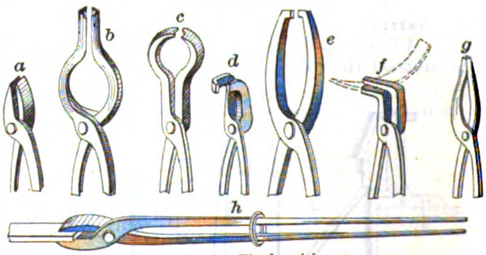
Similar in construction is the clasp which engages the staple on the top of a monkey, the latter being released to fall on the head of a pile when the tongs are opened (*B*, Fig. 3717).

Fig. 6508 shows an arrangement of apparatus for drawing iron from the fire. The windlass has a pulley and transversely movable support secured in the floor. Its object is to operate tongs to draw heated iron from the furnace. See also a CLUTCH for suspending tackle, Fig. 1351, page 578.

A familiar illustration of lifting-tongs is the ice-tongs (*c*, Fig. 6509), which are large iron nippers closed by drawing upon a chain attached to both handles.

On a larger scale substantially the same device *d* is used for lifting stones, etc., the pull on the shackle connecting the two links, drawing together the upper ends of the arms and closing the points on the object to be lifted. They loose their hold upon the stone as soon as it is placed in position, and are therefore useful in laying submerged foundations and breakwaters, as the *lewis* would require the services of a diver to detach it. See LAZY-TONGS; SNAP-DRAGON.

Fig. 6511.



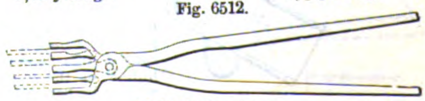
Tongs used by Blacksmiths, etc.

The ordinary fire-tongs *f* have one jointed leg, and do not require special description.

Fire-tongs are mentioned as a part of the furniture of Solomon's Temple, 1004 B. C. They were made by Hiram Abiff.

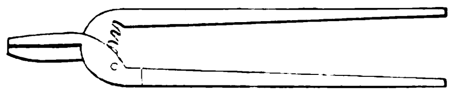
a (Fig. 6510), lifting-tongs or *dog.* *c*, domestic fire-tongs.
b, lazy-tongs. *d*, pipe-tongs.

Fig. 6512.



Multiple-Jaw Tongs.

Fig. 6513.



Adjustable-Jaw Tongs.

Fig. 6511 shows various forms of tongs used by blacksmiths.

a, h, flat-bit tongs; the jaws are flat, and a ring or coupler is placed upon the handles or *reins* to maintain the grip upon the work.

b, angular-bit tongs; useful for holding round or square bars, and also bolts, the heads being placed within the swell of the jaws.

c, pincer tongs; for similar uses.

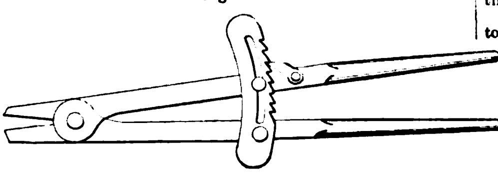
d, crook-bit tongs; used by cutlers, etc.

e, hammer tongs; for handling work punched with holes.

f, hoop-tongs: for holding hoops or rings.

g, smith's pliers; for grasping light work.

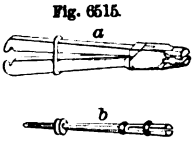
Fig. 6514.



Tongs with Ratchet-Rein.

Fig. 6512 is a tongs for grasping several objects simultaneously. The two outer tongs are rigid to the arms, and the central tongues are pivoted so as to oscillate freely in the plane of movement of the outer ones.

Fig. 6515.



Tongs used by Watch-makers, etc.

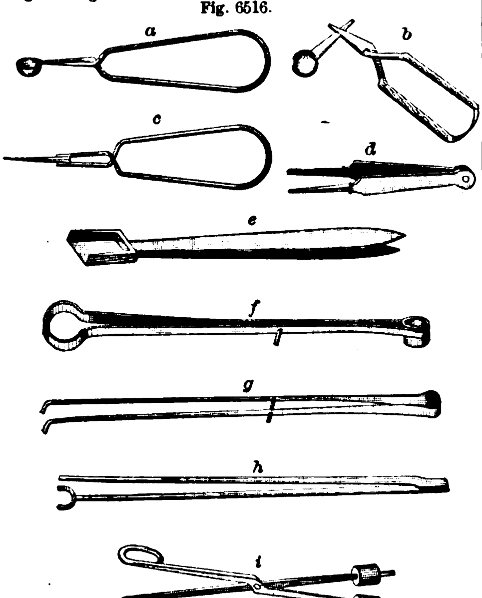
Fig. 6513 is adjustable by the engagement of the pintle which is fast to one jaw with either one of several notches in the other jaw, so as to vary its capacity for grasping.

Fig. 6514 has a ratchet and pawl on the respective handles, which are a substitute for the *coupler* or sliding ring.

a b (Fig. 6515), pin-tongs, closed by a ferrule sliding on the stem, used for holding small wires to be filed, and for various manipulations. *b* is also used as a drill-stock in connection with the bow-drill.

In Fig. 6516 are illustrated a variety of laboratory and metallurgical tongs.

Fig. 6516.



Laboratory Tongs.

a b, spring-steel tongs for holding platinum cups or spoons in a flame.

c, spring-steel tongs with platinum points, for use with blow-pipe, etc.

d, brass tongs, with fine points.

e, iron tongs, with spoon handle.

f g, cupel tongs, of elastic iron, for moving cupels into or out of the muffle.

h, scorifier tongs, for lifting scorifiers or cupels and arranging them in the muffle.

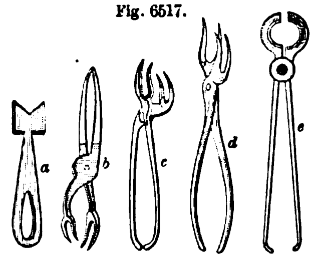
i, iron tongs mounted with cork, for lifting hot flasks.

Fig. 6517 shows tongs, etc., used in the bottling of soda-water and other effervescent beverages.

a is a tying lever for champagne bottling.

b c d, bottling-tongs.

Fig. 6517.



Bottling Pliers and Tongs.

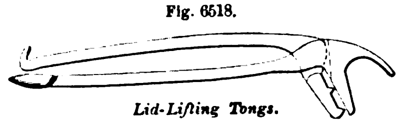
e, siphon-tongs for holding head of siphon-bottles.

Fig. 6518 is a tongs for lifting stove-lids.

Tongue. 1. (*Vehicle.*) The single shaft or pole which, in two-horse vehicles, is attached to the fore-carriage, and is the means of guiding and drawing.

The tongue or pole was the universal appendage to ancient vehicles. Horses, cattle, or asses were yoked to the tongue. When traces were used, in the case of horses, there was only

Fig. 6518.

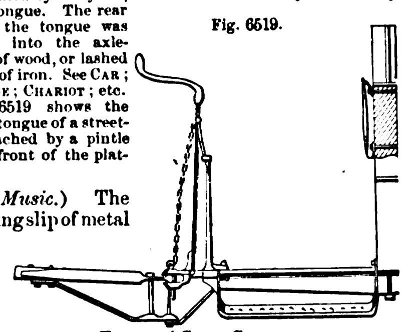


Lid-Lifting Tongs.

one to each animal, and that on the side next to the tongue. They pulled by the yoke, which was fastened by a vertical pin to the tongue. The rear end of the tongue was tenoned into the axle-tree, if of wood, or lashed to it, if of iron. See CAR; CARRIAGE; CHARIOT; etc.

Fig. 6519 shows the jointed tongue of a street-car, attached by a pintle to the front of the platform.

Fig. 6519.



Tongue of Street-Car.

2. (*Music.*) The vibrating slip of metal in a metallic frame, giving a musical tone in an accordeon, concertina, melodeon, parlor-organ, etc. See FREE REED.

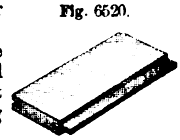
3. The pin in a buckle which pierces and holds the strap.

Buckles and brooches (*fibulæ*) with movable tongues were common in Rome. See BUCKLE.

4. (*Railroading.*) The short movable rail of a switch, by which the wheels are directed to one or the other lines of rail. See SWITCH.

5. (*Carpentry.*) *a.* A fin on the edge of a plate or board, adapted to fit into a groove of an adjacent board. Also used in sliding parts of machinery.

Fig. 6520.



Tongue and Groove.

b. The tapering, projecting end of a timber, worked down to fay upon an edge, or scarf to another timber.

6. (*Nautical.*) *a.* The upper main piece of a built mast.

b. A rope spliced into the upper part of a standing back-stay.

7. The clapper of a bell.

8. The movable arm of a bevel, the principal member being the *stock*, which forms the case when the instrument is closed. See BEVEL.

9. The pointer of a balance.

Tongue-and-groove Joint. A mode of joining wooden stuff in which a long fin on the edge of one board is made to fit into a corresponding groove on the edge of the other board. See JOINT; also Fig. 6520.

Tongue-bit. (*Manege.*) One having a stiff *mouth*, to which is attached a plate or shield so placed as to prevent the horse getting his tongue over the mouth-piece.

Fig. 6521.

Tongue-Chains.

Tongue-chains. The chains by which the fore end of the tongue is supported from the hames of the *wheel-horses.* They may be distended by the *spreader-stick.*

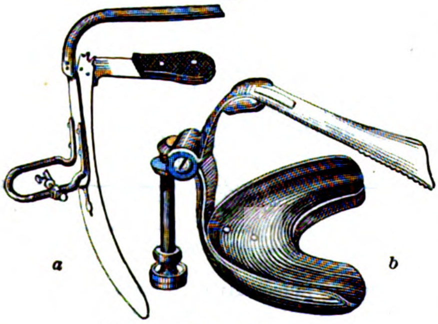
Tongue-com-press'or. A clamp for holding down the tongue during dental operations on the lower jaw. The sublingual and maxillary ducts may be at the same time closed, by applying to them rolls of bibulous paper before applying the compress. See TONGUE-SPATULA.

Tongued-chis'el. A boring-chisel which has a long, downwardly projecting blade, and shoulders which form reamers.

Tongue-de-press'or. (*Surgical.*) An instrument which has a socket to go beneath the lower jaw and form a fulcrum for the pivoted spatula which rests upon and holds down the tongue during oral, laryngeal, and esophageal examinations and operations. A *tongue-spatula.*

***a*, the Elsburg pattern.**
***b*, Church's self-holding tongue-spatula.**

Fig. 6522.



Tiemann's Tongue-Spatulas.

Tongue-spat'u-la. See TONGUE-DEPRESSOR.

Tongue-sup-port'. A device on the tongue-hounds of a wagon to keep the forward end of the tongue elevated and prevent its weight bearing on the necks of the horses.

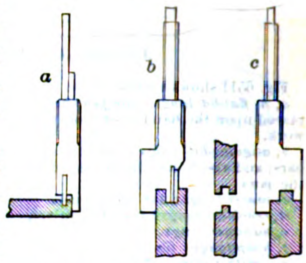
In the example (Fig. 6524), it is a bar, the middle of which rests upon the coupling-rod, and its ends beneath the fore-axle and tongue respectively.

Tongue-test. 1. (*Electricity.*) A test familiar to electricians, determined by the application of a wire to the tongue, which gives a sensation, sharp or otherwise, according to the condition of the line.

2. (*Engraving.*) A test of pyroligneous or nitric acid, used in determining the strength of an etching solution.

Tongu'ing and Groov'ing Planes. (*Carpentry.*) Planes in pairs, adapted for forming tongues and the corresponding grooves into which they are received on the edges of boards, etc.

Fig. 6523.

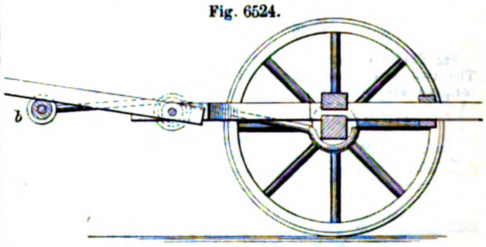


Tonguing and Grooving Planes.

The tonguing-plane *c* has a recessed bit which cuts away two strips at the sides of the plank, leaving the central part, which forms the tongue, untouched. The grooving-plane *a b* has a narrow bit, which forms a channel in the wood. The stocks of both have a ledge projecting below the sole, which serves to determine the distance of the tongue or the groove from the edge of the board. Each is provided with bits of different sizes.

Ton'ing. (*Photography.*) The treatment of a positive photographic print with a weak solution of gold, in conjunction with other modifying chemical salts, by which the whole or a portion of the deposit of metallic silver is replaced by metallic gold in fine division. The effect is to give permanency to the print, subduing and modifying the disagreeable color, and substituting various shades of purple, black, blue, brown, and gray.

Fig. 6524.



Tongue-Support.

Ton'nage. (*Nautical.*) The carrying capacity of a vessel. It is actually equivalent to the difference between the weight of the water displaced by the vessel when light, and that displaced by her when loaded to the greatest safe depth of immersion.

Different rules for calculating the tonnage have been legally established in different countries, some of which have frequently given results varying widely from the true amount which might be safely carried. In deep, full-built ships the actual capacity was always largely in excess of the government-registered tonnage. More recent laws have, in a great degree, remedied this error, but it is extremely difficult, if not impossible, to contrive any general rule by which perfect exactness can be attained.

The rule established by law in the United States, under the Act of 1799, and which continued in force until superseded by that given in the law of May 6, 1864, provided that from the extreme length of the vessel there should be deducted three fifths of the breadth; the remainder was multiplied by the breadth, and the product by the depth, which, in the case of a double-decked vessel, was arbitrarily assumed as being equal to one half the breadth; the latter product was then divided by 95, and the quotient was taken as the legal tonnage on which tonnage dues were to be paid. It was thus made the interest of owners to build excessively deep ships, the law in this way discriminating in favor of clumsy, slow, and inefficient ships, and discouraging attempts at improvements in model.

By the Act of May 6, 1864, vessels are, for the purpose of ascertaining their tonnage, divided into six classes, according to length, those in each class being divided into a certain number of equal parts, or transverse sections, to which different values are assigned in computing the total tonnage of the vessel; the actual depths between decks are measured and taken as factors, and any closed-in space on or above the upper deck, and capable of receiving cargo, etc., is included in the measurement. The dimensions are all taken in feet and decimals of a foot, and the number 100 is used as the final division for ascer-

taining the capacity of the ship in tons, instead of 95, as in the old law.

Class 1. Vessels under 50 feet long, divided into 6 equal parts.
Class 2. Vessels 50 to 100 feet long, divided into 8 equal parts.
Class 3. Vessels 100 to 150 feet long, divided into 10 equal parts.
Class 4. Vessels 150 to 200 feet long, divided into 12 equal parts.
Class 5. Vessels 200 to 250 feet long, divided into 14 equal parts.
Class 6. Vessels over 250 feet long, divided into 16 equal parts.

The details for making the measurements and calculations are too long to be inserted here, but may be found in "Revised Statutes of the United States," 1875, pages 803-806.

The rule adopted in England by the Merchant Shipping Act of 1854 is essentially the same as that established in this country; the measurements are made in feet and decimals, and the principles of calculation are identical. Vessels are divided as follows: —

Not exceeding 50 feet in length, into 4 parts.
Not exceeding 120 feet in length, into 6 parts.
Not exceeding 180 feet in length, into 8 parts.
Not exceeding 225 feet in length, into 10 parts.
Over 225 feet in length, into 12 parts.

In steam-vessels the length, breadth, and hight of the engine-room are multiplied together, the product divided by 100, and the result deducted from the gross tonnage. The space occupied by a propeller-shaft is considered as a part of the engine-room.

It should seem that the American method, employing, as it does, a greater number of divisions for the same length, should be slightly more accurate than the English, or afford at least, on the average, a somewhat nearer approximation to the true capacity of a vessel; either, however, may be relied on generally as coming within 4 or 5 per cent of the truth. This difference may, in extreme cases, amount to 10 or 12 per cent, a trifling error as compared with those incident to the old system.

The ton measurement upon which freight is charged is calculated at 40 cubic feet; the difference between that and the ton of 100 cubic feet, or that of the register, represents the dead weight or displacement of the ship when light, or 60 per cent of the whole, 40 per cent only being available flotative power for cargo.

To-nom'e-ter. An instrument, invented by Scheibler, for determining the exact number of vibrations per second which produce a given tone, and for tuning musical instruments.

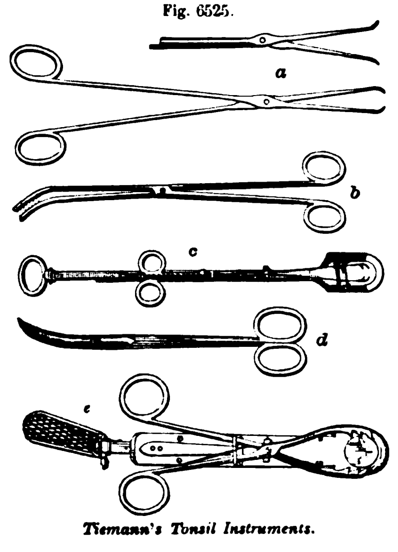
It consists of a set of 65 tuning-forks, any two consecutive ones of which differ in pitch by 4 vibrations per second. The lowest of the series makes 256 vibrations, and the highest 512, completing an octave. To determine the pitch of a given string its note is compared with those of the diapasons above and below it in sound. By counting the resulting beats it will soon be referred to a place between some two of the series, and by comparing the number of beats with each of these two successively, its exact place will readily be inferred. In tuning a string to a given pitch an analogous process is pursued.

An instrument of this kind, invented by the late S. D. Tillman, for illustrating visibly the theory of musical scale and of musical temperament, is described in "Barnard's Report, French Exposition," pages 471-478.

The auditory capacity of the human ear appears to range over about 12 octaves; the gravest audible note representing about 15 vibrations, and the most acute 48,000 per second. This capacity varies in different individuals, some ears being sensible to more acute sounds than others. Incapacity for hearing certain sound vibrations is termed *pitch deafness*. There is reason for supposing that persons whose ears are sensitive to very acute sounds are least able to hear very grave notes, and *vice versa*.

The auditory range of many animals is doubtless very different from that of man. Many persons are insensible to the scream of the bat; it is too acute, but the sound must be perfectly audible to the bat itself. Assuming this animal to have an auditory range of 12 octaves, and that its scream stands midway of the scale, it would be capable of hearing notes 6 octaves higher than those audible to man, — extending up to 2,500,000 vibrations per second. Whales appear to be able to communicate with each other at great distances, and it has been inferred that these animals have the power of emitting sounds too grave to be audible to the human ear, but perfectly distinct to them. See also SONOMETER.

Fig. 6525.



Tiemann's Tonsil Instruments.

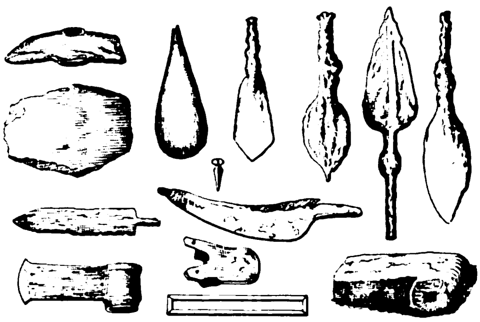
Ton-sil'o-tome. (*Surgical.*) A knife for operations on the tonsils; follicles situated between the pillars of the *velum palati* and projecting into the isthmus of the throat.

a, tenaculum forceps for seizing. *Vulsellum.*
b, Musseux's seizing forceps.
c, Billings' tonsilotome.
d, tonsil-scissors, curved on the flat.
e, Hamilton's tonsilotome.

Tool. 1. An implement adapted to be used by one person, and depending for its effect upon the strength and skill of the operator; or, as defined by Webster, "any instrument of manual operation." It is, however, exceeding difficult to define the line separating tools from machines, and of late it has become usual to embrace in the general term *machine tools*, such machines as the *lathe*, *planer*, *slotting-machine*, and others employed in the manufacture of machinery. See MACHINE.

Fig. 6526 represents a number of bronze and stone tools taken from the excavations of the buried cities of Mesopotamia. They

Fig. 6526.



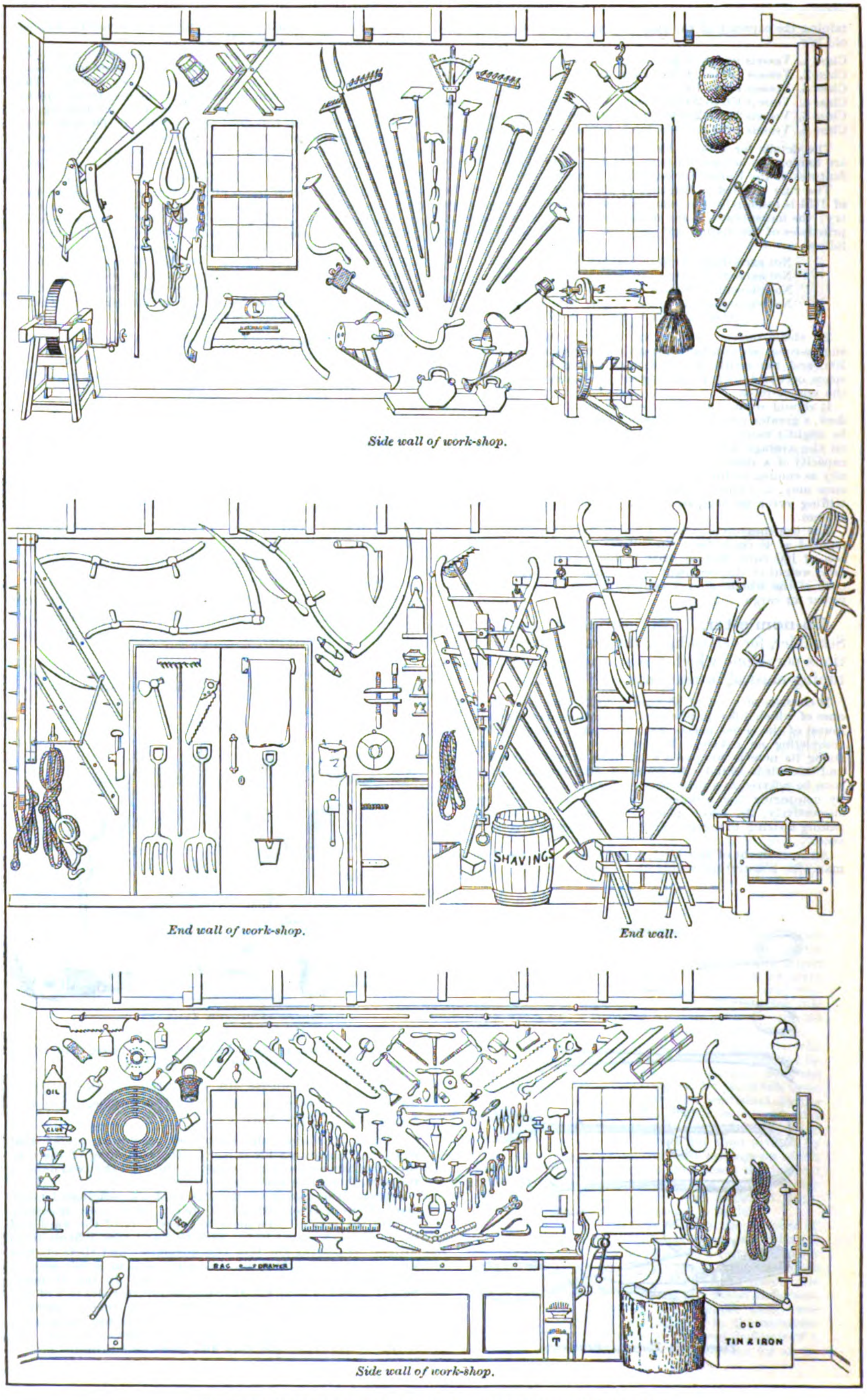
Chaldean Tools.

are knives, spears, a sickle, hatchets, and a piece, evidently a hinge of a door. See *b c*, Fig. 2510, page 1104.

Plate LXX. shows an arrangement of farming-tools on the ends and sides of a tool-house. See also STONE-WORKER'S TOOLS.

William Fairbairn, the celebrated machinist, states that when he commenced his career, at the beginning of the century, the human hand performed all the work that was done in the way of building machinery.

Bramah, the maker of the Patent Lock, originated many descriptions of labor-saving machinery. He found it necessary to give the greatest exactness to every part of the ward and key of this celebrated lock. This he found very difficult to do without employing the very best workmen; and their charges were so exorbitant, that his invention was in a fair way of dropping out of use on account of expense. In this dilemma, he was forced to turn his attention to the introduction of machinery to produce with unerring nicety the different parts of the complicated little apparatus with which his name is yet associated. The workshop in which the many ingenious contrivances to perform this work with speed were invented may be



Side wall of work-shop.

End wall of work-shop.

End wall.

Side wall of work-shop.

ARRANGEMENT OF TOOLS IN A FARMER'S TOOL-HOUSE

PLATE LXX.

See page 2591.

said to have been the training-school for the early machinists, whose labors have, within the present century, built up the mechanical greatness of England. Accuracy of machine-work before his day was utterly unknown. Watt had the greatest difficulty in getting his first model of the steam-engine constructed with sufficient truth to work; its cylinder was not bored, but hammered, and the piston could not be made to fit. The pumping-engine made a tremendous noise, and much astonished the spectators, who regarded it as one of the most remarkable and interesting parts of the performance. Watt knew better, and would have loved a noiseless machine, but was so beset by open condemnation, faint praise, and legal botheration, that he kept his own counsel, and let the vulgar stare and wonder.

The invention of the famous fixed slide-rest by Maudslay, the journeyman, who learned his trade with Bramah, was the first step in a series of inventions leading toward the same end. Maudslay was the man who executed, from the drawings of the elder Brunel, the series of labor-saving machines at present at work in Portsmouth Dockyard for the manufacture of ships' blocks. (See BLOCK-MAKING MACHINE.) These ingenious machines, forty-six in number, were, only a few years ago, the curiosities of the place, and may be, for aught we know, yet. They were the first ever set up in a public yard, and, although they have been at work for sixty years, they remain still in good working order. Maudslay afterward, in conjunction with his partner Field, founded in Lambeth Marsh the famous firm which is still carried on under their names.

Clements was another inventor who learned his art in the school of Bramah, and afterward worked for Maudslay and Field. This ingenious machinist invented the planing-machine, without which no perfect plane can be made. The value of such a machine is incalculable. Indeed, upon the truth of the plane depends the whole value of modern machinery. Of old, by chipping and filing, an attempt to approach the plane was made, but of course perfect accuracy was out of the question.

Another pupil of Maudslay was Nasmyth, the inventor of the STEAM-HAMMER (which see).

Joseph Whitworth, the inventor of the gun bearing that name, improved on Clements's planing-machine (see PLANING-MACHINE) in his "Jim Crow" planer, and also invented many ingenious and useful tools and appliances now commonly used in the workshop. See list of METAL-WORKING TOOLS, pages 1425, 1426.

The following general classification of tools, according to their functions and modes of action, has been proposed by a writer in the "Scientific American":—

1. Geometrical tools, for laying off and testing work, as squares, gages, compasses, drawing and surveying instruments, etc.
2. Percussion tools; as the hammer, etc.
3. Compression tools; for pressing, rolling, polishing, etc.
4. Puncturing tools; needles, awls, punches, etc.
5. Cutting tools, including saws.
6. Combined percussion and cutting tools; as the axe, hoe, and scythe.
7. Combined compression and cutting tools; such as planes, shears, etc.
8. Abrading tools; as whetstones, and also that class of drills which act by abrasion.
9. Forming tools; molds for casting, formers for sheet-metal, dies, etc.
10. Motor tools; as the lever, screw, pulley, and in general those employed to impart motion to other tools, to cause a blast, as bellows, and for like purposes.
11. Holding tools; which employ adhesion or compression for supporting in a fixed position materials to be operated on by other tools. This embraces vises, lathe-chucks, and vessels for containing liquids.
12. Separating tools, as sieves, filters, fanning-machines.
13. Directing tools, used as guides for other tools; such as the miter-box, for guiding the saw in cutting miters: funnels for directing the flow of liquids are included in this class.
14. Weighing-tools; scales, balances, and instruments for determining specific gravity.
15. Implements for measuring solid contents; measures of all kinds used for determining the volume of solids and liquids.
16. Agitators; for mixing different substances, or agitating the particles of the same substance among each other.

Fig. 6527.

Combination-Tool.

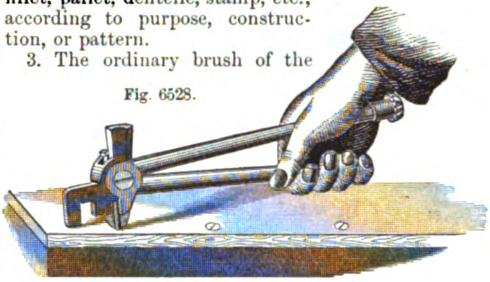
Fig. 6527 is a combined monkey-wrench and claw-hammer. A nut may be grasped between the fixed and movable jaws *a b*, the latter of which is operated by the screw. By unloosing a screw at the back of the handle, the wrench part may be removed, if desired to have it out of the way.

Fig. 6528 combines a hammer, nail-drawer, forceps, wrench, etc.

2. (*Bookbinding.*) The stamping and letter appliances of the finisher. Known as hand, hand-letter, lettering, roller, edge, fillet, pallet, dentelle, stamp, etc., according to purpose, construction, or pattern.

3. The ordinary brush of the painter, consisting of bundles of bristles tied by string or binding wire to the thick end of a cleft handle.

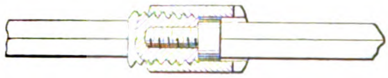
Fig. 6528.



Combined Tool.

The larger sizes are, however, more commonly known by their ordinary name of brush, the term *tool* being generally restricted to smaller sizes, as *sash-tools*, etc.

Fig. 6529.



Coupling-Tool for Drilling.

Tool-car. (*Railway.*) A car carrying an equipment for repairing, replacing on the rails, or removing débris in case of accident. It is a car that railway-men are always glad to have stand idle. It is furnished with cables, ropes, and blocks of various sizes. Jack-screws and crow-bars, picks and shovels, axes, spikes, replacing frogs, vise and set of machinist's tools, and numerous unmentioned appliances.

Tool-coup'ling. A screw coupling by which a drill, for instance, is connected to the bar, rod, haft, or whatever the handle may be properly called in a given case.

In Fig. 6529, the reduced end of a shaft is screwed into the enlarged end of another shaft, the former having a collar upon it just back of a screw, and the outer surface of the latter having a thread cut upon it. A sleeve surrounds the two ends thus screwed together, and is screwed upon the external screw of the latter shaft until an internal flange at the opposite end is forced up against the collar on the former.

Tooled Ash'lar. (*Masonry.*) Ashlar with its face chisel-dressed into parallel ridges and hollows.

Tool-ex-tract'or. An implement for recovering from drilled holes broken tools or portions of rods which may have become disconnected and fallen to the bottom. Two kinds are shown under GRAB, page 1000. Others are shown under WELL-BORING TOOLS; and ARTESIAN-WELL, Fig. 384.

Fig. 6530.

Tool-Extractor.

Fig. 6531.

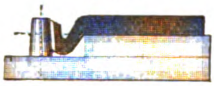
Tool-Extractor for Wells.

In Fig. 6530, the ratchet-rods catch the tool, and the action of raising presses the rods inward.

Fig. 6531 has a hollow die or screw-socket which taps its way on to the end of a rod in the hole,

and thus becomes attached to it, so as to enable its withdrawal.

Fig. 6532.

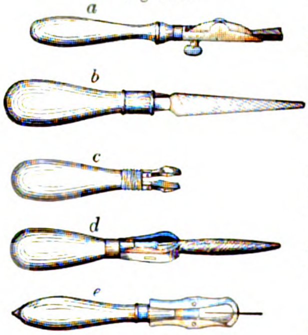


Nasmyth's Tool-Gage.

Tool–gage. Nasmyth's tool-gage, for testing the angularity of the cutting-face of iron-turning tools, has a bed for the shank of the cutter and a conical frustum whose sides have the angle required; say about 3° from the perpendicular.

Tool–hold'er. 1. A tool-handle.

Fig. 6533.



Hand-Tool Holders.

Fig. 6533 shows a number of holders having jaws which are opened and closed by an expanding plug or a screw.

a, patent lever file-handle.

b, patent adjustable self-centering file-handle.

c, the same with ferrule removed.

d, patent adjustable tool-holder.

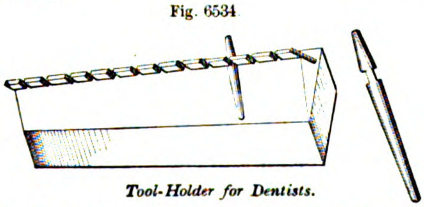
e, patent hand-vise.

See also PORTE-AIGUILLE; PORTE-POLISHER; etc.

2. A tool-tray.

Fig. 6534 is a tool-holder for dentists. The tool is detached from its handle by the engagement of a flattened portion with a notch in the tool-rack; this retains it in proper presentation for future attachment to the handle.

Fig. 6534.

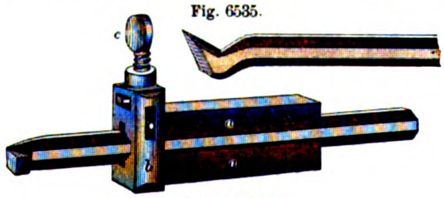


Tool-Holder for Dentists.

3. (*Lathe.*) A device for holding lathe-cutters and similar tools firmly.

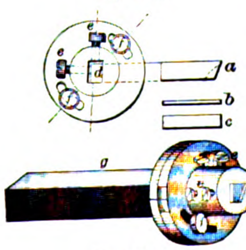
The two pieces *a a'* pass through the slot in the tool-post, the lower one being fast to the jaws *b*, and the upper one having movement in the jaws to accommodate itself to the size of the tool-shank, and being secured by the thumb-screw *c*. See also TOOL-POST; SLIDE-REST; LATHE.

Fig. 6535.



Lathe Tool-Holder.

Fig. 6536.



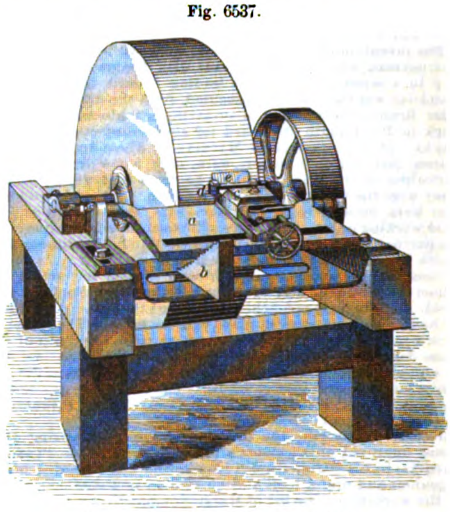
Tool-Holder.

Fig 6536 illustrates Holtzapffel's holder for carrying small rectangular blades used for cutting screw-threads: these are alike in hight *a*, but vary in width *b c*, this being half the pitch of the thread; they are inserted in the mortise *d*, and secured by four set-screws *e e*: the screws *f f* passing through circular slots permit the blades to be set to the particular angle of the thread. *g* is a perspective view of the holder with the tool in position. The list might be increased indefinitely; these are but samples.

4. (*Grinding.*) A device for accurately facing grindstones, and for uniformly holding tools while being ground.

The pivoted plate *a* is adjusted to any required angle by means of the wedge-shaped block *b*, and carries a tool-holder *c*, by which the adjustment of the scraper *d* or a tool to be ground is effected, and it is held firmly while dressing the stone.

Fig. 6537.

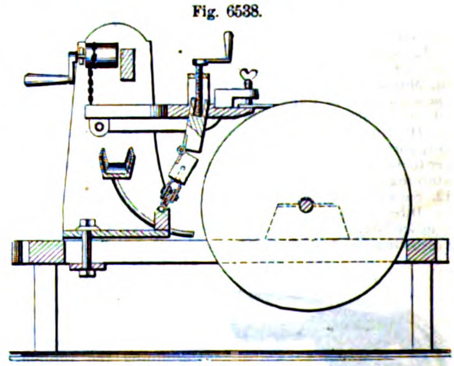


Tool-Holder and Grindstone-Dresser.

The tool-holder has a guide fitting a slot in the pivoted plate, so that it may be moved truly parallel to the face of the stone. A fender-plate *e* prevents the scattering of the particles scraped off.

In Fig. 6538, the tool to be ground is secured in the front end of the shoe, by the movement of which on the horizontal rod the tool is drawn across the periphery of the grindstone. Provision is made for raising and lowering the front end of the shoe to adapt the device to the work in hand.

Fig. 6538.



Tool-Holder for Grindstones.

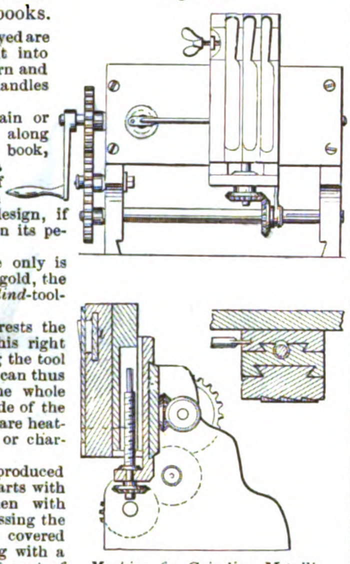
In Fig. 6539, a series of clamping jaws hold the articles to be ground. A quick automatic motion is imparted to the holder transversely to the grinding surface of the stone. An intermittent forward motion is given to the holder by means of an arm on the latter placing in and out of gear a bevel-wheel actuating a screw which works in a nut in the holder.

Tool'ing. 1. (*Masonry.*) Stone-dressing in which the face shows the parallel marks of the tool in symmetrical order.

2. (*Carving.*) Elaborate carving by chisels and gouges in stone or wood in architecture, joinery, cabinet-work, and furniture.

3. (*Bookbinding.*) Ornamental gilding or embossing by heated tools upon the leather binding of books.

Fig. 6539.



Machine for Grinding Metallic Articles.

The tools employed are brass stamps, cut into the desired pattern and mounted in handles (Fig. 6540).

Long lines, plain or figured, running along the sides of the book, are formed by a circular disk of brass, rotating in a handle, the design, if any, being cut on its periphery.

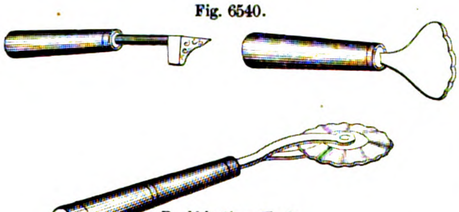
When pressure only is applied, without gold, the work is termed *blind*-tooling.

The workman rests the handle against his right shoulder, holding the tool near the axis; he can thus run the tool the whole length of each side of the cover. The tools are heated at a gas-stove or charcoal-furnace.

Gold-tooling is produced by covering the parts with albumen and then with gold-leaf, and pressing the hot tool on the covered parts. On wiping with a hot rag only that part of the gold-leaf is left which was in contact with the hot tool.

Lettering is done by means of brass letters, of different sizes, set up in a wooden handle. The words in most common use are often made in one piece, as shown in Fig. 6541.

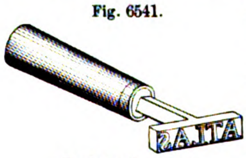
Fig. 6540.



Bookbinding Tools.

When the ornaments, lettering, etc. are complete, the book is polished by rubbing with heated irons of various shapes and sizes; one of these is shown in Fig. 6542.

Fig. 6541.

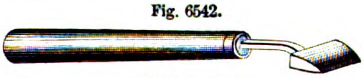


Bookbinding Tool.

Tool-post. (*Lathe.*) A device on the upper part of a slide-rest by which the cutter is held.

In that shown (Fig. 6543), the end of the tool is inserted in the beveled slot and fixed at the required angle for cutting by the binding-screw *a*; it may be released or readjusted by a very slight movement of this screw.

Fig. 6542.



Polishing-Tool.

Tool-rest. (*Lathe.*) The portion of a lathe to which the tool is attached, and which has usually several adjustments; longitudinally and transversely of the shears, and vertically. See SLIDE-REST, Figs. 5188, 5189; SLIDE-LATHE, Fig. 5187.

In Fig. 6544, the segmental rest is oscillated in the poppet-block to incline the tool, by a screw which engages its intaglio screw-rack.

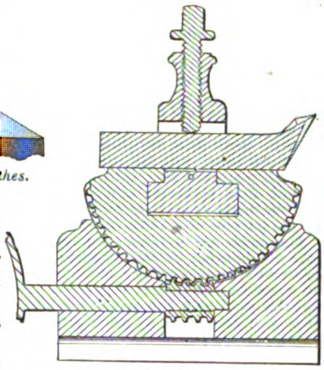
Tool-stack. A *tool-post* or *tool-holder*.

Tool-stay. (*Turning.*) The stay is fitted in the lathe-rest, and its slot affords a holder for a drill or internal cutting-tool.

Fig. 6543.

Tool-Post for Lathes.

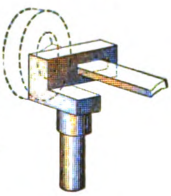
Fig. 6544.



Lathe Tool-Rest.

Tooth. In a mechanical sense, a term applied to a projecting lug, whose duty is to tear, crumble, cut, or to mash with the object to which it is applied. For instance: the teeth on the cylinder of a *grain-thrasher*, a *corn-sheller*, an *apple-grinder*, on a *harrow* or *clod-crusher*, on a *saw* or *file*, or on a *cog-wheel*. The character of a *tine*, or *prong*, is that of piercing, as in the familiar instance of the *tines* of a fork; as we say, a *two-tined* or *two-pronged* fork.

Fig. 6545.



Tool-Stay.

The tooth of a wheel is better called a *cog*.

Specifically: 1. A small, narrow, projecting piece, usually one of a set; as,

2. The tooth of a comb, a saw, a file, a card, a rake. See SAW-TOOTH, etc.

3. A *cog* of a wheel.

4. A *tine* or *prong* of a fork.

Tooth, Ar-ti-fi'cial.

Hippocrates, about 400 B. C., refers to instruments for the extraction of teeth, and cites a mode of fixing them by gold wire. They were probably natural teeth artificially inserted.

Celsus, about the Christian era, refers to filling carious teeth with lead and other materials. Soon after this we read of false teeth of bone and ivory.

Aetius, in the fourth century, describes the filling of carious teeth.

Martial, in one of his epigrams, attributes the whiteness of Lecania's teeth to the fact of her wearing those of some other person.

Mr. Welding of Philadelphia states that he has seen a tooth which had been plugged with gold taken from the alveolus of an Alexandrine mummy.

Blagrave's "Mathematical Jewell," published in the time of Queen Elizabeth, tells us that "Sir John Blagrave caused his teeth to be all drawne out, and after had a set of ivory in agayne."

In Ben Jonson's "Silent Woman," published in 1607, one of the characters says: "A most vile face! and yet she spends me forty pounds a year in mercury and hog's bones. All her teeth were made in the Blackfriars."

Ivory was for many years the favorite material for artificial teeth, that from the hippopotamus being preferred. The teeth of the narwhal, as being somewhat harder, were also used. Volney, Chateaubriand, the elder Pitt, and George Washington also used artificial dentures thus made. See DENTURE.

About 1765 Pierre Lavouse, a workman in the royal porcelain works at Sèvres, France, made rude imitation teeth of porcelain, but the art was not practiced to any considerable extent until about forty years ago, when it began to be utilized in the United States, where it has now developed into a manufacture of no inconsiderable importance.

The principal materials employed are feldspar, silica, and kaolin, with various fluxes for promoting fusion. Coloring materials, as titanium for yellow, platinum sponge for gray, oxide of cobalt for bright blue, and oxide of gold for red, are

also used for tingeing the body of the tooth and its enamel. The variety of shades which may be produced by the use of different colored bodies and enamels is almost infinite; 40 differently colored bodies and 130 standard shades of teeth, classified by numbers, are known in the trade.

The feldspar is heated to a red heat, plunged into water, broken to pieces by the hammer, and foreign matters, such as mica or iron, separated; it is then coarsely pulverized, and afterward ground to an almost impalpable powder. The silex is subjected to the same process, and the colors are also thoroughly ground.

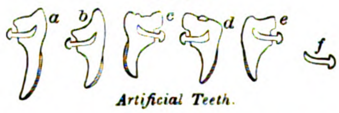
The materials, having been dried and sifted, are taken to the mixing-room, where they are properly proportioned, and again ground, in combination with water, into the various mixtures desired; the body to the consistence of putty, the point enamel to a thick batter, and the outside and gum enamels, of cream.

Small platinum pins, with solid heads and jagged ends, are formed from platinum wire by a machine, and are inserted into the matrices previous to the teeth being formed; these are for the purpose of holding each tooth to its plate.

The molds are of brass, and are made in two parts. The pins are inserted by one workman, and the mold transferred to another, who takes up a small quantity of the point enamel on a spatula and presses it into the matrix; a third workman fills the mold with the body composition, and then closes it. It is now pressed in by machinery and placed in the drying oven.

When sufficiently dry it is taken out and the teeth transferred to clay slides and brought to a cherry-red heat in a furnace. This process is called *biscuiting*. They are now soft, like chalk, and may be cut or filed as desired. Having been arranged into sets, they are next trimmed and smoothed, and receive a coating of enamel, laid on with a brush, and also an enamel which, after heating, assumes the natural color of the gums. Any surplus enamel is then removed, and the teeth are laid carefully on beds of quartz sand, in trays of fire clay, which are then placed in a muffle contained in the furnace and surrounded by a mass of incandescent fuel. After remaining from fifteen to thirty minutes, depending on the state of the fire, the teeth are removed finished, the material having been thoroughly hardened and the various colors brought out by the heat.

Fig. 6546.



Artificial Teeth.

Artificial teeth are attached to the artificial gum by platinum pins. *a*, incisor tooth; *b*, canine; *c d e*, molars; *f*, pin.

See also DENTURE.

Tooth-brush. A brush, usually of bristles, for cleaning teeth. A tooth-brush of spongy rubber is described in Francis's patent, 1869. Sponge also is cited.

Tooth-cem′ent. Oxide of zinc mixed with a solution of chloride of zinc, used for filling teeth.

Toothed Wheel. A *cog*-wheel. See list under GEARING.

Tooth′ing. Bricks left projecting at the end of a wall for the purpose of building on an addition thereto.

Tooth′ing-plane. A plane in which the *iron* has a serrated edge and is placed upright. It is used for scoring surfaces which are to be veneered. The scoring helps the *bond* of the glue.

Tooth-key. The tourniquet, or lever tooth-drawer.

Tooth-net. A large, anchored fishing-net.

Tooth′pick. Agathocles was poisoned by a medicated toothpick handed him after dinner, 289 B. C.

The *toth-gare* of the Anglo-Saxons. Made anciently, as now, of silver, wood, quill, and what not.

Magnetic toothpicks were made at the end of the seventeenth century.

Tooth-pow′der. Apuleius recommended charcoal; camphorated chalk is good.

Tooth-plug′ger. See DENTAL PLUGGER, page 686; PLUGGER, pages 1749, 1750.

Tooth-saw. The dental saw is a fine frame-saw, used for cutting off the natural teeth for the attachment of pivot teeth; for sawing between the teeth; or for sawing off the wires of artificial teeth to detach them from the plate.

Tooth-sink′ing Ma-chine′. A machine-tool for making the teeth of saws. That shown in Fig. 6547 is driven by a pulley at the back. The emery-

Fig. 6547.

Tooth-Sinking Machine.

wheel is started or stopped by the foot, and is brought down upon the saw-blade by the hand, an adjustable gage limiting its range of motion, so as to have the depth uniform. The saw-bed is fed between each stroke, by means of a hand-wheel pinion and rack.

Top. 1. (*Nautical.*) A platform surrounding the head of the lower mast, formed of timbers called cross-trees, which are laid across the *trestle*-trees, the latter being supported by cheeks secured to the sides of the mast below the head.

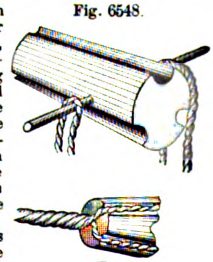
The top serves to form an extended base for securing the lower ends of the topmast shrouds, and is also a place of rest for the men aloft.

It is occupied by riflemen during a naval engagement at close quarters. Nelson was killed by a musket-ball from the top of the French vessel with which the "Victory" was engaged.

2. (*Rope-making.*) A plug with three grooves used to regulate the twist of a rope when three strands are being *laid up* (twisted).

Each strand occupies one of the grooves, and the *top* is held by a diametrical pin and two pieces of soft rope called *tails*. The three stands are attached to the hook of the *breast-board* and to the hook of the *sledge*; rotation is given to the cluster from the former; the top is forced as far as possible toward the *sledge-hook*, so as to allow the twist to commence at that end, the top giving way as the twist crowds it forward to the head end of the yarns. The process of twisting shortens the strands, and the sledge moves forward also, at which time the man at the sledge commences to rotate the hook at his end in a direction contrary to that by which the strands are twisted together.

Fig. 6548.



Top.

The pins by which the block is held in the angles formed by the twisting rope are called *woolders*; the ropes are *tails*. These are wrapped around the rope so as to oppose, by their friction, the advance of the top.

The motion of the *top* is regulated to insure equal hardness to the rope.

3. (*Fiber.*) A narrow bundle of slivers of long-stapled wool, containing about $1\frac{1}{2}$ pounds. The slivers are made by a pair of combs. See WORSTED.

4. The uppermost piece in the back of a chair. A *slat-top* is mortised at its ends into the sides of the *posts*. A *round-back* is mortised at its lower edge to the tops of the posts. A *rim-back* is one in which

the back and elbows are formed of a continuous piece.

5. That portion of a cut gem which is between the *girdle*, or extreme margin, and the *table* or flat face.

6. A well-known toy, which has attained its greatest excellence among the Japanese.

From the steadiness of its motion and its strictly perpendicular position when at speed, it has been suggested to place upon it a mirror at right angles to the axis, to act as an artificial horizon at sea.

Top and But. (*Shipbuilding.*) A mode of working plank which does not maintain its width from end to end. The top of one plank and the but of the other are worked together so that the two layers make a double breadth of even width.

Each plank has one edge straight, the other edge having a long and a short slope; the long slope being toward the top, and the short one toward the but of the tree from which the planks are sawn.

Top-ar′mor. (*Nautical.*) A top railing with posts and netting on the top-sides.

Top-block. 1. (*Nautical.*) A single iron-bound hook-block; it hooks to an eye-bolt in the cap. The top pendants are rove through the top-blocks when swaying up or lowering down the topmasts.

Fig. 6549.

Top-Block.

2. (*Vehicle.*) A projecting piece on which the bows of the carriage top rest when down. See Fig. 3971.

Top-chain. (*Nautical.*) One of the chains by which the lower yard is sustained if the slings be shot away.

Top-cloth. Tarred canvas to cover hammocks when stored away on the top, in action.

Top-flat, or **Top-card.** A slat or narrow board having card-teeth on its under surface, placed above the large central cylinder of a carding-machine so as to arrest knots and act coincidently with the cylinder in bringing the fibers into parallelism, preparatory to *drawing*, *doubling*, and *spinning*. See CARDING-MACHINE.

Top-gal′lant. The mast, rigging, and sail next above the topmast, as, maintop-gallant mast, foretop-gallant shrouds, or braces; mizzen top-gallant sail. See SHIP.

Top-ham′per. (*Nautical.*) The masts, spars, and rigging of a vessel. The clutter of a deck. Boats *inboard* and on their davits. Horse and gang casks, anchors, cables, and coiled or belayed ropes of the running rigging. Sometimes applied to unnecessary weight above deck.

Top′i-cal Col′or-ing. A term used in calico-printing to indicate that the color or mordant is applied to specific portions of the cloth forming the pattern, in contradistinction to the application of color to the cloth in a dye-bath.

Top′it. The top-piece of a train of rods in well-boring. See WELL-BORING.

Top′mast. (*Nautical.*) The mast above the lower mast; the second from the deck, and below the top-gallant mast. See SHIP; SAIL.

Top-mi′nor. (*Rope-making.*) *Top-minors* are holes through which the individual strands are drawn on the way to the twisting-machine. See ROPE.

Top′o-graph′i-cal Sur-vey′. A mapping of a country with absolute accuracy and minuteness of detail, made with elaborate instruments and repeated careful observations, as distinguished from a *reconnoissance*, or hurried survey made with portable instruments in a hurried manner.

Top′per. An equilateral, *single-cut* file, or *float*, used by comb-makers. See COMB.

Top′ping. 1. Reducing to an exact level the points of the teeth of a saw.

2. (*Nautical.*) Lifting one end of a yard higher than the other end.

Top′ping-lift. (*Nautical.*) A tackle for raising the outer end of a gaff or boom.

Top-rope. (*Nautical.*) A rope to sway up a topmast.

Top′sail-schoon′er. A vessel otherwise schooner-rigged, but carrying a square sail on the foremast.

Top-saw. The upper saw of a pair in a circular saw-mill. In large logs, the lower and larger saw does not penetrate to the upper edge. The *top* or supplemental saw cuts through the upper surface and down to the kerf of the lower saw. The top-saw is a little in advance or rear of the under one, to make the kerf complete without collision of the teeth of the respective saws. See *d*, Fig. 1298.

Top′side-line. (*Shipbuilding.*) A sheer line drawn above the top timber at the upper side of the gunwale.

Top-sides. (*Shipwrighting.*) The upper part of the ship's sides. These, under Feather's system, are of iron; the upper frames terminating in broad forks or saddles, which sit upon and are fastened to the wooden parts of the sides.

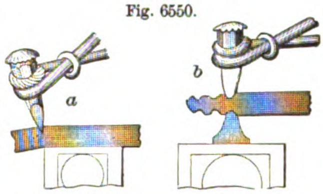
Top-tack′le. (*Nautical.*) Used in swaying up a topmast.

Top-tim′ber. (*Shipbuilding.*) In the ribs of a ship's side, the timber next above the futtocks. See FRAME.

Top-tim′ber Line, or **Top-breadth.** (*Shipbuilding.*) A line in the sheer plan drawn to the sheer of the ship fore and aft, at the hight of the under side of the gunwale amidships.

Top-tool. A blacksmith's tool which has a flexible handle, such as a withe of hazel, and used above the work, being struck by a hammer. In contradistinction to the bottom tools, which are below the work, and have a tang which fits a square hole in the anvil.

Fig. 6550.

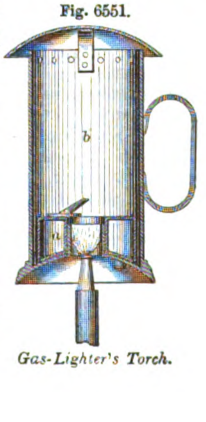


a. Top-Tool. *b. Top-Fuller.*

A *top-fuller* is a tool with a narrow round edge, like the pane of a hammer, and having the ordinary hazel-rod handle.

Torch. The torches of the ancients (*funalia*, because made of rope) were conical, and bound at intervals. Flambeaux of waxed cords, straw, or papyrus-leaves were also used; also *fasces* of wooden rods, fir, oak, ash, hazel, cornel. Tubes filled with combustible matter. The *palearia* of the thirteenth century were torches of straw; the *thyrsus*, thread covered with wax rolled round a staff.

Fig. 6551.

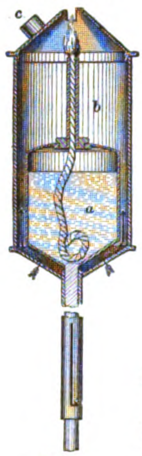


Gas-Lighter's Torch.

Fig. 6551 is a gas-lighting torch. A spirit-lamp *a* is set in a case *b*. This case has an orifice at the bottom, which is placed over the burner in order to light the gas-jet. The lamp can be trimmed through a door in the case, and is protected from the weather.

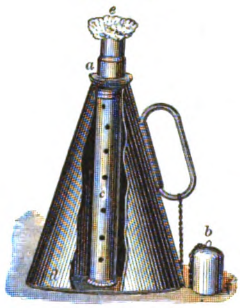
In the torch, Fig. 6552, the lamp *a* is inclosed within a case *b* for protection, but the wick tube may be protruded through an opening at the top for the purpose of lighting a lamp, the handle having motion in a sleeve at the bottom of the case. *c* is a wrench for opening the gas-cocks, and a slot across the top of the case is for the same purpose.

Fig. 6552.



Torch.

Fig. 6553.



Plumber's Torch.

Fig. 6553 is a plumber's torch. See also ELECTROPHORUS.

2. Torches for military purposes are made of a number of strands of twine, slightly twisted, or of old rope, covered with a composition to give light, consisting of tallow, wax, and rosin, or equivalent ingredients.

Tor'cu-lar. (*Surgery.*) A tourniquet or bandage.

Tor-ment'or. (*Husbandry.*) A heavy harrow with cutting teeth, used in English husbandry for breaking down stiff clods, or tearing up the surface-turf. It resembles a harrow, but runs on wheels, and each tine is a hoe or cutting-share.

Tor-pe'do. A movable chamber or mine charged with an explosive which is fired by contact or by fuse.

They are here divided into

1. Nautical.	4. Railway.
2. Military.	5. Fishing.
3. Oil-well.	6. Toy.

1. (*Nautical.*) Torpedoes are of four classes, —

a. Drifting.	*c. Boom.*
b. Anchored.	*d. Maneuvered.*

The drifting and anchored preceded the boom and maneuvered, and are adapted for circumstances and positions where (*a*) they may be allowed to drift with the stream or tide against a vessel in a river or channel or at anchor; or (*b*) may be placed in the path of a vessel, or in the line of attack.

The maneuvered class is adapted to be navigated usually beneath the surface of the water, its course and depth being determined and regulated by various devices to bring it in contact with the ship against which it is directed. The *torpedo* perishes in the explosion; the *torpedo*-boat, on the contrary, carries a torpedo, and either explodes it against the enemy's vessel in such a manner as not itself to suffer in the contact, or launches it against the vessel after attaining such a degree of proximity as to insure the aim and power of navigation of the torpedo. See TORPEDO-BOAT.

Several terms used in practice are rather general than accurately technical, as they denote whole classes. Such are, —

Magnetic torpedo, one exploded by electro-magnetism, by spark, wire, or ignited pencil-line in a fuse; in contradistinction to one fired by contact, clock-work, etc.

Submarine torpedo, one placed beneath the surface of the water.

Can-torpedo, one in a metallic caisson.

Laniard-torpedo, one pulled off by a laniard, etc.

The torpedo is so named from a species of ray found in the Mediterranean, which has the power of imparting an electric shock when touched. The *Gymnotus electricus*, a fresh-water eel of South America, has a similar power. The torpedo-ray has long been known. Theophrastus, in his "Treatise on Poisonous Animals," says that "the torpedo can send the power which proceeds from it through wood and through harpoons, so as to produce torpor in those who have them in their hands." Athenæus, in the "Deipnosophists," says: "Clearchus the Solensian has explained the cause of this in his 'Treatise on Torpor,' but since his explanation is rather a long one, I do not recollect his exact words." The author of the "Banquet of the Learned" goes on to say: —

"Plato, the philosopher, says in the 'Meno,' 'you seem very much to resemble the sea-torpedo, for that fish causes any one who comes near it to become torpid'; and an allusion to the name occurs also in Homer, where he says,—

"'His hand was torpid at the wrist.'

"'The torpedo,' says Aristotle, 'is one of the cartilaginous and viviparous fishes; and, to provide itself with food, it hunts after little fish, touching them and causing them all to become torpid and motionless.'

"Archestrus says in his 'Demetrius,' —

"'Then I took a torpedo, calculating
If my wife touched it with her tender fingers
That they would get no hurt.'"

For an account of the Gymnotus, see Humboldt's "Cosmos."

In the early instances, floating mines were used in breaking booms, bridges, or other obstructions to navigation, as well as in breaking a cordon of ships or destroying a fleet in port.

In 1585 four floating mines were sent from Antwerp by Zambelli, against a bridge across the Scheldt, erected by the Duke of Parma. Each flat-boat of about eighty tons' burden was stowed with 7,000 pounds of powder confined by mason-work and heavy stones. The mines were to be exploded by a match-rope and by clock-work. One was successful, and made a breach of 200 feet in the bridge, doing immense damage in the vicinity.

September 30, 1628, the English employed floating tin caissons of powder against the French at Rochelle. One exploded against a vessel without seriously damaging it. The others were intercepted.

"In the afternoon come the German, Dr. Knuffler, to discourse with us about his engine to blow up ships. We doubted not the matter of fact, it being tried in Cromwell's time, but the safety of carrying them in ships." — PEPYS'S *Diary*, 1662.

In 1688 an immense floating bomb was prepared by the French against the port of Algiers, but was not used.

In 1693 - 95 similar contrivances were used by the English in besieging St. Malo, Dieppe, and Dunkirk, without serious damage.

In 1770 the Russians burned the Turkish fleet in the port of Tchesme, and destroyed the fortifications by the shock of the explosion.

In 1804 the loaded catamarans of Fulton were used by the English against the French fleet off Boulogne. But little damage was done.

The experiments were repeated again and again against Le Forte Rouge at Calais, 1804 (Fulton blew up the brig "Dorothea" in Walmer Roads, October, 1805. See Fulton's "Torpedo War," and "Torpedoes, their Invention and Use," by W. R. King, U. S. A., 1866, Plates XVIII., XIX.); Rochefort, 1809; the pontoon bridges of the French on the Danube, at Essling; in 1813, by the Austrians in attempting to destroy the bridges across the Elbe at Kœnigstein.

About 1843 Colonel S. Colt constructed a torpedo with which he blew up a ship in the Eastern Branch of the Potomac River, near the Washington Navy Yard; it is believed that the most important feature of this consisted in the application of electro-magnetism as a means of exploding the contained powder.

Torpedoes were extensively employed by the Russians during the Crimean war as a defense for the harbor of Cronstadt. These were suspended from buoys to which they were connected by pipes inclosing at their upper part a small glass tube containing sulphuric acid; on the buoy being touched by a passing vessel, the tube would be broken and the sulphuric acid come in contact with chlorate of potash in the lower part of the pipe, causing its immediate inflammation and consequent explosion of the gunpowder in the magazine.

The experiment of the "Louisiana" before Fort Fisher in 1864 is one of the latest instances. Two hundred and fifteen tons of powder were stowed on board. A tier of barrels, with the upper heads removed, were covered by 60-pound canvas bags. A Gomez fuse was woven through the mass. Three modes of explosion were adopted, — clock-work and percussion, candles, slow-match. The vessel was towed within 851 yards of the works, and exploded in one hour and fifty-two minutes, without doing any damage whatever to the fort. See *infra*, Fig. 6560.

a. The *drifting* torpedo is of various forms, and in its mode of action it is carried against the enemy's works or vessels by the current of the river, the set of the tide, or the drift of the wind.

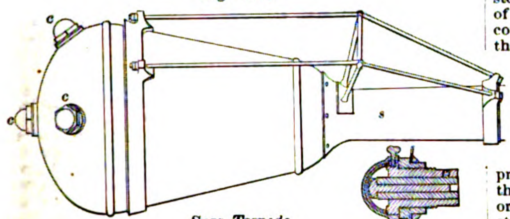
They may be divided into *can* or *buoy* torpedoes, according to shape; *laniard*-torpedoes, which are pulled off by a cord; *hydrogen*-torpedoes, which, when the can strikes a vessel, turn a stream of hydrogen on to a piece of spongy platinum and ex-

plode the charge; *horological* torpedoes, exploded by clock-work after the expiration of a given time.

The *Boule de Verdun* is the name given to a crawling torpedo which was to have been launched at Verdun with the purpose of destroying a bridge which the Prussians had thrown across the Meuse, about three miles below the city. It was a nearly spherical chamber, about 40 inches in diameter, and contained a clock-work mechanism for pulling the trigger of a double-barreled pistol which ignited the primary powder. It was based upon the principle that a spherical body of a weight slightly greater than the displaced water, and having its center of gravity and magnitude coincident, will seek and keep the deepest portion and current of the river. It was not used, as Verdun capitulated just before it was to be launched.

A drifting spar-torpedo intended to overcome obstructing chains or booms was invented by Lewis, of the British Royal

Fig. 6554.



Spar-Torpedo.

Engineers. It had a spar weighted to float nearly vertically, and when the upper end met with an obstruction, the lower end passed underneath, and, the weight being dropped by the action, the lower end, carrying the torpedo, rose rapidly and struck against the vessel's bottom.

b. Anchored torpedoes are attached to mooring piles or anchors. They are firmly connected to submerged structures, or by a cable or swaying boom which allows them some lateral play.

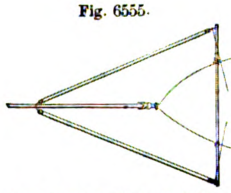
c. Spar-torpedoes. The spar-torpedo is carried on the end of a spar rigged overboard from the bows of a vessel, as seen in Figs. 6555 and 6556, or attached to the prow.

It is of sheet-copper with brazed joints. It has a sensitive primer, with a cylindro-conical head communicating with the magazine of the torpedo. The head is in contact with and protected from the water by a thin hemispherical cap of soft, well-annealed copper. Fig. 6554 shows the torpedo, the smaller figure being an enlarged view of the exploding arrangement.

The charge is usually fired by contact, but sometimes by electricity. The system was used in the extensive torpedo practice in Florida Bay, 1874.

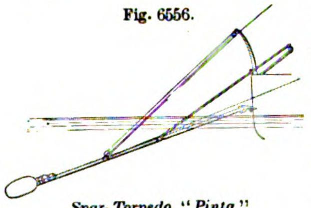
Figs. 6555, 6556, show it as rigged on the "Pinta."

Fig. 6555.



Spar-Torpedo Fittings, "Pinta" (*Plan*).

Fig. 6556.



Spar-Torpedo, "Pinta" (*Side View*).

The Wood and Lay spar torpedo was used in the United States Navy, notably by Lieutenant Cushing in destroying the Confederate ram "Albemarle" at Plymouth, N. C., in 1864. It was attached to a spar by means of the lug *b*; run beneath the enemy's vessel; detached from the spar by a device for that purpose; allowed to rise against the vessel by its flotative power, when the lanyard was withdrawn, allowing the ball *a* to fall upon the cap *c* and explode it and the charge.

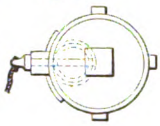
The *otter*-torpedo, so called, is towed by a line from a boom rigged out athwart ship.

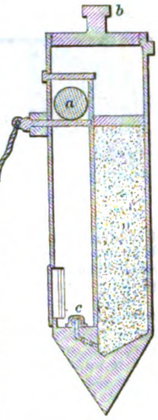
d. Maneuvered torpedo.

The *fish*-torpedo is so named from a certain resemblance in form, and from its having an independent and automatic swimming action after being launched in the direction of the object of attack.

It is also known as the *Whitehead* torpedo, and as the *Luppis-Whitehead* torpedo, from the names of two persons intimately concerned in its suggestion and invention.

Fig. 6557.





Wood and Lay Torpedo.

The body of the *Ericsson* torpedo consists of a box of thin steel plates, 8 feet 6 inches long, 30 inches deep, and 20 inches wide. The explosive is placed at the bow. The propellers are two-bladed, 3 feet 2 inches in diameter, with a pitch of 5 feet. Both revolve around a common center in opposite directions. The motive power is a small double-cylinder oscillating-engine, driven by compressed air, which is supplied by a 25 horse-power steam-engine on shore, and transmitted through a tubular cable, connected just abaft the stern, as shown in Fig. 6558. The air-pressure also governs an equipoise rudder, secured under the bottom and near the bow. The steering is effected by applying the force of the air against the tiller on one side, counteracted by the tension of a spring on the opposite side.

The submersion is regulated by two horizontal rudders turning on a transverse axle which projects from each side near the bow. These wings or rudders are so contrived and governed that they keep the torpedo at a depth of from 7 feet to 12 feet below the surface, and are provided with automatic devices, so that the latter limit cannot be exceeded. In order to note the course of craft, a light steel mast is secured to the deck. This is 12 feet in length, and terminates above in a wooden ball, the forward side of which is painted sea-green, so as not to be perceptible to the enemy, and the rear white, so as to be easily distinguished above the water by those dispatching the torpedo. Openings are made in the engine-compartment, through which the water enters, completely filling the interior space. The machinery is made of bronze with boxwood bearings, so that the water serves as a lubricant to every portion, thus doing away with stuffing-boxes at the rudders. The apparatus is launched overboard by means of swinging-davits, as shown in the figure. The bow-piece containing the charge is detachable.

The *Lay* torpedo used at Newport is a cigar-shaped vessel, 30 feet long and 3 feet wide, formed of water and air-tight iron plates, in three compartments. One of these is to contain the motive power,— compressed carbonic-acid gas. Another holds the machinery, which is controlled by an electric battery on shore by means of two wires, one of these governing the throttle and the other the steering-apparatus. In the third compartment is stored 500 pounds of powder or other explosive, and in the forward portion of the vessel explosive shells are also arranged to be fired by an electric spark passing through a third wire. These wires are embedded in a cable which is paid out as the vessel moves on. The shells are exploded without injury to the torpedo, but of course the explosion of the magazine causes its destruction.

Of late years the subject of harbor defense by means of torpedoes used offensively against an attacking fleet, has attracted great attention, and a naval torpedo-station has been established at Goat Island, Newport Harbor, for the purpose of instruction in their use and management on board vessels specially constructed for this object. See TORPEDO-BOAT.

No less than 18 United States vessels were destroyed through the agency of torpedoes during the late war.

One was blown up, but not destroyed.

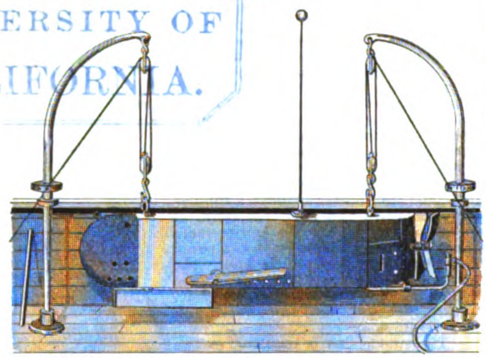
Of these were the monitors "Patapsco" and "Tecumseh," at Charleston and Mobile Bay respectively; the iron-clads "Cairo" and "Baron de Kalb," in the Yazoo River; the iron-clads "Milwaukee" and "Osage," in the Blakely River.

In the case of stationary submarine torpedoes, the operator must know the position of each, and be provided with means for determining when a vessel approaches within its range. For this purpose instruments for measuring angles are employed, or the torpedo itself is provided with devices for indicating the proximity of a ship.

Experiments are now being made at Portsmouth, England, on torpedoes of the latter class. A network of these is connected by insulated wires with a galvanic battery on shore; the wires of one set conveying the message to the operator, and those of the other serving to explode any selected torpedo by touching a key.

In other cases the firing circuit is closed automatically by the action of the signaling apparatus. The firing is effected by a strand of platinum wire, made red hot by the passage of a current when the circuit is completed. These experiments are said to prove that comparatively large charges cannot be exploded without compromising other charges within their effec-

Fig. 6558.



The Ericsson Pneumatic Torpedo.

tive area. The question remains to be decided whether it will be more practically advantageous to employ comparatively small torpedoes placed closely together, or those of larger size placed at greater intervals apart.

Another English writer remarks that during the civil war in America, the Federal fleet was in no instance successful in passing a well-arranged system of fortifications where torpedoes were used, unless the forts were first reduced from the land; and in no instance did the navy fail to accomplish its object where torpedoes were not used.

As an instance of the fallibility of torpedoes, it was found after the capture of Charleston that the "Ironsides," the most powerful vessel in the Federal fleet, had lain for three months over a torpedo containing 3,000 pounds of powder. This was to have been exploded by electricity, but failed to go off.

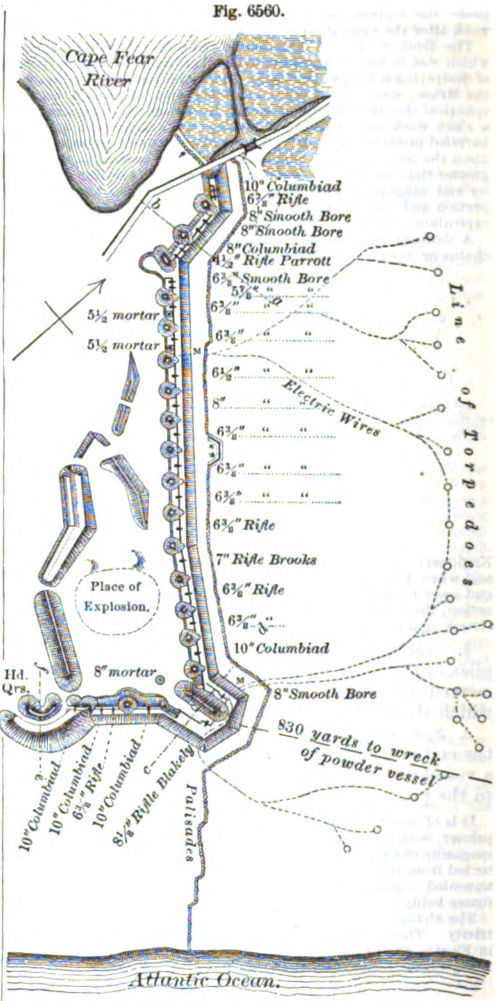
An instance of the moral effect of torpedoes was shown in the Franco-German war, where the French navy was completely paralyzed by the presence of torpedoes thickly studded along the German coast, and not a single engagement between the fleet in German waters and the sea-coast defenses is recorded.

Published information on the subject of the torpedo trials may be found in the "Report of the Austrian Commission," 1868; "Army and Navy Journal," 1874; "Revue Maritime," September, 1872, January, 1873; Captain Harvey's "Treatise on the Management of the Sea-Torpedo," London, 1871; Sarrepont's "Les Torpilles," etc.

2. (*Military.*) A mine or countermine to destroy a work, a storming column, or a working party. In this sense a *petard* may be considered as a torpedo. Torpedoes for land defense are usually shells of small caliber, 6 and 12 pounders, provided with a percussion or friction device which causes an explosion when the ground over the torpedo is stepped on. Sometimes several are laid in a row, and a piece of board placed over them to increase the chances of explosion.

At Fort Fisher, larger torpedoes, connected in sets and designed to be fired by electricity, were arranged on the land face

Fig. 6560.



Plan of Fort Fisher, N. C., showing the Part extending across the Isthmus, and the Face protected by Torpedoes.

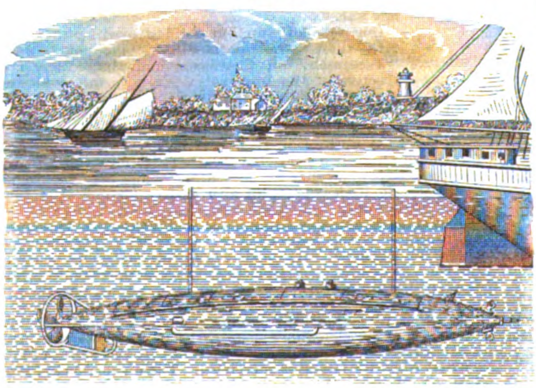
of the work. The wires leading to the majority of these were cut by fragments of shell during the bombardment, probably preventing considerable loss of life during the assault. Torpedoes buried in the ground and fired by a similar arrangement when trodden upon, and others connected by wires with electric batteries, were used in the defense of Sebastopol.

Fig. 6560 shows the northeast face of Fort Fisher, N. C., with the line of torpedoes, twenty-four in number, which were connected with the fort by three sets of double wires, each apparently intended to fire five or more torpedoes. The torpedoes were of three kinds: shells, 13″ diameter; boiler-iron cylinders, 13″ diameter and 18″ long; buoy-shaped sheet-iron cylinders of about the same capacity as the cylinders. Before the storming of the fort shells had cut a number of the wires leading from the work, saving the attacking party from much loss and demoralization.

Ground-torpedoes, buried beneath the surface to explode when trodden upon; *bridge*-torpedoes (Haupt's), to rend the timbers or arches of bridges in demolishing them; and *railway*-torpedoes, to blow up a track when a train passes, are all effective military devices.

3. Torpedoes for opening the fissures of oil-wells have been patented by Colonel E. A. L. Roberts and others, and their use has restored productiveness to many wells. In some cases the wells have become choked by paraffine or

Fig. 6559.

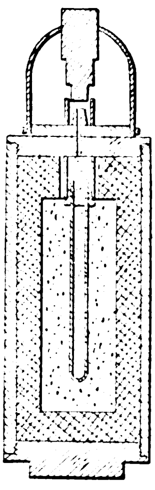


Lay-Torpedo.

other concretion, some perhaps by sediment; in others it is probable that an explosion has opened fissures leading to other pockets or veins of oil.

Some torpedoes of this kind are exploded by a time-fuse, which is let down with the instrument. Others are exploded by a gunlock and wire from above, or by a plunger; but the best and most usual mode of igniting the charge seems to be an electric connection.

Fig 6561.



Roberts's Torpedo for Oil-Wells.

Fig 6561 illustrates a torpedo in which a powder-chamber is surrounded by nitro-glycerine, and a quick-match passes from the powder to the priming-chamber, which communicates through a tube with the fulminate, which is exploded by a hammer. An electric connection not only enables the operator to explode the charge at will, but other packing than water may be used to confine the explosion. A bag of flaxseed is often used for this purpose, which is lowered into the well dry, and, becoming saturated, swells and completely closes the aperture. The bag may be cut or torn open and withdrawn.

In an explosion in an oil-well in the petroleum region, where the boring was over 800 feet deep, two cartridges were prepared, the one 25 inches in length, the other 35 inches, and each 5 inches in diameter. These were connected by a short copper wire, 30 feet in length, so as to adjust the two charges immediately opposite to several mud-veins which were known to be that distance apart, the heaviest charge of 30 pounds nitro-glycerine being at the lower vein, 783 feet deep, the lighter charge at the upper vein. Twelve exploders were inserted in the largest cartridge, and eight in the other, forming a train of twenty exploders, which, by means of insulated wire, were connected about 250 feet from the well with an electric battery.

Everything being arranged, the order was given to fire. In an instant the discharge took place, and a report like a cannon fired from a distance, accompanied by a very perceptible vibration of the earth around, was noticed by those present. The operator and an assistant immediately pulled on the wire, thereby endeavoring to prevent entanglement. When about fifty feet of the wire had been drawn out a reaction ensued, dragging the parties who were pulling at the wire toward the well for a distance of ten feet, to their surprise and great wonderment; this arose from the column of water lifted by the explosion and its return and fall.

4. (*Railway.*) A cartridge placed on a rail to be exploded by a passing train, and thereby signal "caution" or "danger" to the engineer.

5. In the Rocky Mountain regions, some sporting gentry have adapted torpedoes to trout-fishing.

They take a cartridge of Giant powder, weighing about a quarter of a pound, insert into it a piece of fuse, properly capped, about six inches in length; then, lighting the fuse, the cartridge is thrown into any deep hole supposed to contain trout or any other fish. After the cartridge has been thrown into the water, smoke and bubbles of gas are seen to rise to the surface, then in a few moments comes the explosion, — a dull, heavy report. The surface of the water is seen to bulge up, and the ground can be felt to shake for fifteen to twenty feet back from the water.

Immediately after the explosion, all the fish that happen to be within a circle of twenty-five or thirty feet of the spot where the cartridge fell, come to the surface, either killed outright or so badly stunned that it is some minutes before they recover.

6. An explosive toy, consisting of a small quantity of fulminating-powder and fine gravel, wrapped in thin paper. It explodes with a sharp detonation when thrown upon any hard substance.

Tor-pe'do-an'chor. An anchor or fastening to hold a submarine torpedo to its selected bed. A serviceable form is that of a ship's anchor, to which the torpedo is attached by a chain with a universal joint.

Tor-pe'do-boat. A vessel carrying a *torpedo*, and either exploding it against the side of another vessel beneath the water-line, or launching it against the enemy's vessel when it may be trusted to reach its destination by the force of the impulse, or by a motor on board.

The *torpedoes* are carried on the ends of spars rigged forward, or are towed by booms, or are cigar-shaped vessels known as *fish*-torpedoes, which may be considered self-navigated projectiles. See TORPEDO.

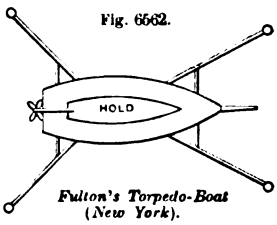
The first *torpedo*-vessel was perhaps the "American Turtle" of David Bushnell, of Connecticut, in 1776. His was a submarine vessel having a torpedo in tow.

It was composed of two shells of sufficient capacity, when joined together and made water-tight, to contain the operator, together with sufficient air to enable him to remain under water for half an hour. He caused the boat to rise or sink by pumping the water from or allowing it to enter a chamber beneath him, at the same time lowering or raising a block of 200 pounds of lead which might be made to touch bottom. He propelled the boat by means of an oar, from a compartment in the fore part, and at its stern a magazine containing powder was attached; this was fired by a lock operated by clock-work in the magazine, which was set in motion at the time of its detachment from the boat, and was calculated to run a sufficient time to allow the operator to reach a place of safety previous to the explosion. With this apparatus he succeeded in frightening the crew of the British 64-gun ship "Eagle," in New York Harbor, and afterward blew up a schooner at New London.

The celebrated Fulton, between the years 1800 and 1807, devoted considerable attention to torpedoes and torpedo-boats, and in 1810 published a work on the subject.

While in France he constructed a boat which, when at the surface, was propelled by a sail, and resembled an ordinary boat; the mast could be struck, and the boat, with its contents, submerged to the depth of several fathoms, and propelled by machinery, at the rate of about four miles an hour, in any direction desired. This invention at first met the approval of Napoleon, who, however, afterward appears either to have lost faith or grown tired of it, as the boat was never brought to any farther practical test.

Fig. 6562.



Fulton's Torpedo-Boat (New York).

After the return of Fulton to America, he continued the experiments, without, however, much success. Fig 6562 shows a boat he devised of 300 tons burden, with sides 6 feet thick, designed to be cannon-proof, and musket-proof decks 6 inches thick. She was to be propelled by a scull-wheel, and was intended to carry two torpedoes on each side, fixed on the ends of spars 96 feet long, supported by guys from the mast-head.

During the late civil war a number of these submarine "infernal machines" were constructed by each party.

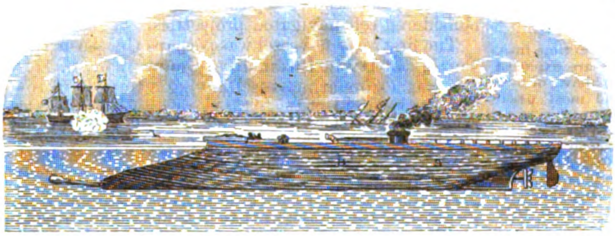
The first of these attacks was made off Charleston, against the United States war-vessel "Ironsides," by a cigar-shaped boat, under the command of Lieutenant Cassell, with a crew of three men, carrying a torpedo containing 60 pounds of powder at the end of a spar. Not knowing the action of the explosion, and thinking that their boat would probably be sunk by it, her crew jumped overboard before ramming. The explosion, though severe, failed to make any hole in the bottom of the "Ironsides"; the boat was also uninjured, and was found drifting, half full of water, by her engineer, who climbed into her, made up his fires, and steamed back safely to Charleston.

The submarine torpedo-boat which sunk the United States steamer "Housatonic," of 1,240 tons, and 13 guns, off Charleston, the largest vessel thus destroyed during the war, was 35 feet long, made of boiler-iron, and could be submerged to any desired depth, or propelled upon the surface. She was designed to pass under the bottom of a vessel lying at anchor, and drag a floating torpedo, which should explode on striking the vessel, and could remain submerged for half an hour without inconvenience to her crew, which consisted of nine men, eight to work the propeller and one to steer. The following is her history in brief: She was first sunk by the swell of a passing steamer, drowning all hands, except her commander. After being raised she again capsized and sunk, her commander and two others alone escaping. Being again raised, she made an experimental trip, under one of her constructors, and, while submerged to a great depth, became unmanageable from some unknown cause, and remained for many days, with her crew of nine dead men, at the bottom of Cooper River. Her last achievement was the destruction of the "Housatonic," when she and her crew disappeared forever from all human knowledge.

Of late, however, it is not considered as an absolute prerequisite to an efficient torpedo-boat that she should be capable of being entirely submerged when making an attack. Admiral Porter's system provides vessels of sufficient power to resist the fire of an enemy, and attack openly when necessary. See Fig. 6563.

The destruction of the rebel ram "Albemarle," at Plymouth, N. C., October 27, 1864, was accomplished by the use of one of Wood and Lay's torpedoes (see TORPEDO, Fig. 6557), modified for use by a ship's launch.

Fig. 6563.



Porter Torpedo-Boat.

The steam-launch was run up under cover of night, and succeeded in eluding the picket-boats of the enemy. The "Albemarle" was discovered lying fast to the wharf, with logs around her, about 30 feet from her side. As the launch approached she was fired on from the shore, but continued her course straight for the ram. Striking the logs, they were driven inward some feet. "The torpedo-boom was then lowered," says Lieutenant Cushing, "and, by a vigorous pull, I succeeded in driving the torpedo under the overhang, and exploding it at the same time the 'Albemarle's' gun was fired. A shot seemed to go crashing through my boat, and a dense mass of water rushed in from the torpedo, filling the launch and completely disabling her." The "Albemarle" sunk at her moorings. Lieutenant Cushing and one of his crew escaped by swimming.

Just before the close of the war an attack was made, in the James River, on the merchant-vessels which had brought supplies to Grant's army, by the Confederate fleet of three iron-clad rams and seven gunboats, all armed with torpedoes, fixed on the ends of spars, 30 or 40 feet long, which projected from their bows, and could be raised or lowered by a tackle. This fleet was stopped by a boom, and two of the iron-clads got aground, where they remained all night, under fire from the banks; but although their torpedoes were completely riddled with rifle-shot, not one was exploded by the striking of the fuses.

The Porter torpedo (Fig. 6563) is an iron vessel 174 feet long, 28 feet broad, and 13 feet deep. It consists of two hulls of equal strength, one within the other. A person may pass between the inner and the outer vessel from stem to stern. The compartments are water-tight, so that if the vessel sustains any injury from grounding or from other cause, only a small part will be filled with water. When in fighting trim, the compartments have water let in so as to submerge the vessel with the exception of about three feet. The masts are also lowered, and nothing rises above the deck save the short smoke-stack, the pilot-house, and the heavy forecastle gun. It has a "ram" snout from which the shell may be thrust out on a long staff. After this explodes, the enemy's ship may receive a thrust from the ram and a shell from the gun. If it be desired to deliver a broadside attack, there are two apertures on each side of the vessel, through which torpedoes may be thrust by means of poles.

Tor-pe′do-boom. A spar bearing a torpedo on its upper end, the lower end swiveled and anchored to the bottom of the channel.

The boom sways back and forth, and is difficult to catch by any form of drag or grapple.

Tor-pe′do-catch′er. A forked spar or boom extending under water, ahead of a vessel, to displace or explode torpedoes.

Tor-pe′do-drag. A cable bearing grappling-hooks to catch torpedoes. The ends of the cable are generally carried in boats some distance apart, which are propelled up and down the channel.

Sometimes the drag-rope is thrown ahead of a vessel by a shell from a small mortar, and drawn in by the windlass.

Tor-pe′do-fuse. One adapted for torpedo service, and classed: *percussion*, *friction*, *chemical*, *electric*.

Tor-pe′do-raft. A raft pushed ahead of a vessel, with hooks or grapples underneath, to clear the channel of torpedoes.

The raft sometimes carries its own torpedo in front, to blow up obstructions or hostile shipping.

Tor-pe′do-ram. One which carries an explosive in the ram to supplement the force of the collision.

Tor-ri-cel′li-an Tube. A glass tube invented by Torricelli, open at one end and hermetically sealed at the other. Being filled with mercury, the open end is plunged in a basin of mercury, and the metal falls until its vertical hight is just counterbalanced by the pressure of the atmosphere, — a vacuum termed the Torricellian vacuum being at the upper end of the tube. The discovery furnished the world with the BAROMETER (which see).

Fig. 6564.

Torricellian Vacuum.

Tor-ri-cel′li-an Vac′u-um. So called from Torricelli. See TORRICELLIAN TUBE; BAROMETER.

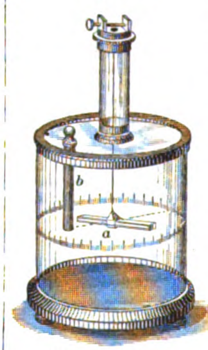
Tor′sal. (*Carpentry.*) A short beam under the end of a girder where it rests on a brick wall.

Tor′sion-bal′ance. An instrument originally contrived by Coulomb for electrical purposes. It is, however, equally fitted for measuring magnetic intensity. See ELECTROMETER; GALVANOMETER.

It consists of a glass cylinder covered by a plate which supports an upright tube. From the center of the top of the tube a fine silk thread is suspended, supporting a magnetic needle. The glass cylinder serves to prevent the needle from being disturbed by exterior currents of air, and its circumference is graduated. On bringing a magnet whose strength we wish to measure in contact with the glass, the needle will be deflected to an amount depending on the strength of the magnet employed, and thus the relative intensities of different magnets may be measured.

In that illustrated, the cover is perforated to receive the vertical magnet *b*, whose contrary poles exert an attractive or repulsive force on the nearest pole of the suspended bar-magnet *a*. This is suspended by a fine wire whose resistance to torsion brings the pole of the suspended magnet back to zero when the disturbing magnet is removed.

Fig. 6565.



Torsion-Balance.

Fig. 6566.

Torsion or Slide-Catch Artery-Forceps.

Tor′sion-e-lec-trom′e-ter. An instrument for measuring the force of an electric current by deflecting a needle attached to a wire which is twisted by the movement. See previous article.

Tor′sion-for′ceps. (*Surgical.*) An instrument for twisting the severed ends of an artery; or for holding an artery while a ligature is applied.

Tor′ta. A flat circular heap of *slimes* of silver ore, from which the water has partially evaporated till it has become of a proper consistency for tramping. The auriferous or argentiferous slimes are treated by the Patio process, — salt, magistral, and mercury being added to the *torta* and tramped in by animals every alternate day. The heap is also turned by wooden shovels, and subsequently washed, the metalliferous portions being separated from the earthy mud by gravity. See AMALGAMATOR, page 75.

Tor-ti-col′lis Brace. (*Surgery.*) An apparatus for remedying distortion of the neck.

Dr. Marcoe's has an upright steel bar fastened to a pelvic band and extending along the spine to a little below the level of the shoulders, secured in position by straps passing over the

Fig. 6567.

Torticollis Brace.

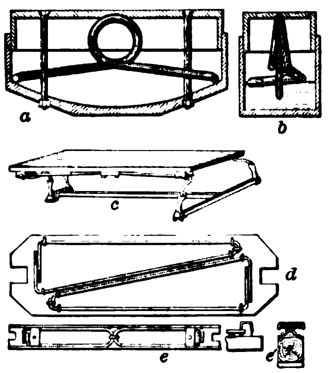
shoulders, under the axillæ, and fastened to buttons or pads over the scapula; to its top is adjustably attached a steel lever which carries a padded spring, forming the head-band, which is provided with a universal joint, so that by means of a thumb-screw the patient's head may be fixed in any position; a bandage passing from ear to ear beneath the chin is attached to the head-band, and a second bandage may be carried over the top of the head. See also SPINAL BRACE; SCOLIOSIS BRACE.

Tor'tion-al Spring. One in which is utilized the power of a bar to resist a twisting force.

a b are respectively longitudinal and transverse vertical sections of a car-spring, showing how the bent rod is packed in the chamber so as to utilize the tortional stiffness of the rod.

c shows the application of a tortional spring to a carriage-bed. One of its bearings is firmly and rigidly secured to the bolster or other bed-piece, and its other bearing, to which the lateral lever arm is attached, is so arranged as to allow of a partial revolution or a vibratory movement at that point, securing the proper twisting of the rod to develop its torsional action.

Fig. 6568.



Tortional Springs.

d has rods beneath the spring-boards, which are pressed flat by the weight imposed, twisting the rods in so doing.

e e' are two views of a somewhat similar arrangement.

See also *g*, Fig. 1142.

Tor'toise. The testudo, or ancient defense, by the soldiers holding their shields over their heads, resembling the carapace of the tortoise.

Tor'toise-shell. The use of it in inlaying is mentioned by Pliny.

The plates forming the covering of the *Testudo imbricata*, a species of turtle inhabiting the seas of the torrid zone. The plates are sometimes detached from the living animal by placing it on its back over a fire and applying sufficient heat to soften them, when they are pried off, and the creature is allowed to escape to mature another crop. The material is translucent, mottled with brown, yellow, and reddish hues, and is used for making combs, boxes, and various ornamental objects. It is softened by boiling water, and may then be pressed by molds into various shapes. It may also be welded while soft by thinning the edges, overlapping and pressing them. When a slit is made, and the piece softened by heat, it may be formed into a ring by stretching. When dry and cold it may be divided with a fine saw, smoothed with a single cut file, technically known as a *quannet*, and then by a scraper. The work is polished on a buff-wheel with rotten-stone and oil.

Fragments, such as cuttings, shavings, and filings, are agglutinated by treating with hot water and pressing; the mass may then be molded to any desired shape. This method is much practiced in France.

Tortoise-shell is frequently applied to wood by gluing, forming a veneer. It is also inlaid with the precious metals or mother-of-pearl forced into its substance by pressure while the shell is softened by heat.

It was much used among the Romans for decorating furniture, and is said by Pliny to have been first applied to this purpose by Carvilius Pollio.

Half a century ago it was much employed for ladies' combs, which were then made of enormous size.

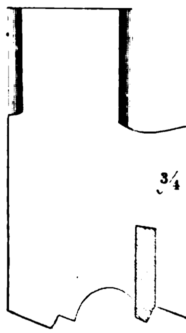
Artificial tortoise-shell is made by melting gelatine with various metallic salts.

Horn may be made to imitate tortoise-shell by brushing it over with a paste composed of two parts lime, litharge, and a little soda lye. The sulphide of lead is formed by the combination of the lead of the litharge with the sulphur contained in the albumen of the horn, producing dark spots which contrast with the lighter color of other parts.

To'rus. A semicircular projecting molding, occurring in the base of a column of certain orders.

To'rus Bead-plane. A certain form of plane for making the semicircular convex molding known as a *torus*.

Fig. 6569.



Torus Bead-Plane.

Toss'ing. (*Mining.*) *Tozing.* The operation of agitating ore in a *kieve;* a tub in which it is rotated in water by a stirrer on a vertical axis. See KEEVE; JIGGING. The operation is also called *tre-loobing.*

Touch. 1. (*Shipbuilding.*) The broadest part of a ship's plank worked *top* and *but.*

2. A plan of assaying by color. See TOUCH-NEEDLE.

Touch-box. A box with lighted tinder, formerly used by cannoneers to light their matches.

Touch-hole. The priming-hole or vent of a gun.

Touch-nee'dle. (*Assaying.*) A small bar composed of an alloy of gold and silver, gold and copper, or of gold alloyed with a proportion of both metals, employed in assaying by the touchstone.

A number are employed: one being of pure gold, a second composed of 23 gold and 1 copper, a third of 22 gold and 2 copper, and so on; these are rubbed upon the stone, and the color of the streak compared with that made by the metal to be tested. A farther means of comparison is afforded by moistening the streaks with nitric acid, or by heating the stone.

Silver is similarly tested by touch-needles composed of lead and silver. See TOUCH-STONE.

Touch-pa'per. Paper saturated with a solution of nitrate of potash.

Touch-stone. (*Assaying.*) A velvet-black, silicious stone, basalt or flinty jasper, used on account of its blackness and hardness for testing the relative qualities of gold and silver in alloys of the precious metals. A *touch-needle,* composed of an alloy of known fineness, and the piece to be tested, are each rubbed on the stone and the color of their streaks compared. See TOUCH-NEEDLE.

Tour-bill'ion. A paper case filled with inflammable composition, and having holes for the escape of the flame disposed around it so as to cause the case to rise vertically and rotate on its axis at the same time. It has wings to direct its motion.

Tour'ists' In'di-cat'or. A WAYMARKER, PEDOMETER, or other instrument for measuring or automatically mapping a route.

Tour'ma-line. 1. A prism of schorl used in polarizing apparatus.

2. *Rubellite* and green tourmaline are used as gems.

Tour'na-sin. (*Pottery.*) A knife for the removal of superfluous slip from the baked ware which has been ornamented by the BLOWING-POT (which see).

Tour'nay. A printed worsted material for furniture upholstery. *Tournai* in Belgium (Fl. *Doormick*).

Tour'ni-quet. (*Surgical.*) An instrument for compressing an artery in amputations. The invention of Morelli, 1674, modified by other distinguished surgeons. Also used in compressing aneurisms and tumors. See Fig. 212, page 103.

The screw-tourniquet was invented by Petit of France, 1718. The form now in common use, an improvement on that of Petit, was patented by Savigny of London in 1800. Improvements have also been made by Nuck, Verduc, Monro, and others.

The heroes before Troy had one field physician, but in general the soldiers of the armies of the ancients, or sympathizing females, gave what attention they could to the wounded. In the Roman army each cohort had a physician. The first trace of

field-hospitals is in the sixth century. The convention of Ratisbon, 742, ordered that every army should have a corps of chaplains, and every colonel a confessor, but does not refer to a medical staff.

Gustavus Adolphus appointed four surgeons to a regiment.

The essential parts of a tourniquet are a pad, which is compressed upon the severed artery above the point of division, and a band, by which it is tightly held to the limb.

a (Fig. 6570) is Tiemann's direct-pressure tourniquet. Both sides of the pad are free from pressure, so as not to stop the circulation of the venous blood.

b, Petit's spiral tourniquet.

c, United States Army field-tourniquet.

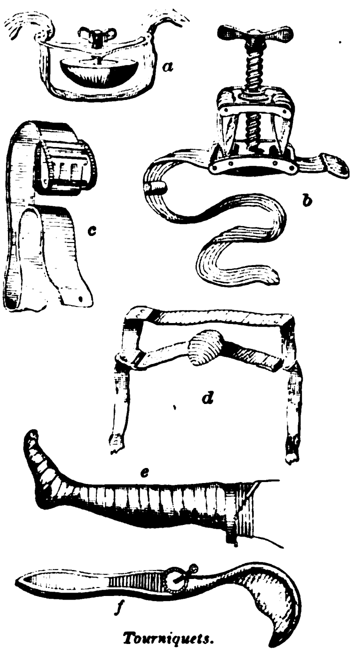
d, Valentine Mott's tourniquet.

f, Lawrence's eye-tourniquet.

e, tourniquet by Professor Esmarch of Kiel, particularly adapted for operations, as necrotomy, in which a great effusion of blood is to be apprehended.

The lower portion of the limb is enveloped in oiled silk, to prevent soiling the bandage, and an elastic rubber bandage is then tightly wrapped around the lower part of the limb, forcing the blood out of the vessels. Above the termination of the bandage, an india-rubber cord is wound four or five times around the limb, and its two ends are joined by a hook upon one entering a link of the chain attached to the other. In order to perform the operation, the oiled silk and bandage are removed; when completed, the rubber cord is slowly unwound, and any small arteries which may have remained unnoticed, tied. This tourniquet can be adjusted to any portion of the limb, and the location of the principal arteries need not be considered. The compression of the soft parts and arteries by the rubber tubing is so complete that no blood can enter the bandaged portion of the limb.

Fig. 6570.



Tourniquets.

Tow. The coarse part of hemp or flax separated from the finer by the *hatchel* or *swingle*. The longer and fine fiber is called *line*.

Tow-boat. A steam-tug.

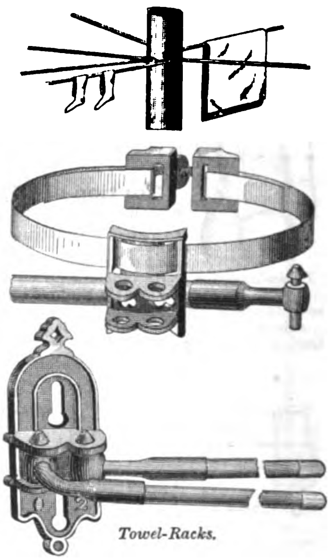
Tow'el-ing. Coarse linen fabric, such as huck-a-back, diaper, etc.

Tow'el-rack. A frame or rod on which to hang towels to dry. Fig. 6571 shows two kinds: one has a strap clamped to the stove-pipe; the next is an enlarged view of the same; the lower one has a plate screwed to a wall or piece of furniture, and several jointed rods projecting from it.

Tow'er. (*Architecture.*) A structure, lofty in proportion to its base, and circular or polygonal in plan, frequently consisting of several stories. In a church, that part which contains the bells and from which the steeple rises.

Towers, beginning with that of Babel, have been erected from the earliest ages as memorials, and for purposes of religion and defense. In latter years, as shot-towers and chimneys of manufacturing establishments, they have been built of great hight for purposes of practical utility.

Fig. 6571.



Towel-Racks.

Tow'er-clock. A large clock designed for church turrets and similar situations.

That shown in Fig. 6572 has the works arranged in an iron case having legs which are bolted to the floor; the pendulum-rod passes through an elongated opening in the floor. Wooden boxes filled with stones are used as weights. See also Fig. 1332, page 570.

Fig. 6572.

Howard's Tower-Clock.

Tow-hook. An artilleryman's hook, used in unpacking ammunition-chests.

Tow'ing. (*Nautical.*) A mode of propulsion of a vessel through the water by a rope from another vessel, or from the shore, or by a rope laid along a canal or river and passed over a drum on board the vessel.

In harbors tow-boats, or *tugs*, are specially devoted to this purpose. On canals horses or mules are generally employed. The substitution of other motors for animal power has of late years engaged much attention, and various other means have been either tested or proposed. Prominent among these is the system introduced into Belgium, and employed on the Erie Canal, between Albany and Troy. In this a submerged wire rope is employed resembling a telegraph cable, and passing

over a drum, rotated by the engine on the tow-boat. This drum has pivoted clips which clasp the rope as it presses upon their feet and let it go after passing over the drum; a roller then presses upon the cable, causing it to descend in a nearly perpendicular direction to the bottom, so that its slack may not act as a drag on the boat. The tug is designed to tow six canal-boats, at a speed of three miles an hour.

The "Nythia" tug is operated by this means on the Danube. This boat has a length of 138 feet, beam 24½ feet, depth of hold 7½ feet, two false keels, and a rudder at the bow and stern worked by separate wheels placed nearly amidships. She is propelled by twin screws, 4½ feet in diameter, worked by two vertical engines near the bow, and supplied with steam by the same boilers which work the clip-drum machinery.

The clip-drum has a diameter of 10 feet 6 inches, it is keyed to the end of the main shaft, overhanging the boat on the port side. Two swiveled guide-pulleys, of the same diameter as the drum, are employed to conduct the rope, which passes above the first and beneath the second, to the clip-drum: a third similar pulley behind the drum directs the rope downward. The bow of the boat slopes downward to the water's edge, permitting the rope to pass freely over it at any angle. With eight barges in tow, this boat has attained a speed of 5¾ miles an hour, making a progress of nearly 3 miles an hour against a current of over 2¾ miles.

Chain towage is also used on the river St. Lawrence, for propelling the tugs which bring the vessels up the rapids below Montreal. The cable of 7,000 length was laid in July, 1873. The power is obtained from a pair of long-stroke engines, 22-inch cylinder, 5 feet stroke. The chain barrels are 2 feet in diameter, and carry 9 tons of 1¼-inch short-link chain. The engineer was Mr. A. G. Nish.

Tow'ing-bri'dle. (*Nautical.*) A chain with a hook at each end for attaching a towing-rope to.

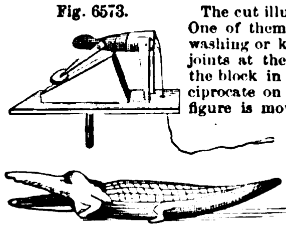
Tow'ing-path. The track on the *berme* of a canal for the draft animals.

Tow'ing-post. A stout post on the deck of a tug-boat to fasten the towing-line to.

Tow-line. (*Nautical.*) A hawser or rope used in towing a ship or canal-boat; a *tow-rope.*

Toy. Among the more serious historical matters disinterred from the Egyptian tombs are a number of dolls and toys.

Fig. 6573.



Egyptian Toys (*Museum of Leyden*).

The cut illustrates two of the latter. One of them is the figure of a man washing or kneading dough, and has joints at the hips and arms, so that the block in the hand is caused to reciprocate on the inclined plane as the figure is moved by the string. The other figure represents a crocodile having its upper jaw hinged, as in nature.

The game of thimble-rig occurs in a painting, and the illustration is from the work of Professor Rosellini.

Toys have been disinterred by General di Cesnola from the tombs of Golgoi and Idalium in Cyprus, — painted dolls of clay modeled with the fingers; mounted cavaliers armed with shields, or horses attached four abreast to cars. One, a horse a foot in length, rolling on movable wheels, was found in a diminutive grave, older probably than Hector and Andromache.

The toys of the Roman children were of various kinds; some found at Pesaro were little leaden gods and goddesses, with altars and sacrificial instruments (*Lararium puerile*). They had also puppets, geometrical figures of ivory to be fitted together, dolls, terra-cotta figures with arms and legs moved by a string, like the modern *patins* and *marionettes;* popguns, blow-guns, bows and arrows, tops.

Hooker, the naturalist, states that he was amused at the Monastery of Doobdi, in Sikkim, which is on the flank of the Himalayas, by watching a child playing with a popgun, made of bamboo, similar to that of quill, with which most English children are familiar, which propels pellets by means of a spring-trigger made of the upper part of the quill. "It is easy," he says, "to conclude such resemblances between the familiar toys of different countries to be accidental, but I question their being really so. On the plains of India men may often be seen, for hours together, flying what with us are children's kites; and I procured a jews-harp from Thibet. These are not the toys of savages, but the amusements of people more than half civilized, and with whom we have had indirect communication from the earliest ages. The Lepchas play at quoits, using slate for the purpose, and at the Highland games of 'putting the stone' and 'drawing the stone.' Chess, dice, draughts, Punch, hocky, and battledoor and shuttlecock, are all Indo-Chinese or Tartarian."

Wooden carved toys are almost exclusively produced in the hilly wooded regions of Germany and Switzerland, where they are generally carved by the peasants, when not employed in farm labors, the whole family, even to the smaller children, taking a part in the work.

The cheaper kinds, as Noah's arks, soldiers, tea-sets, etc., are principally produced in the vicinity of the Black Forest, Nuremberg being the principal depot.

Sonneburg, in Thuringia, exports about 25,000 cwt. of the better class of wooden toys, made in the town and vicinity.

Switzerland excels in wooden cottages, models, etc., and France in mechanical or clock-work toys.

Rocking-horses, carts, velocipedes, drums, doll's houses, and a variety of other articles, are made in large quantities in London. The United States makes its own toys of the larger kind, riding-horses, volocipedes, etc., but the small ware is yet largely imported.

"France and Germany are the chief competitors in the toy market, — the first for taste, and the second for cheapness. The peasants of Saxon Switzerland spend their winter evenings in cutting out the immense supply of farmyards and their appropriate animals, soldiers of every nation, and household implements of every kind, which, dispatched to Paris from Olbernau, in fragile wooden boxes, are sold for two or three francs. Beasts, covered with velvety coats, colored according to the animal, are made at Rodach, toys in porcelain at Ohrdruff; whilst the baby dolls, simply attired, come from Sonnenberg, Neustadt, and Wallerhausen. Men made in plaster are dispatched to us from Prussia, whilst leaden soldiers, measuring about an inch in hight, painted and heavily armed, come from Bavaria, Nuremberg, and Furth. Household utensils in china — such as pipkins, saucepans, cups and saucers, dolls' heads in china, games of lotto, penny watches, wooden wheelbarrows, spades, and rakes — are made in the departments.

"The Quartier du Temple, in Paris, produces all other toys. The population of that curious old quartier are now wholly occupied by toy-making, and each workman has his speciality. For instance, the man who makes rabbits striking on a drum with their fore-paws makes no other toy. Of these there are annually 43,200 sold, prime cost, at four and sixpence a dozen.

"There are six manufactories of brass trumpets in Paris alone. 200,000 are monthly made in this city. Their prime cost is 1*s.* 3*d.* per dozen, and the supply never equals the demand. They are made of oak or beech; the wood employed is sent from Villers Catteress; the parchment from Coutances and Issoudun.

"Of dolls the number is legion. One manufacturer alone supplies the children of this capital with 50,000 per annum; and it would be impossible to detail the scores made of scraps of indefinite materials, put together by poor seamstresses living in garrets, to be sold by women still poorer crouched beneath a *porte-cochère*, now shivered by the bitter blast, and a few months hence scorched by the blazing sun. These dolls for the humble are made by no rule, but the *bebes* for the rich employ several separate trades. There are workmen who stretch the flesh-tinted leather with which they are covered, and nail it on boards, that it may acquire the requisite suppleness; others cut the skin into the shape required to cover legs, arms, etc.; others line these detached pieces with calico; others, again, fill the sewn skin with bran. A separate branch of the trade is that of adapting heads and arms to the bran-filled bodies. These heads, when in porcelain and paste, come from Germany, whereas waxen occiputs are molded and tinted in Paris. Wig-making for dolls employs three separate trades, namely, makers of human hair wigs, of wigs manufactured from the Thibet goat, and those of lamb skin. Dolls' shoes have a trade to themselves. It appears that combs for these inanimate coquettes are only to be found in the Rue Acunaire, where is a *fabrique* of dolls' combs." — *London Star.*

"The tin toys used in this country are now nearly all made in Meriden, Connecticut, where large quantities of tin household goods are also manufactured.

"Wooden toys, of the less fragile kind, are largely manufactured in several Connecticut towns, and in New York and Philadelphia. These consist of children's wheelbarrows, drums, rocking-horses, carriages, carts, blocks, rail-cars, hoops, sleds, etc.

"The patentees of the new sensation toys, as the dancing negro, the returning ball, and Quaker popgun, are said to have made fortunes. The railway train, and several other new toys, have also had great temporary success. Red india-rubber balloons are made in France, and filled here with gas.

"Pewter toys, comprising soldiers, landscapes, trees, etc., are now largely made in this country, though many are yet imported from Germany.

"The stuffed bodies of dolls are made in New York, Boston, and Philadelphia, as also the arms; but Germany still sends many. The arms of stuffed dolls are an especial article of commerce. They are not, like the legs, attached to the bodies, but are sold separately. The heads are likewise purchased, and are either of French porcelain and finely featured, of German china or papier-maché, of English wax, of American india-rubber, or of an imitation of papier-maché. This latter is of thin layers of muslin, coated with oil paint, which has the advantage of washing without injury, and is exceedingly strong, though by no means of fine finish.

"India-rubber hollow toys of every description, except balls, grotesque masks and birds, and men that squeak when squeezed, are among our own productions.

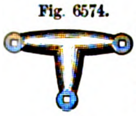
"Mechanical toys, such as imitation steam-engines, steamers, etc., are made here; as also kaleidoscopes. A negro jig-dancer, propelled by steam, is the latest Yankee notion. A kerosene lamp heats a small brass vessel full of water and shaped like a top. It revolves in its socket, and moves a wire which communicates with the figure.

"Clay marbles come exclusively from Saxony, and are prepared in molds by machinery, from a clay not found in other countries. The material for agate marbles is obtained in the Hartz Mountains of Germany.

"A Japanese top has been lately in vogue, and several Chinese toys have been for years in use.

"Croquet instruments are made in Pawtucket and Providence, Rhode Island, and in Boston and Springfield, Massachusetts. Maple is the wood principally used, though lignum-vitæ is sometimes employed. For more expensive kinds boxwood is the material. Small balls, for parlor use during the winter months, are also made. The new game of martelle employs the same woods. The parlor balls are of ivory." — *Commercial Advertiser.*

Fig. 6574.



T-Iron.

T-plate. 1. An angle-iron of T-form, having two branches.

2. A carriage-iron for strengthening a joint, such as at the intersection of the tongue and cross-bar; the coupling-pole, or reach, and the hind axle.

Trace. 1. (*Saddlery.*) A strap, chain, or rope, attached to the hames, collar, or breast-band of a harness, and to the single-tree or other part of a vehicle, and by which the vehicle is drawn.

Traces were not common in ancient Egypt, or among other contemporary nations. The animals, whether horses, asses, or cattle, were yoked to the tongue. Sometimes *one* trace passed back from the yoke along the tongue. No such thing in old Egypt as a breast-band or collar combined with a pair of traces.

Fig. 6575.

Trace-Fastener.

There were no draft or pack animals in Mexico of any kind. They appear to have had no beef or mutton, and so ate each other and dogs.

Traces are shown in Froissart and Du Cange.

2. (*Fortification.*) The ground plan of a work.

Trace-buck'le. (*Saddlery.*) A long heavy buckle used in attaching a trace to a tug.

Trace-chain. (*Saddlery.*) A wire chain used as a trace.

Trace-fas'ten-er. A hook or catch to attach the hind end of a trace to a single-tree or splinter-bar.

In Fig. 6575, the spring, acting upon the fastening pin through the pivoted lever, retains the pin securely in the position in which it holds the trace.

Trace-hook. A hook on the end of a single-tree or splinter-bar, to which is attached the harness-trace. When the trace has a cock-eye, it is looped over a stud driven into the end of the single-tree.

There are, however, many modes of attaching. Fig. 6576 shows several.

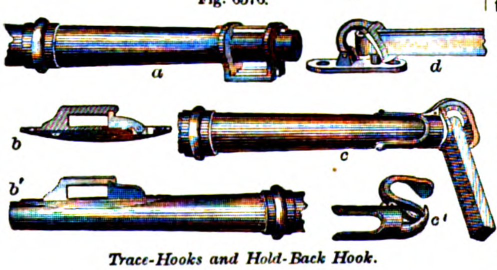
a has an iron loop which is passed through the loop at the end of the trace, then slipped upon the single-tree, and held by a spring-latch.

b b' are detached and *in situ* views of a trace-hook, with a spring-latch to form a mousing.

c c' are views of a trace-hook with a hinged latch-piece, which is kept closed by pulling on the trace, but is readily detached by a specific movement.

d is a hold-back hook for the strap of the breeching.

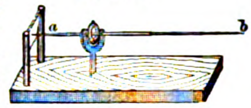
Fig. 6576.



Trace-Hooks and Hold-Back Hook.

Trace-loop. (*Saddlery.*) A square metallic loop used to attach a coach-trace to the trace-post or end of the evener-bar or single-tree.

Fig. 6577.



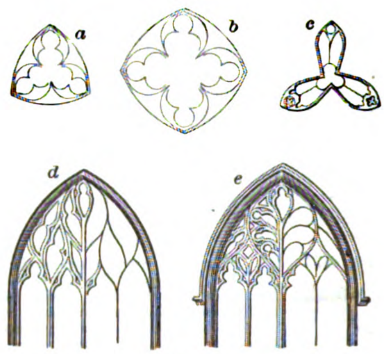
Tracer.

Tra'cer. A kind of silhouette instrument for transcribing on a different scale, or marking on a surface at *a* the outlines of an object at *b*.

Tra'cer-y. (*Architecture.*) The species of pattern-work formed or traced in the head of a Gothic window by the mullions being continued, but diverging into arches, curves, and flowing lines enriched with foliations. The styles varied in different ages and countries.

a b c, elements of German tracery.
d, French flamboyant tracery.
e, English leaf-tracery.

Fig. 6578.



Tracery.

Tra'che-o-tome. (*Surgical.*) A kind of lancet with a blunt and rounded point, mounted on a handle and fitted to a canula which passes along with it, and is allowed to remain in the opening made in the trachea. It is used for making an opening to remove foreign substances, or to permit passage of air to the lungs.

a, probe-point tracheotomy-scalpel.
b, Pitha's tracheotome and dilator.
c, Langenbeck's tracheotome.
d, Langenbeck's tracheotomy double-hook.
e, Buck's tracheotomy-guide.
f, Tiemann's tracheotome and dilator.
g, Trousseau's dilator.
h, Tiemann's tracheal forceps.
i, double trachea-tube.
j, Johnson's obdurator.
k, Tiemann's universal forceps.

Tra'che-a-for'ceps. A long curved forceps for extracting articles which may have accidentally intruded themselves into the windpipe or throat. See *h* and *k*, Fig. 6579.

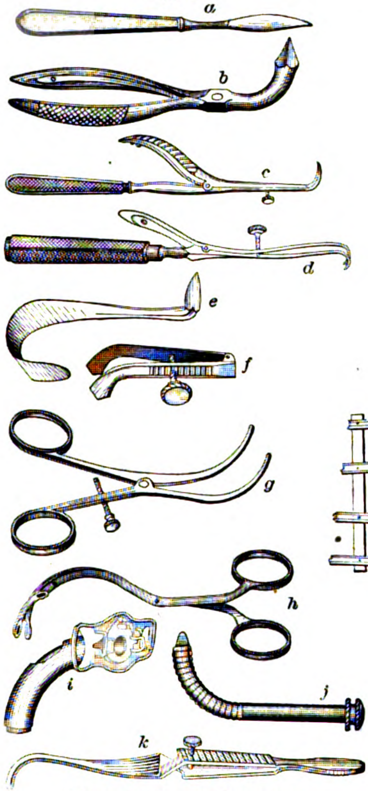
Tra'che-ot'o-my-tube. (*Surgical.*) A tube to be placed in an opening made through the walls of the trachea to permit passage of air to the lungs in case of stricture of the larynx, or the presence of foreign bodies in the air-duct. The operations of *laryngotomy*, *tracheotomy*, and *bronchotomy* are essentially similar, the terms being derived from the name of the part whose walls are penetrated to remove foreign bodies or permit passage of air to the lungs. Fig. 6580 shows several forms of tracheotomy-tubes, with buttons or shields to prevent the

canula from accidentally slipping entirely into the trachea.

Tra′cing-in′stru-ment. An instrument for copying figures on an enlarged or reduced scale. Its principle is the same as that of the profile-machine.

A long straight arm and a shorter curved arm have a universal-joint movement about a common point. The longer arm being passed over the outlines of an object, the shorter arm, which is provided with a pencil or tracer, produces a copy on a smaller scale, upon a sheet held in proper position to receive it; or the functions of the two may be reversed, producing an enlarged copy. The *silhouette* instrument is similar.

Fig. 6579.



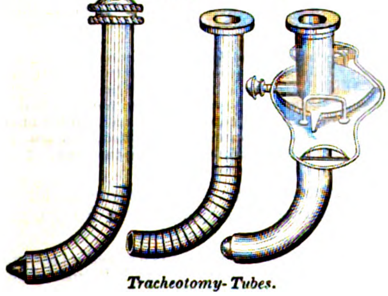
Tiemann's Trachea-Instruments.

Tra′cing-pa′per. A tissue-paper of even body treated with oil, solution of resin or varnish, to render it transparent.

Various formulas are given for preparing it.

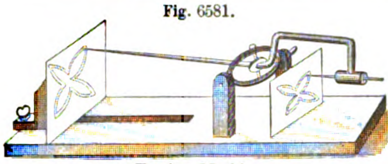
1. Dip the paper in a mixture of equal parts Canada balsam and camphene, and dry.

Fig. 6580.



Tracheotomy-Tubes.

Fig. 6581.



Tracing-Machine.

2. One ounce Canada balsam and one gill spirits of turpentine; dissolve with gentle heat, and spread the mixture with a brush on one side of good tissue-paper.

3. Moisten the paper with equal parts of nut-oil and spirits of turpentine, dry immediately by rubbing with wheaten flour, and hang up to complete the drying.

4. A German process recently patented consists in saturating the paper, preferably writing-paper, with benzine, and before this evaporates applying a varnish prepared as follows: boiled bleached linseed oil, 20 parts; lead shavings, 1; oxide of zinc, 1; Venice turpentine, $\frac{1}{4}$. Mix, and boil eight hours; when cool, strain and add white gum copal, 5; gum sandarach, $\frac{1}{2}$. The varnish may be applied by dipping, or with a brush or sponge.

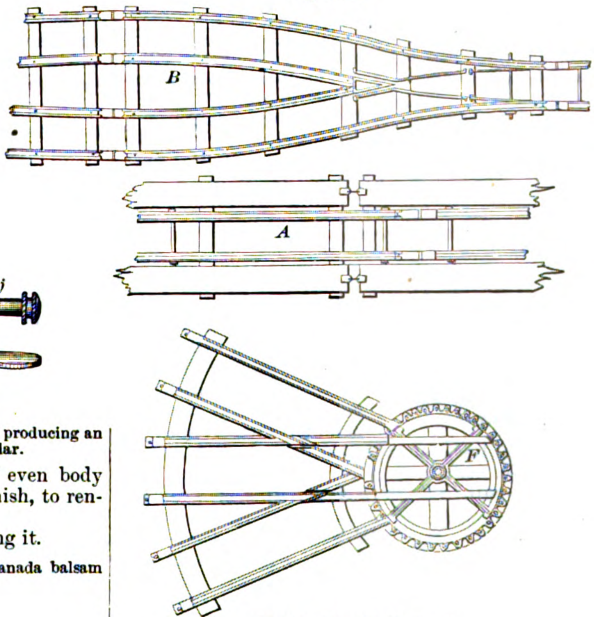
The following are the sizes usually met with: —

Double Crown .... 20 × 30 inches.
Double D. Crown .... 30 × 40 inches.
Double D. D. Crown .... 40 × 60 inches.
Grand Royal .... 18 × 24 inches.
Grand Aigle .... 27 × 40 inches.
Vellum Writing, 18 to 28 inches wide.

Track. (*Railway.*) The rails on which the locomotives and cars travel. The *way*. See RAIL.

Stimpson's patent of August 23, 1835, extended till 1852, was a great advance in the construction of railway-tracks. He made rails with gutters to hold the flanges of the wheels and avoid obstruction to passing carriages; guttered crossing-plates of cast iron; running the flanges of the outer wheel on top of the outer curve while the flange of the wheel on the inner curve ran in a guttered rail, or the tread of the inner wheel running on the flat of the rail while the outer wheel-flange ran on top of the rail.

Fig. 6582.



Peteler's Portable Railway.

Collyer, 1867, has two flanges on the wheels, the outer and smaller of which runs on the inner curve in turning.

Fig. 6582 illustrates a portable railway for excavating and constructing purposes; the sections *A* of railway, the turnouts *B*, and turn-tables *F* are dragged along the ground into position, laid on sleepers, and locked together for use.

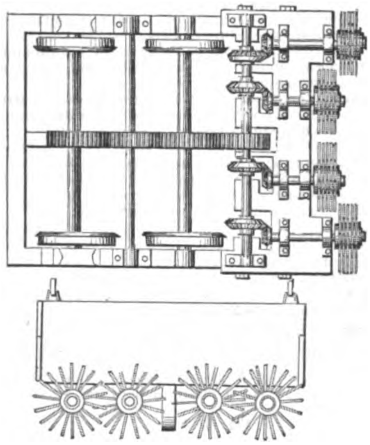
Track-boat. One pulled by a towing-line, as on a canal. See TOWING.

Track-clear'er. 1. (*Railway.*) *a.* A cow-catcher in front of, or bars extending down from the front frame of the locomotive, to push objects from the track.

b. A track-sweeper to remove snow.

In Fig. 6583, the brushes are rotated by gearing connection to the axles, and are made of radials of whole rattan inserted in a hub. See also SNOW-PLOW; STREET-SWEEPER.

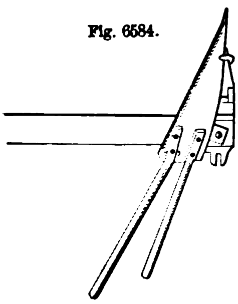
Fig. 6583.



Track-Clearing Machine.

2. (*Harvesting.*) A triangular frame on the outer end of the cutter-bar of a mowing or reaping machine to draw the grain toward the cutter and leave a clear track for the grain-wheel in the next round.

Fig. 6584.



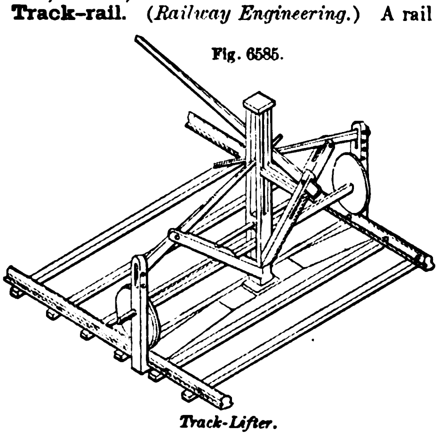
Track-Clearer for Mowing-Machines.

Track-har'ness. (*Saddlery.*) A breast-collar single harness, made up in the lightest and plainest manner.

Track-lay'er. (*Railway Engineering.*) A carriage provided with apparatus for placing the rails in their proper positions on the track as the machine advances over a portion of the track already laid down. Robertson's patent, No. 82,350.

Track-rail. (*Railway Engineering.*) A rail for the tread of the wheel, in contradistinction to a guard-rail, for instance. See RAIL.

Fig. 6585.



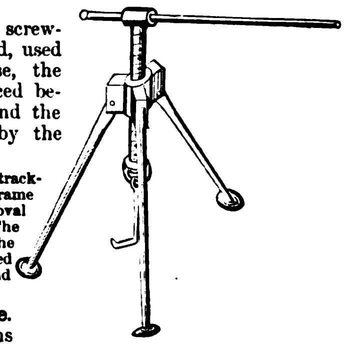
Track-Lifter.

Track-rais'er. A lifting-jack for raising rails which have become sprung below the proper level.

Fig. 6585 is a screw-jack on a tripod, used for this purpose, the hook being placed beneath the rail and the screw rotated by the handspike.

Fig. 6586 is a track-lifter in which the frame has wheels for removal on the track. The claws take under the rails, and are raised by the compound levers.

Fig. 6586.



Rail-Jack.

Track-scale. One which weighs a section of railway-track with the load thereupon. The Fairbanks track-scale is shown under WEIGHING-SCALE.

Trac'tion. The adhesive friction of a wheel on the rail, a rope on a pulley, etc. The tractional surface of a driving-wheel is the face of its perimeter.

Trac'tion-en'gine. A locomotive-engine for drawing heavy loads upon common roads, or over arable land, as in agricultural operations.

Some of the earliest locomotive-engines, as Murdock's, were designed for this very purpose.

One of the earliest forms of traction-engine was Boydell's. This had endless chains of boards fitted to its wheels, forming a sort of endless railway which was laid down and taken up by the engine as it proceeded; the wide bearing afforded by these enabled the engine to travel over soft ground.

Bray's had very wide wheels, provided with sliding plates which were protruded through openings in its periphery and withdrawn by central eccentrics. These embedded themselves in the ground and caused the machine to advance. Compare ROAD-LOCOMOTIVE, ROAD-ROLLER, ROAD-STEAMER, etc.

Figs. 6587, 6588, show that of Thomson of Edinburgh, who first applied rubber tires to this class of engines, as improved by Williamson of New York.

The framing, *a a*, is of wrought-iron, in a single piece. The rims of the driving-wheels *b* are perforated with numerous holes into which the back of the rubber tires *c* are forced, obviating slippage; these are surrounded by endless chains *d*, armed with bars of steel, and held in position by a flange on each side of the wheel. The boiler *e* is of the upright tubular kind, and connects with two steam-cylinders whose pistons operate crank-shafts turning gears which cause the wheels to revolve. By means of appropriate levers the gears may be shifted so that the drivers may be caused to make six or eighteen revolutions to one of the crank-shaft. The gear on one side may also be thrown out while that on the other is working, thus facilitating the turning of abrupt corners.

By means of a reversing gear *f* the engine may be run either forward or backward.

The steering-wheel *g*, through the medium of a vertical shaft and bevel-gears, changes the direction of the single front wheel by which the machine is guided. The water-tank *h* is provided with a suction-pump by which it may be filled from a running stream or other convenient source. One of the coal-bunkers *i* is placed on each side of the platform on which the fireman stands.

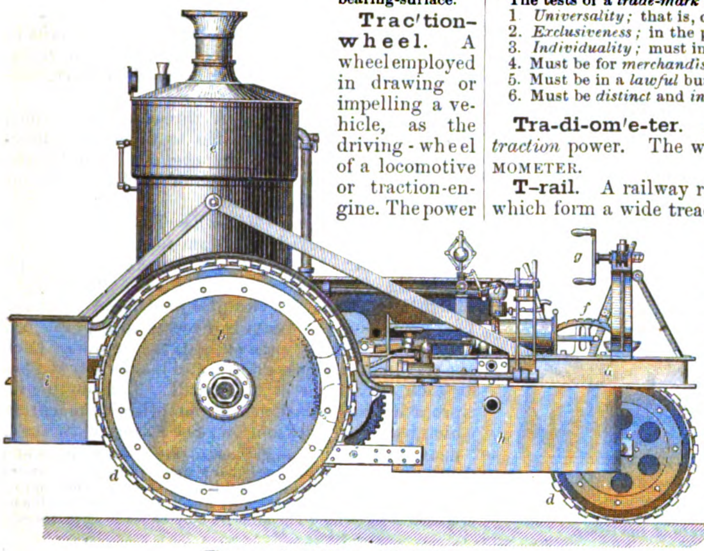
Fig. 6589 is Longstaff and Pullan's traction-engine; its general features do not differ essentially from those of others previously described. Its minor details are, however, according to the Mechanics' Magazine, so arranged as to render it one of the most efficient machines of this class. By a peculiar mode of suspension of the boiler, priming is obviated, and ten hours' work may be performed without refilling the tank. See also ROAD-LOCOMOTIVE; ROAD-ROLLER.

Trac'tion-gear'ing. An arrangement for turning a wheel and its shaft by means of friction or adhesion.

In Fig. 6590, the peripheries of the two wheels *a b* are grooved to receive the band *c*, by which they are both rotated in the same direction. The circumference of the driven wheel *d* is

doubly beveled to correspond with the grooves in the driving-wheels, that it may have a greater bearing-surface.

Fig. 6587.



Thomson Road-Engine (Side Elevation).

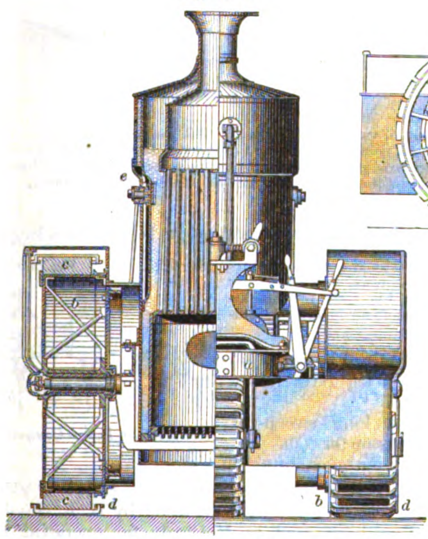
Trac'tion-wheel. A wheel employed in drawing or impelling a vehicle, as the driving-wheel of a locomotive or traction-engine. The power is applied to the wheel, and the frictional adhesion of the rotating-wheel on the rail or ground is the immediate cause of progression.

Trac'tor. An obstetric forceps.

Trade. (*Mining.*) *Attle*, or rubbish.

Trade-mark. An arbitrary symbol affixed by a manufacturer or merchant to a vendible commodity. The principal purpose of a trade-mark is to guaran-

Fig. 6588.



Thomson Road-Engine (End View and Section).

tee the genuineness of a product. It is, in fact, the commercial substitute for one's autograph. In all ages it has been used to denote origin, and thus to protect the purchaser as well as the vender. All countries protect the integrity of trade-marks, and nearly all civilized nations have treaties or conventions securing reciprocity of protection.

The tests of a *trade-mark* are: —

1. *Universality;* that is, commonly recognized as such.
2. *Exclusiveness;* in the possession of the owner.
3. *Individuality;* must indicate origin and ownership.
4. Must be for *merchandise.*
5. Must be in a *lawful* business.
6. Must be *distinct* and *invariable.*

Tra-di-om'e-ter. A measurer of *drawing* or *traction* power. The word is a bungle. See DYNAMOMETER.

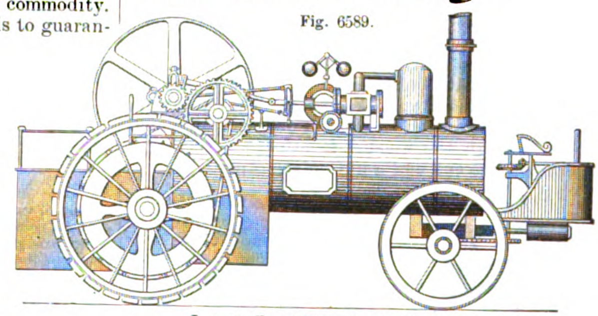
T-rail. A railway rail having two flanges above, which form a wide tread for the wheels of the rolling stock. The vertical web is gripped by the chairs, which are spiked to the ties. Invented by Birkenshaw, 1820. See RAIL; RAILWAY.

Trail. (*Ordnance.*) The end of the stock of a gun-carriage, which rests upon the ground when a gun is "unlimbered," or in position for firing. The stock proper is inserted into a forked iron plate, the *lunette*, having a loop wrought on its outer extremity, which is passed over the pintle-hook of the limber when the gun is limbered up.

2. (*Architecture.*) A running enrichment of leaves, flowers, tendrils, etc., in the hollow moldings of Gothic architecture.

Trail-board. (*Shipbuilding.*)  One of the curved boards on each side of the stem, reaching from it to the figure-head.

Fig. 6589.



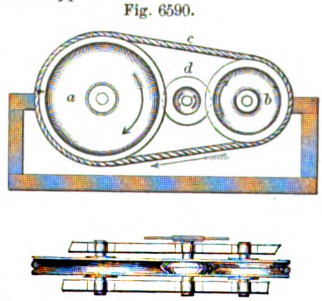
Longstaff and Pullan's Traction-Engine.

Trail'er. A self-acting brake formerly used on inclined planes. A *stopper.*

Trail'ing-ax'le. An axle behind the driving-axle in British locomotives.

Trail'ing-spring. In British locomotives, the springs fixed on the axle-boxes of the trailing-wheels of a locomotive-engine, which bear slightly against the side frames, so as to leave as much weight as possible upon the

Fig. 6590.



Traction-Gearing.

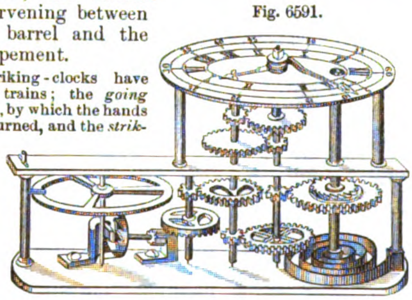
driving-springs, and to assist in deadening any shock which may take place.

Trail'ing-wheel. One of the wheels of a locomotive not concerned in the driving.

Trail-net. A net drawn or trailed behind a boat; or by two persons on opposite banks in sweeping a stream.

Train. 1. (*Machinery.*) A set of wheels, or wheels and pinions in series, through which motion is transmitted in regular consecution: *e. g.* the *train* of a watch; the wheels intervening between the barrel and the escapement.

Fig. 6591.



Watch-Train.

Striking-clocks have two trains; the *going* train, by which the hands are turned, and the *striking* train, by which the striking part is actuated. Watches and clocks which do not strike are destitute of the latter.

2. (*Ordnance.*) *a.* A certain number of field or siege pieces, organized and equipped for a given duty.

b. The hinder part of a gun-carriage; the *trail.*

3. A line of combustible material to lead fire to a charge or mine. See BLASTING; FUSE.

4. (*Metallurgy.*) Two or more pairs of connected rolls in a rolling-mill and worked as one system.

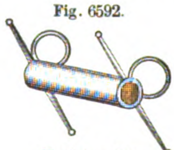
The first pair are known as the *muck*, or *puddle-bar train*, and the finishing as the *merchant-train.*

5. (*Railway.*) A series of cars coupled together.

6. (*Vehicle.*) A heavy long sled used in Canada in hauling wood or merchandise.

Train'ing-bit. (*Manege.*) A wooden gag-bit used when training vicious horses. The cheeks are of iron, and are connected by a rod or iron which passes through the wooden mouth-piece, having a head upon one end and a nut on the other.

Fig. 6592.



Training-Bit.

Fig. 6593.

Trammel.

Train'ing-hal'ter. (*Manege.*) A halter made in the same manner as a riding-bridle, with the exception of having short instead of long cheeks, which are provided with rings into which bit-straps may be buckled.

Train'ing-lev'el. (*Ordnance.*) An instrument for leveling or training guns. See LEVEL.

Train'ing-pen'du-lum. (*Ordnance.*) An instrument having a pendulum and a level member, with a glass and bubble; used in training guns to any required elevation.

Train-road. (*Railway.*) A construction railway; a slight railway for small loads.

Train-tack'le. (*Ordnance.*) A purchase by which a gun-carriage is secured to a ring-bolt in the deck, to prevent running out while loading.

Train-way. A hinged platform which forms a bridge leading from a wharf to the deck of a ferry-boat.

Tra-jec'to-ry. (*Ordnance.*) The curved line described by the center of gravity of a projectile in its flight.

Tram. 1. (*Mining.*) A four-wheeled truck for carrying a *corve, hutch*, or *basket* on a pair of rails in a mine, or in carrying the coal or ore. The *tram-way* was the first iron railway. See RAILWAY.

2. One of the rails of a tram-road.

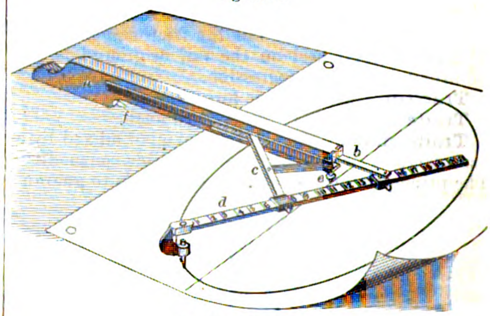
3. (*Silk-manufacture.*) A thread of silk formed of two or more *singles* twisted together in a direction opposite to that of the *singles;* used for the *shoot* or *weft* of some description of goods. *Organzine* is double-twisted, like a rope.

Tram-car'riage. (*Mining.*) The carriage (usually of iron) employed on a tram-road. A *tram.*

Tram'mel. 1. (*Drafting.*) *a.* An ellipsograph consisting of a cross with two grooves (Fig. 6593), which form guides for two pins on a beam compass. The pencil on the beam is directed in a prescribed elliptical path as the pins slide in the grooves. Each pin travels in its own groove, and makes four strokes for each revolution of the pencil. This double reciprocation has occasioned its adoption in machines which require speedy motion See TRAMMEL-WHEEL.

Bowly's *trammel*, or *oval compass* (Fig. 6594), consists of a slotted stock *a*, in which slides a bar *b*, and a protractor *c*, united to the graduated scriber *d* by adjustable sockets. One end of the scriber has a swivel-holder for a pen, pencil, cutting-blade, or glazier's diamond. The arms *b c* may be set so as to describe ellipses of varying proportions. The instrument turns on a pin *e*, and a pointer *f* at the end of the slot determines the direction of one axis of the ellipse; it may be so adjusted that either the longer or the shorter axis may be parallel with the stock.

Fig. 6594.



Bowly's Trammel.

b. A *beam-compass.*

a a (Fig. 6595) are *trammel-points*, to be placed on a long bar for striking large circles. They are held at the desired points by set-screws, and the larger sizes (*b*, Fig. 6596) have an arrangement for holding a lead-pencil.

Fig. 6595.

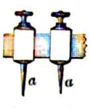


Fig. 6596.

Trammels, or Beam-Compasses.

2. A shackle to put on a horse's leg to teach him to pace.

3. A long sweep-net for birds or for fish.

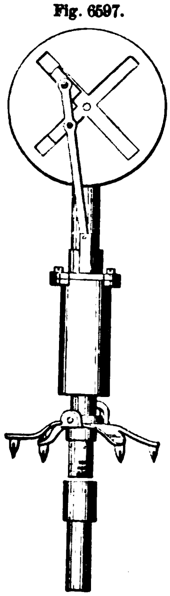
4. A pothook, hung in a chimney.

Tram'mel-wheel. Sometimes called a *slosh-wheel.* It was patented in 1836 by B. F. Snyder, and has been used by McCurdy for operating the needle of a sewing-machine. It has also been used for driving a saw, or gang of saws.

This wheel has two slots crossing each other at right angles and forming guides for two sliding-blocks, to which a pitman is connected. The rim of the wheel is not an essential part. As the wheel rotates, the sliders keep in their own grooves, crossing each other's tracks, and the pitman makes two up and two down strokes for each revolution of the wheel. This compara-

tively rapid execution makes the device useful for small pumps, churns, etc. See Fig. 3894, B, page 1769.

Fig. 6597.



Trammel-Wheel.

A modification of the trammel is found in the annexed multiple-gearing, in which the wheel with six slots is driven by the revolution of the wheel with three arms. Each arm has an anti-friction wheel at the end, which traverses the slots. Each revolution of the small wheel makes a half-revolution of the trammel-wheel.

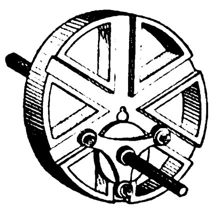
Tramp. 1. An iron sole-piece worn beneath the shoe to protect the foot and the shoe from injury when digging.

2. A tool for trimming hedges.

Tram-plate. The first form of iron railway-rail.

It was patented by Carr of Sheffield,

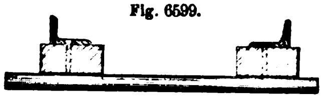
Fig. 6598.



Trammel Multiple-Gearing.

1776. Previous to this time, the wooden trams had been protected by malleable iron plates, a practice introduced at Newcastle about 1602. The Coalbrookdale Iron Company substituted cast-iron plates 5 feet long, 4 inches broad, and 1¼ inch thick; this was in 1767. Carr was the first to make the iron rail. Jessop made edge-rails of cast-iron in 1789. Birkenshaw introduced the rolled rail in 1820.

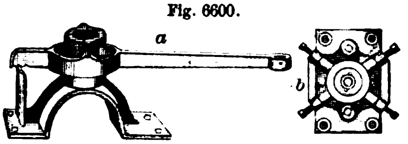
Fig. 6599.



Tram-Plates.

Tram'pot. (*Milling.*) The support in which the foot of the spindle is stepped. The arched trampot *a* is used for straddling the driving-shaft where bevel-

Fig. 6600.



Trampot.

gear is employed. The more common form *b* has a movable center adjustable by means of four set-screws.

Tram-road. A road in which the track for the wheels is made of timbers, flat stones, or iron, while the horse-track between is left sufficiently rough for the feet of the horses.

One was laid down in 1602 in the neighborhood of Newcastle by Beaumont, and was in use in 1676. It is not likely that they would be disused until superseded by railways. They are described by Roger North in 1676 as being rails of wood grooved to form tracks for the wheels which traversed therein.

An iron tram-road was laid between Wandsworth and Croydon, in England, in 1802.

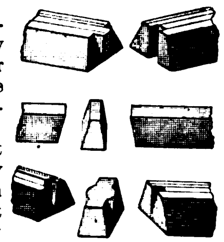
A flagstone tram-road was laid in the Commercial Road, London, before 1829. On it the merchandise of the East and West India Docks was transported to the city of London.

Iron railways were laid down by Carr at Sheffield, 1776, and by the Coalbrookdale Iron Company in 1786. See RAILWAY.

Matthews's stone tram-way (English) has stones 4 feet 2 inches in length, 14 inches wide at base, 11 inches at top, and 10 inches deep. He proposed several mortise and tenon joints, shown in the illustration, to give mutual vertical and lateral support.

Tram-staff. (*Milling.*) A miller's straight-edge, which is employed to test the squareness of the spindle with the face of the stone.

Fig. 6601.



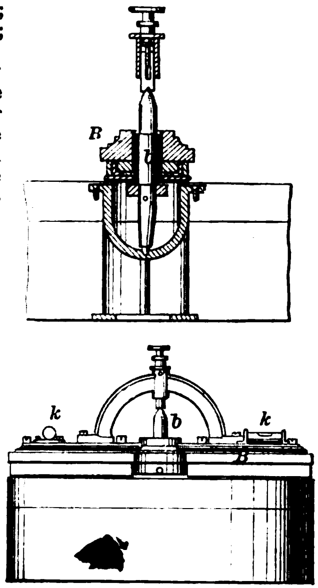
Matthews's Tram-Joint.

The gage-staff *B* is centered upon the millstone by means of the circular center fitting over and around the spindle *b*. *k k* are spirit-levels.

The *red-staff* is a straight rule with a red edge, to lay upon the stone and touch with red any prominent parts, in order that they may be reduced to the general level.

Tram-way. A wooden or iron way adapted to *trams*, that is, coal-wagons. It was the precursor of the railway. They were originally of wood, and first made in England in 1600. See TRAM; TRAM-ROAD; RAILWAY.

Fig. 6602.



Tram-Staff.

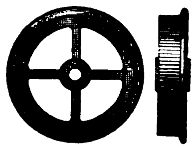
Tram-way Mo'tor. The English name for the locomotive which is not used on rails. See TRACTION-ENGINE; ROAD-LOCOMOTIVE; STEAM-CARRIAGE; STREET-RAILWAY CAR.

Tram-wheel. A wheel used on the small cars employed in mining and excavating operations, and which run on what in England are known as *tram-ways*. These in general have wooden rails merely faced with iron.

Trank. (*Glove-making.*) An oblong piece cut from the skin, and from which the shape of the glove is cut on a knife in a press.

Tran'sept. The north and south *arms* of a cruciform church, assuming the building to be correctly aligned, the choir to the east.

Fig. 6603.



Tram-Wheel (Mining).

Trans'fer. An impression taken on paper, cloth, etc., and then laid upon an object and caused to adhere thereto by pressure.

In engraving, a tracing may be made in pencil and transferred to the *ground* by running through the plate-press. See ENGRAVING.

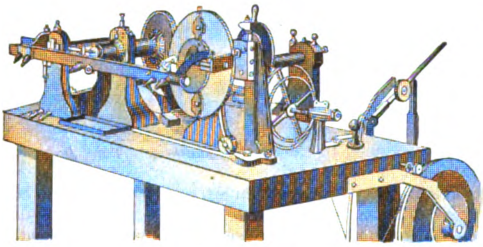
An impression from a plate or stone may also be transferred to a stone, as in the processes described under LITHOGRAPHY, section 3, page 1334.

In Kuehn's mode of making pictures by transfer, the different colors requisite for a picture are printed

on sized paper and successively transferred to a japanned plate.

To obtain a transfer larger or smaller than the original, an impression is taken upon india-rubber, by one of several modes: To effect it on an enlarged scale, the surface of a sheet of vulcanized india-rubber, equal in size to the subject, is coated with a thin film of an elastic composition, and on it is taken an

Fig. 6604.



Transfer-Lathe.

impression of the print, block, or plate. By means of a peculiar expanding frame, the sheet of india-rubber is now stretched on all sides simultaneously till it attains the size required. While retained in this form, it is laid down on a lithographic stone, or zinc plate, properly prepared, which is then in a condition to furnish impressions by the ordinary method.

The reduction of the object is obtained by stretching a comparatively small piece of india-rubber till it can cover the subject; the impression being then taken, it is released from the strain and returns to the original size, and the process is finished by transferring it to a stone or plate.

For surface-printing it is transferred to a plate, which is then *bit away* in the parts not covered by the ink, leaving the impression salient. From this a matrix is taken by the electrotype process, and this, by a repetition of the process, furnishes a block from which impressions may be had by the usual surface-printing process. The use of the camera is now general and preferable.

Trans-fer'ring-ma-chine'. (*Engraving.*) This machine is used by bank-note engravers to obtain upon rollers cameo copies of engraved dies, and to transfer impressions from the rollers to the plates, from which notes, etc., may be printed.

In bank-note and similar engraving, the views, portraits, and ornaments are not engraved immediately upon the plate from which impressions are printed, but each design and ornament is engraved on a separate piece of softened steel, which forms a *die*. The dies are placed in a closed crucible, with animal charcoal, brought to a red heat in a furnace, and, after cooling, are ready for the transferring-machine.

The die is placed on the adjustable bed-plate of this machine, and a softened steel roller is placed in the oscillating head above. Arrangements are made for bringing the parts in perfect apposition, so that the roller may come in contact with the die in the required place. The die and roller being then brought forcibly together, the roller is made to revolve over the die, and the metal of the former is pressed into all the lines of the die, making a cameo or salient impression of the engraving.

The roller is then hardened, and is ready for delivering an impression to a bank-note plate. The pressure of the roller upon the plate in the transferring-machine is given by a system of compound levers, and is regulated by the pressure upon a treadle of the foot of the operator, or by a hand-lever. The rolling is repeated again and again by rocking it back and forth until the steel of the roller has insinuated itself fully into every line of the die, whether heavy or light, and the larger machines can give a pressure of 35 tons.

When a bank-note is ordered, the directors make choice of the designs they require, each being on a separate piece of paper, as printed from the die. The choice being made, the arrangement is to be determined, and the rollers are then brought forward to deliver their impressions separately upon the face of the plate, which is attached to the bed-plate of the transferring-machine. Thus each view, ornamental letter, portrait, lathework, rosette, or star is transferred to the plate. The *lettering* is then engraved upon it with the graver, or by die. By lettering is meant the name of the bank and such matters. These completed, it is ready for the printing-press. See also TRANSFER-PRESS; BANK-NOTE ENGRAVING.

Trans'fer-lathe. (*Coining.*) For the purpose of reducing large designs in relief, to proportions suitable for coin, a machine has been invented in France and imported into the United States Mint.

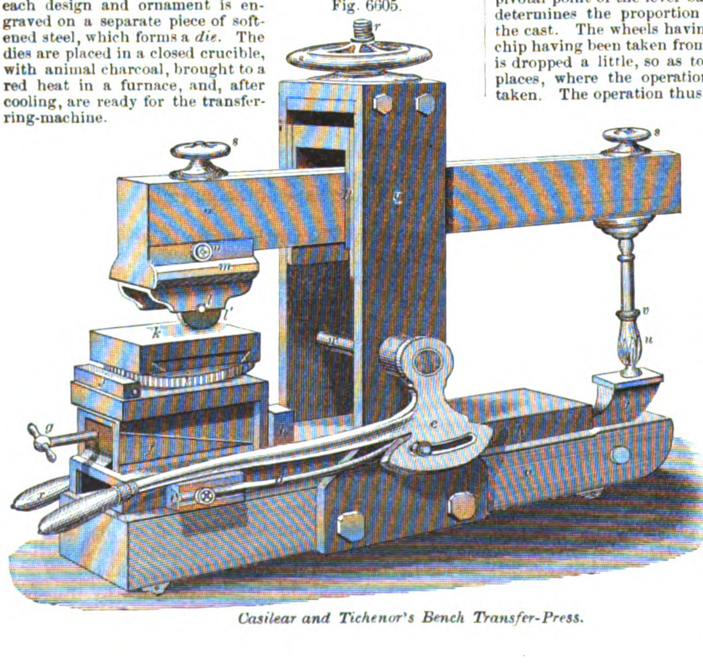
If the design has been made in wax or other soft material, a cast in metal is taken of it, and from this copy, properly fixed in the transferring-machine, the engraving is made on the end of the *hub* from which *dies* are to be *sunk*.

The brass cast is fastened to the larger wheel of the machine, and the softened steel plug to the small wheel on an arbor parallel to the former. These wheels revolve at an equal rate. Across the front of the machine, opposite the faces of the cast and the steel block, is a horizontal bar, pivoted at one end to a standard on the bed-piece, and drawn toward the faces of the cast and block by a spring.

On this lever are two important parts of the machine. A steel stub projects against the face of the copy and a graver against the face of the steel block. Now, as the two wheels revolve, the cameo or salient design on the copy thrusts out the stub, and the graver is withdrawn in the equivalent ratio from the steel. When the steel stub traverses the flat face of the copy, the graver does the same on the steel.

The relative distance of the stub and the graver from the pivotal point of the lever-bar, to which they are both attached, determines the proportion which the engraving shall bear to the cast. The wheels having made a revolution, and a circular chip having been taken from the steel, the outer end of the lever is dropped a little, so as to bring the stub and graver to other places, where the operation is repeated, another chip being taken. The operation thus proceeds till the whole face of the casting and steel have been traversed, the latter being a "copy in little" of the former. The roughnesses and graver-marks are dressed off by the tools of the die-sinker.

Fig. 6605.



Casilear and Tichenor's Bench Transfer-Press.

Trans'fer-pa'per. Prepared paper used by lithographers, or for copying in a press. See page 1330.

Trans'fer-press. Fig. 6605 is a bench transfer-press, invented by George W. Casilear and George W. Tichenor of the United States Treasury.

The following statement of parts will sufficiently describe it, in connection with the previous description and the other articles,—BANK-NOTE ENGRAVING; STEEL-PLATE ENGRAVING; etc.

a, bed.
b, carriage.
c, carriage-lever, which gives the motion.
d, connecting-rod.
e, adjustable slide.
f, wedge.

g, screw.
h, wedge-post.
i, division.
j, dog and spring.
k, slide and table.
l, railway.
l', roll.
m, rocker for leveling the roll.
n, screws for moving the rocker.
o, beam.
p, beam-box in which the beam swings.
q, uprights.
r, screw for raising beam.
t, fulcrum.
u, adjustable fulcrum-rod.
v, check-nut.
w, shaft.
x, lever of fulcrum which gives the pressure to the beam.

Trans'fer-print'ing. A name applied to the processes of *anastatic printing*, *chemitype*, and *paneiconography*.

In the first a printed sheet is moistened with dilute acid and pressed upon a zinc plate, which becomes etched in those parts which have not been touched by the ink; a mixture of gum and water being applied adheres to the etched portions, leaving the inked parts intact. On passing an inked roller over its surface the ink adheres to the printing, but is repelled by the rest of the plate, so that impressions may be taken from it in a copper-plate-press.

In *chemitype* a zinc plate is varnished, etched, and the etching bitten in with acid; the etched lines are then filled up with molten fusible metal, which is afterward scraped down to a smooth level; strong acid is then applied, which eats away the zinc, leaving the fusible metal in relief to print from.

In *paneiconography* the design is transferred from a print or lithograph, or else drawn by hand, with lithographic ink, on a zinc plate. An inked roller being drawn over the plate, the new ink adheres to the old, and is strengthened by being sprinkled with powdered rosin. Acid is applied, which eats away the zinc between the printed lines, leaving the latter in relief to print from.

Trans-fer'rer. A base-plate for an air-pump receiver, which enables the exhausted receiver to be removed from the air-pump.

Trans-fu'sion-ap'pa-ra'tus. Apparatus for transfusing blood from one living animal into the veins of another. The idea of renewing vital power by the transfusion of the blood seems to have been familiar to the ancients, and is found in the works of the alchemists of the Middle Ages, who imagined that it might be the means of perpetuating youth.

Various successful experiments were tried upon the lower animals, but the first recorded operation of the kind on a human subject was by Dr. Denis of Paris, who, in June, 1667, injected eight ounces of arterial blood from a lamb into the veins of a child.

Subsequently calf's blood was infused into the veins of a maniac, who, shortly after, regained his reason.

These successes led to numerous other attempts of the kind, but the general results were such that the practice was forbidden by the Parliament of Paris in 1668.

The injections were, in these cases, performed by means of a common syringe.

The operation was performed in England at the same period, and was practiced by Lower, 1691.

"A man that the college [Gresham] have hired for 20*s* to have some of the blood of a sheep let into his body, and it is to be done on Saturday next. They purpose to let in about 12 ounces, which they compute will be let in in a minute's time by a watch." — PEPYS'S *Diary*, 21 Nov., 1667.

The experiment was performed at Arundel House two days afterward, upon the person of Arthur Coga. ("Phil. Trans.," No. 30, page 557.)

Pepys states that, on the 14th November, 1666, the blood of one dog was passed into the side of another, the latter losing its own blood by the opposite side. The first dog bled to death; the latter, whose blood had been substantially withdrawn and substituted, recovered. He suggests letting the blood of a Quaker into an archbishop to amend the life of the latter.

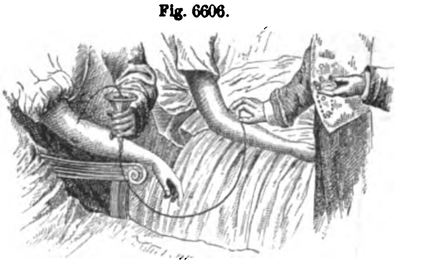
After the lapse of a century the subject was taken up by Harwood, whose researches proved that blood could not be transfused from one animal to another belonging to a different natural family without fatal results to the latter. More modern experiments, particularly those of Prevost and Dumas, show that the blood of calves or sheep injected into the veins of a cat or rabbit is fatal, and mammals, into whose veins the blood of birds is transfused, die. The experiments of Milne-Edwards and Lafond indicate that this result does not take place when the animals belong to nearly allied species; thus an ass, whose blood was nearly exhausted, was reanimated perfectly by the blood of a horse.

The difference of results in these cases appears to be attributable to the different sizes and shapes of the blood globules in animals; these vary much in different species, and later investigations show that the blood of those species whose globules do not differ greatly in form and dimensions from those of man may be injected without injurious results.

Prevost and Dumas have shown that serum — that is, blood deprived of its fibrin and globules — is of no effect; while, on the other hand, when the fibrin has been destroyed by agitation, leaving the globules intact, strong revivifying effects are produced.

Fig. 6606 represents the process as practiced in Paris. The bared arm to the left is that of the blood-donor; the other that of the person into whose veins the blood is injected. The blood flows from the arm of the former into a cup, is pumped from the lower part of the cup, and forced through a canula

Fig. 6606.



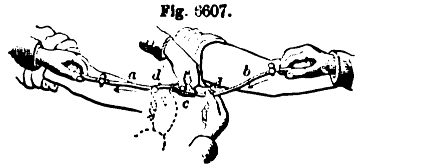
Transfusion-Apparatus.

into the veins of the patient.

In order to prevent coagulation of the blood, the instrument is immersed in tepid water; the tubes used are of gold.

The aspirator is so arranged that no air can possibly enter with the blood.

Fig. 6607.



Aveling's Transfusion-Apparatus.

Aveling's apparatus is shown in Fig. 6607. The following directions are given for using it: —

The apparatus is immersed in a basin of tepid water, and the air expelled by compressing the bulb.

The arm of the patient having been bound, a fold of skin over a vein at the bend of the arm is raised, transfixed, and divided.

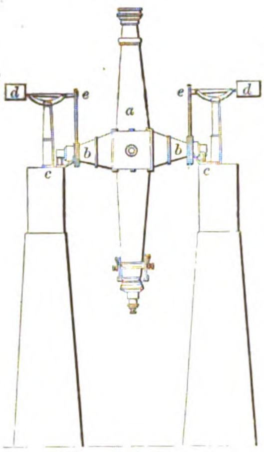
The vein is now seized with a pair of fine forceps, raised, an incision made into it, and a bevel-pointed silver tube *a* inserted. When this tube is taken out of the water it is kept full by placing the thumb over its orifice. The arm of the blood-donor being brought into close proximity to that of the recumbent patient, an incision, as in ordinary blood-letting, is made into his arm, and the round-pointed tube *b* inserted therein, by an assistant. The india-rubber part of the apparatus, filled with water, and kept so by turning the cocks at each end, is now fitted into the two tubes, the cocks are opened, and the operation commenced by compressing the india-rubber tube on the efferent side *d*, and squeezing the bulb *c*; this forces two drachms of water into the afferent vein. Next shift the hand from *d* to *d'*, and compress the tube on the afferent side, allowing the bulb to expand slowly, when blood will be drawn into it from the efferent vein. By repeating this process, any quantity of blood can, at a desired rate, be transmitted, the amount being measured by counting the number of times the bulb is emptied.

Tran'sit. 1. (*Astronomical.*) The transit-instrument is the most important of what may be called the technical astronomical instruments. The smaller and portable kinds are used to ascertain the local time by the passage of the sun or other object over the meridian, while the larger and more perfect kinds, in first-class observatories, are used for measuring the positions of stars, for forming catalogues; its special duty being to determine with the greatest accuracy the right ascension of heavenly bodies.

In the latter case it consists of a telescope *a* supported on a horizontal axis *b b*, whose extremities terminate in cylindrical pivots resting in metallic supports *c c*, shaped like the upper part of the letter Y, and hence termed the "Y's," and imbedded in two stone pillars. In order to relieve the pivots from friction and facilitate the turning of the telescope, counterpoises *d d* are provided operating through levers *e e*, carrying friction-rollers upon which the axis turns. When the instrument is in proper adjustment, the telescope should continue in the plane

of the meridian when revolved entirely round upon its axis, and for this purpose the axis must lie in a truly east and west line. To effect this adjustment its ends are provided with screws by which a motion, both in azimuth and altitude, may be imparted.

Fig. 6608.



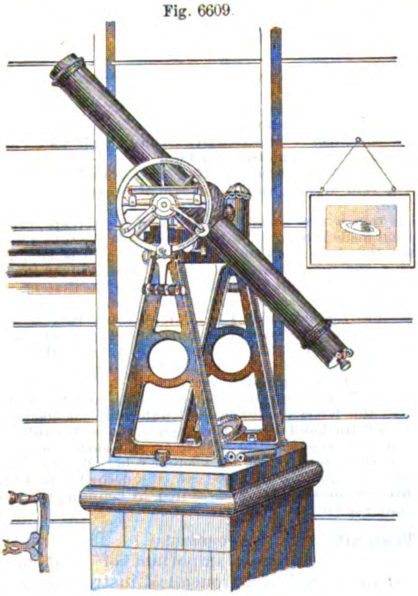
Transit-Instrument.

Fig. 6609 shows the transit of the Uckfield Observatory, England. The frame supporting the axis is of metal, and rests on the top of a pillar of masonry.

All instruments of this kind have a diaphragm, consisting of a single horizontal wire and a number of vertical wires, placed in the center of the field of view, and illuminated at night by a lamp throwing its light through one of the trunnions, which is made hollow for the purpose, upon a mirror set at an angle of 45° to the axis of the tube, which reflects it on to the wires. At the extremity of the other axis is a vertical circle, provided with a vernier, for measuring declinations. Levels are also attached to adjust the instrument to perfect horizontality, or to indicate the correction to be applied to the observation if this adjustment be imperfect.

The portable transit merely differs from the foregoing in being mounted upon a metallic stand, capable of being transported from place to place, and being readily set up at the point of observation. The base of the stand rests upon three foot-screws, by which, in connection with the levels, the horizontal adjustment is made.

Fig. 6609.

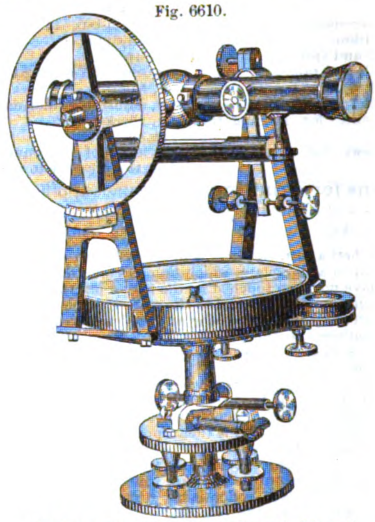


Uckfield Transit.

The transit instrument in the National Observatory, Washington, has an object-glass with a clear aperture of $5\frac{1}{4}$ inches, and a focal length of 88 inches. It is mounted upon piers of granite, which rest on a foundation of stone, extending 10 feet below the surface of the ground. The cost of this instrument was $ 1,480. The object-glass was valued at $ 320.

The transit in the prime vertical was made by Pistor and Martins of Berlin. The object-glass of the telescope has a clear aperture of 5 inches, with a focal length of 78 inches. The eye-tube carries a system of 2 horizontal and 15 vertical stationary wires, with one movable vertical wire. This instrument is mounted at one end of its axis, and outside of its supports. It is reversed from one side to the other twice during every observation; and though it weighs upward of 1,000 pounds, so perfect is the system of counterpoises, and the reversing apparatus, that it can be manipulated by a child. The cost of this instrument was $ 1,750.

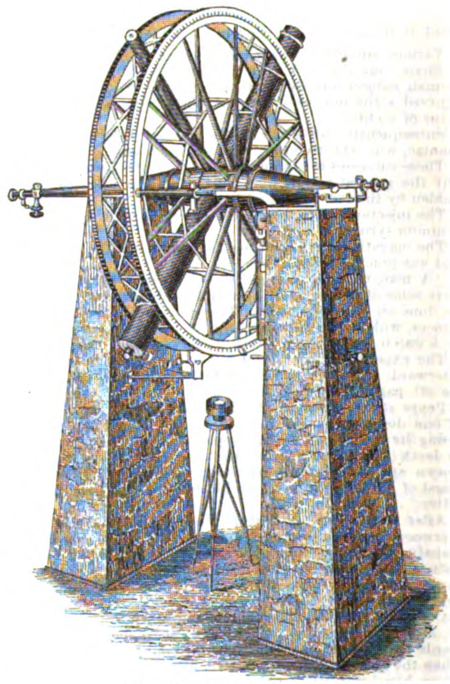
Fig. 6610.



Engineers' and Surveyors' Portable Transit.

A transit-instrument by Bauer of St. Petersburg has the eye-piece situated in the axis on which the telescope rotates. A reflecting prism in the middle of this axis receives the light from the objective and deflects it at right angles to its original position. The observer is thus enabled to maintain an unchanged position, always looking in a horizontal direction.

Fig. 6611.



Troughton's Transit-Circle.

2. (*Engineering.*) The surveyor's transit is a portable instrument of the theodolite kind, designed for

measuring both horizontal and vertical angles. It is provided with horizontal and vertical graduated circles, one or two levels, and a compass, and is mounted upon a tripod-stand. See THEODOLITE.

Tran′sit-cir′cle. Troughton's transit-circle (Fig. 6611) unites the functions of the mural circle and the transit-instrument.

The telescope is fixed between two parallel, flat metallic circles, or rings, the exterior faces of which are graduated to 5′. These rings are connected with the horizontal axis by two sets of hollow, radial arms, so as to form two wheels 4 feet in diameter, and are connected with each other by a system of transverse and diagonal rods. The axis, 3 feet in length, consists of a central cylindrical portion into which the spokes are inserted, and two projecting cones resting on Y's in two stone piers. The faces of these piers coincide with the plane of the meridian. The Y's are provided with vertical and horizontal adjustments for placing the line of collimation of the telescope exactly in the plane of the meridian.

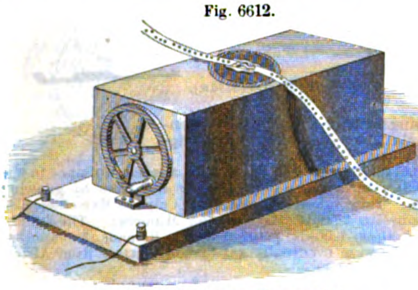
Tran′sit-in′stru-ment. See TRANSIT.

Trans-la′tor. (*Telegraphy.*) An instrument, such as a relay, for repeating a message upon a second circuit when the line-current of the former circuit is too feeble to carry the signal to the ultimate station. A *repeater*.

Trans-mit′ter. (*Telegraphy.*) The sending or dispatching instrument, especially that under the automatic system, in which a paper strip with perforations representing the Morse or similar alphabet is passed rapidly through an instrument called an automatic *transmitter*, in which the contacts are made by metallic points wherever a perforation occurs, and are prevented where the paper is unpierced.

The *transmitters* of various electricians agree in the respect noted, but vary in details. That shown is the Wheatstone, in

Fig. 6612.



The Wheatstone Transmitter.

which the perforated ribbon-paper strip is caused to advance step by step through the machine by the successive grips of an oscillating cradle, regulated to advance the paper a distance exactly corresponding to the previous spacing of the holes by the *perforator*, so that by the action of a rising pin, elevated and depressed alternately at each to-and-fro motion of the rocking-frame, the message-ribbon is automatically and mechanically impelled forward. Two other spring *contact*-pins are actuated by the same mechanical movement, by means of eccentric cam arrangements. Thus, when the perforated paper ribbon is carried automatically forward step by step, in rapid succession, by the action of the central pin, if a *current-passing perforation* is in position at the moment of passing the paper ribbon with either pin, the respective pin will rise through the hole and make a metallic contact with the battery through the instrument, sending a current into the line. If no perforation in the paper ribbon is in position at the time of the automatic elevation of the respective pins, they fall back by the compensating influence of adjusting springs, and a *mute* movement is made, forming an interval in the alphabetical system.

Trans-mit′ting Mo′tion. Items of information on this subject will be found under the appropriate headings, embracing details, such as *shafting*, *clutch*, *pulley*, *band*, *wheel*, *gearing*, *wire-rope*, *air as a means of transmitting motion*, etc.

Tran′som. 1. (*Building.*) A horizontal piece framed across a doorway or a double-light window.

2. (*Shipbuilding.*) A beam bolted across the stern-post, supporting the after end of a deck and giving shape to the stern. The *third*, *second*, and *first* transoms are, referring to them in the rising order, below the *deck* transom. The *wing* transom is the sill of the gun-room ports; the *helm* transom is at the head of the stern-post and forms the head of the ports.

3. (*Ordnance.*) A horizontal piece connecting the cheeks of a gun-carriage.

4. (*Surveying.*) The vane of a cross-staff.

Tran′som-knee. (*Shipbuilding.*) A knee bolted to a transom and after-timber.

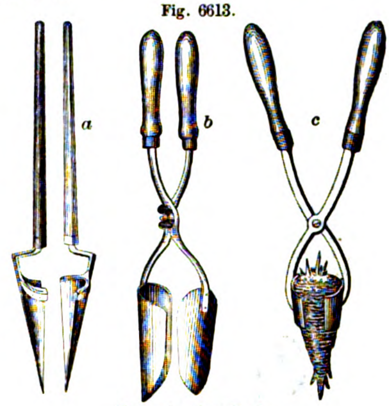
Tran′som-win′dow. (*Building.*) *a.* A window divided by a transom.

b. A window over the transom of a door.

Trans-plant′er. (*Agricultural.*) An implement for removing and transplanting flowers, bulbs, etc.

In *a*, the blades may be used separately for digging or stirring the earth, or pivoted together, to grasp the roots and lift them with a certain quantity of earth attached, without dropping the latter.

Fig. 6613.



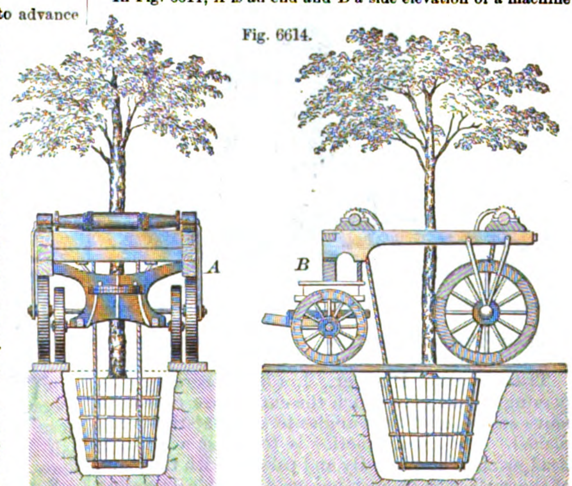
Transplanting-Tools.

b is a slight modification of the above; the handles are held together by the grasp of the hand or by a ring slipped over them. *c* is a root-puller.

Trans-plant′ing-ap′pa-ra′tus. A machine or truck for removing trees for replanting.

In Fig. 6614, *A* is an end and *B* a side elevation of a machine

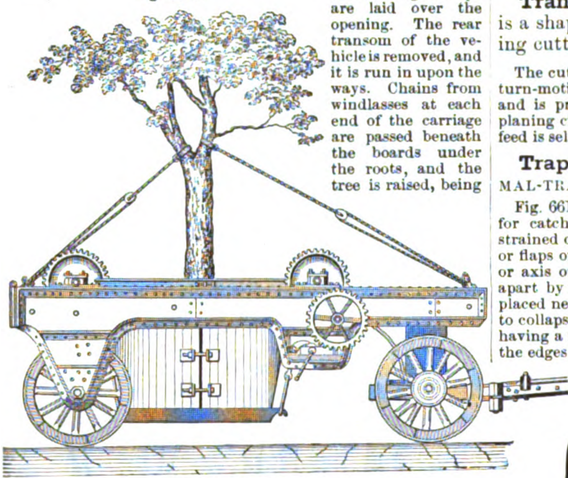
Fig. 6614.



Transplanting-Apparatus.

for transplanting small trees, and drawn by a single horse. A trench is dug around the roots of the tree, and the earth left around them is surrounded by branches of trees or staves which are secured by hoops or other suitable means. When a sufficient depth is attained the earth beneath is cut away and planks shoved under. Timbers serving for ways are laid over the opening. The rear transom of the vehicle is removed, and it is run in upon the ways. Chains from windlasses at each end of the carriage are passed beneath the boards under the roots, and the tree is raised, being steadied by guys if necessary; when raised clear of the ground it is conveyed to the spot where it is to be replanted.

Fig. 6615.

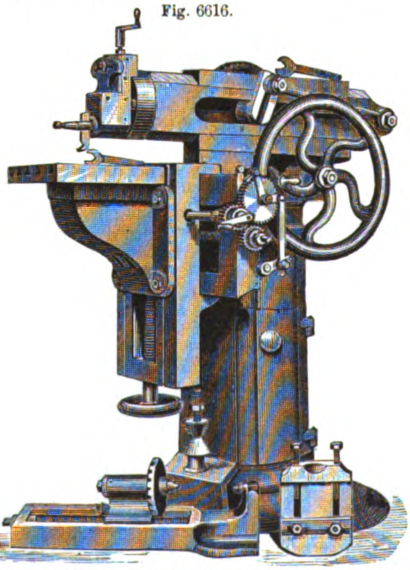


Transplanting-Apparatus.

Fig. 6615 is an apparatus of the same kind for removing larger trees, and requiring several horses.

These have been used in replanting the Bois de Boulogne, near Paris, which was nearly destroyed during the Franco-Prussian war of 1871.

Fig. 6616.



Shaping-Machine (New York Steam-Engine Company).

Trans′port. (*Nautical.*) A ship employed in the conveyance of troops or stores.

Trans-verse′ Plan′er. 1. (*Wood-working.*) A planing-machine in which the cutters are caused to move across or at right angles to the material being planed. The usual practice is to adjust a rotating head or arms horizontally and parallel with the plane of the surface to be operated on, the table traveling in either direction under the head, thus bringing all parts of the material in contact with the cutters. See Fig. 3796, page 1728.

2. (*Metal.*) A shaper or planer with its cut transverse of the table. See next article; also Fig. 6150, page 2477.

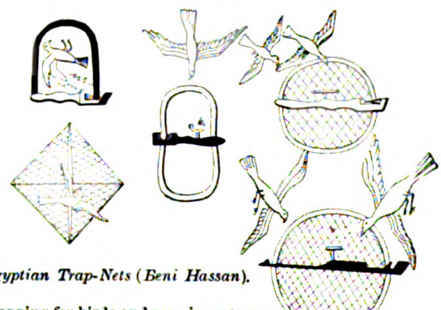
Trans-verse′ Shap′ing-ma-chine′. Fig. 6616 is a shaping-machine with a horizontally reciprocating cutter-head on a pillar.

The cutting-bar has any stroke up to 8 inches, and quick return-motion. The table is moved up and down by a screw, and is provided with chuck, center, and vise. Apparatus for planing circular or any other form or shape is attached. The feed is self-operating or by hand. See also Fig. 6150, page 2477.

Trap. 1. A snare for animals. See also ANIMAL-TRAP.

Fig. 6617 illustrates traps in use among the ancient Egyptians for catching birds. They were generally made of network strained over a frame, and consisted of two semicircular sides or flaps of equal size, one or both moving on the common bar or axis on which they rested. When set the flaps were kept apart by means of strings which slipped aside when the bait placed near the center of the bar was touched, allowing the flaps to collapse and secure the bird. Another kind was square, having a framework running across the center and not around the edges of the trap like the first.

Fig. 6617.



Egyptian Trap-Nets (Beni Hassan).

Trapping for birds and vermin was common of old, the falling shutter and tripping-prop being the most usual kind.

The rabbits (*leberides*) of Spain were a great nuisance in the time of Strabo, destroying both seeds and trees by gnawing the roots. They infested Iberia, from Calpe to Marseilles, also the Gymnesian islands (Majorca and Minorca). The inhabitants of these islands petitioned the Romans for another land. They were eventually subdued by ferrets from Africa. (STRABO, Book III.)

Pliny refers to similar instances of overrunning by animals, in Lib. VIII. chapter 29. The inhabitants of Abdera, in Thrace, were driven out of their town by rats and frogs, and settled on the frontiers of Macedonia. (JUSTIN, Lib. XV. chapter 2.)

Frogs annoyed the Egyptians once upon a time.

"At Casilinum (Nova Capua), 500 men of Præneste sustained against Hannibal, in the hight of his power, so desperate a siege, that, by reason of the famine, a rat was sold for 200 drachmee, the seller dying of hunger and the buyer surviving." — STRABO, Book V. chapter 4.

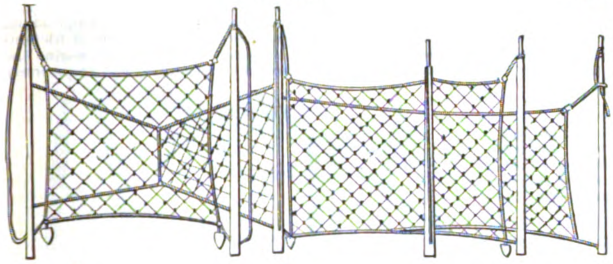
Cats are not mentioned in the canonical Bible, but were common in Egypt; they accompanied fowlers on their excursions, and were much revered. It was a capital crime to kill one. When they died they were embalmed, and buried at Bubastis. A cat is mentioned in the Apocrypha, and the animal is referred to by Herodotus.

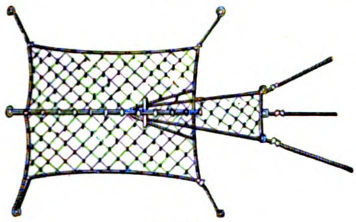
Fig. 6618.

Stench-Traps.

2. A sink or depression in a sewer-pipe to prevent passage of air.

Fig. 6619.





Trap-Net.

Fig. 6618 illustrates various forms of stench-traps for closet-pans.

A fish-trap and strainer consists of a detachable chamber, provided with a strainer, and isolated from the main, when required, by means of a stop-valve at each end. By this means eels, fish, and other matters which would choke the smaller service-pipes of a building are arrested, and when their presence is discovered may be removed by detaching the section and emptying it. It is useful in mains supplied from rivers and deficient in filtering arrangements.

See under the following: —

Animal-trap.	Moth-trap.
Bell-trap.	Mouse-trap.
Bird-trap.	Rat-trap.
Cruive.	Sand-trap.
Curculio-trap.	Shingle-trap.
Fish-trap.	Sink-trap.
Fly-trap.	Spring-trap.
Insect-trap.	Steam-trap.
Man-trap.	Stench-trap.
Mole-trap.	

3. A kind of movable step-ladder.

Trap-cut. A mode of cutting gems in which the facets consist of parallel planes, nearly rectangular, arranged round the center of the stone. See GEM.

Trap-door. A lifting or sliding door in a floor, roof, ceiling, or stage.

Tra-peze′. A swinging frame used by gymnasts in flying leaps and performing evolutions from a suspended pole.

Trap′e-zoid′al Wall. A retaining wall, vertical against the bank, and with a sloping face.

Trap-net. A fishing-net in which a funnel-shaped piece leads the fish into a pound from which extrication is not easy. The illustration shows an elevation and plan.

Trap-stairs. A stairs with trap-door at top.

Trap-valve. A valve hinged on one side of its seat, and opening and closing like a shutter or trap-door. A *clack-valve.*

Trash. (*Manege.*) A collar or leash to restrain a dog in coursing.

Trass. *Tarrass.* A volcanic earth, or calcareous tufa, resembling pozzuolana, and found in several districts of France and Germany, the theaters of extinct volcanic action; the Vivarais, in the center of France; at Brohl, near Andernach, on the Rhine. Like the hydraulic cement of Baiæ, it consists of ingredients which enable it to harden under water.

Beithier's analysis is as follows: —

	Trass.	*Pozzuolana.*
Silica	0.570	0.445
Alumina	0.120	0.150
Lime	0.026	0.088
Magnesia	0.010	0.047
Oxide of iron	0.050	0.120
Potash	0.070	0.014
Soda	0.010	0.040
Water	0.096	0.092
	0.952	0.996

Trave. (*Manege.*) A wooden frame or stocks to confine a horse or ox while shoeing.

Trav′el. 1. (*Steam.*) The distance which the slide-valve travels in one direction for each stroke of the piston.

2. The length of stroke of any object; also known as the *excursion.*

Trav′el-er. 1. (*Nautical.*) An iron thimble, ring, or grommet adapted to slide on a bar, spar, or rope. A large ring of this kind is fitted on the bowsprit of a cutter, the jib tack is hooked to it, and it is hauled in or out to suit jibs of various sizes.

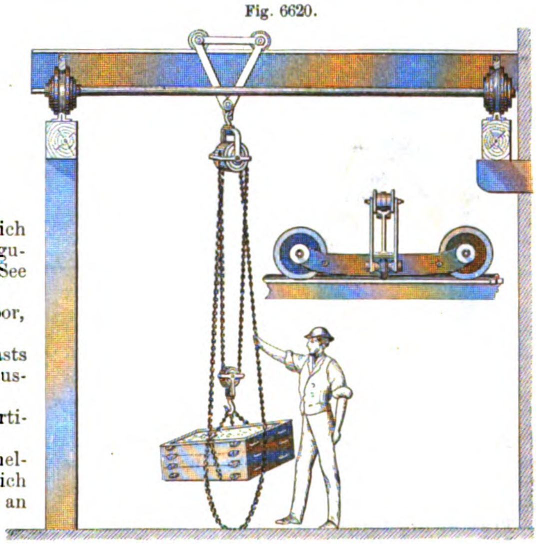
2. (*Machinery.*) A crab traversing on an elevated movable beam, supported on framework; it is intended for raising heavy loads and moving them from place to place in a workshop. Fig. 6620.

3. (*Spinning.*) A small open ring or metallic loop placed about the race of a ring, used in ring spinning-frames.

The yarn passes from the delivering rollers to and through the traveler and then to the bobbin.

The cut shows a ring and traveler applied to a Sawyer spindle, — an American invention, now being largely introduced; 650,000 of them in the last two or three years. It is run at a higher rate of speed, doing more and better work, with less power, than the ordinary spindle used in ring frames. The spindle is supported only at the bottom and at a point much nearer the top of the bobbin than usual. The spindle is steadied nearer its upper end, and prevented from vibrating, permitting the spindle to be made much lighter and shorter than usual.

Fig. 6620.



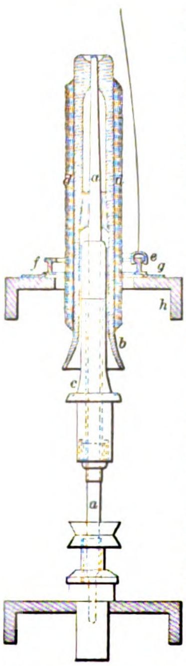
Traveler, with Differential Pulley.

The spindle *a* is sustained within the bobbin *b*, by the upper end of the elongated bushing *c*, supported, as usual, in the bushing rail of the frame.

The yarn is represented at *d*, the traveler at *e*, the ring at *f*, the holder at *g*, and the movable ring-rail at *h*.

The spindle and the bobbin, held to it by friction, rotate and twist the thread extending from the bobbin through the

Fig. 6621.



Sawyer's Spindle, with Ring and Traveler.

traveler, and the latter, held back owing to its friction on the race of the ring, detains the yarn and enables the spindle to revolve on its axis oftener than the traveler revolves on the race about the spindle; and this excess of motion on the part of the spindle enables the spun yarn to be wound on the spindle-bobbin.

The ring has a double race, so that it may be reversed when worn, and it is confined to the ring-rail by an adjustable holder that permits this ring to be set exactly concentric with the spindle.

Trav'el-ing-bag. A satchel or carpet-bag.

Trav'el-ing-belt Pro-pel'ler. (*Marine.*) A form of propeller in which a belt traverses over twin-wheels.

Trav'el-ing-crane. A crab for lifting weights, fixed on a truck which moves on rails, on top of a frame or building.

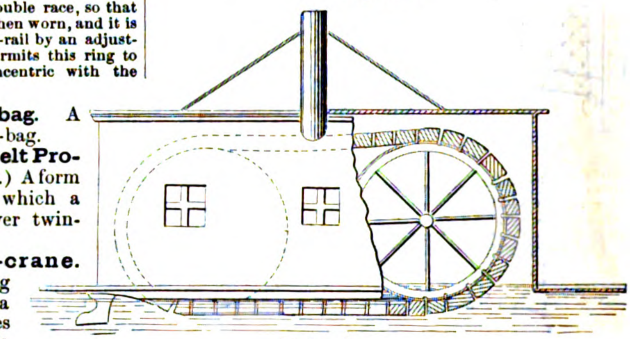
Among the earliest examples of this kind are those designed by Rennie for the mahogany sheds at the West India Dock, London. These move in one direction only, and are used for piling away the logs of timber.

A subsequent improvement was to support the frame on which the crab or carriage travels, upon rollers, so that it has a movement at right angles to that of the crab.

Fig. 6623 represents an overhead steam-crane. The engine, instead of being stationary at one end of the *gantry*, is mounted on the carriage and travels with it.

The engine is fitted with single and double purchase-blocks, link motion for reversing, strap-brake, with foot-lever and pawl to hold the load suspended when required; the longitudinal and transverse traveling motions are driven by sets of friction-clutches, so that without stopping or reversing the engine the load may be lifted and traversed longitudinally and transversely

Fig. 6622.



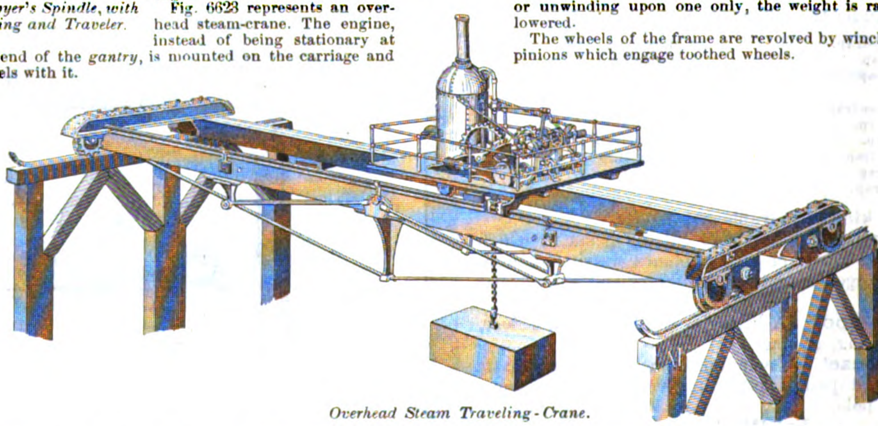
Marine Car.

at the same time. The levers are all controlled by a single operator.

Fig. 6624 illustrates an arrangement of this kind. Two triangular frames are mounted on wheels which run upon rails and support two parallel beams; on these is laid a railway, upon which the carriage containing the pulleys for the chain traverses; the ends of the chain pass along and above the beams to fixed pulleys at each end, and thence down to the winches at the bases of the frames. By winding upon one of these winches, and unwinding from the other, the carriage is traversed from side to side; by winding or unwinding upon one only, the weight is raised or lowered.

The wheels of the frame are revolved by winches and pinions which engage toothed wheels.

Fig. 6623.



Overhead Steam Traveling-Crane.

Trav'el-ing-der'rick. One mounted on a carriage. (See TRAVELING-CRANE.) The crane differs from the derrick in the construction of the frame. See CRANE; DERRICK.

Trav'el-ing-forge. The wagon, with its tools and stores, which accompanies a battery of field-artillery for the purpose of repairs. See BATTERY-FORGE.

Trav'ers. A skeleton-frame which holds the bobbins of yarn, which are wound therefrom on to the warp-frame. See WARPING-MILL.

Trav'erse. 1. (*Fortification.*) A short embankment of earth thrown up to intercept an enfilading fire. They are placed on the terreplein, between the guns on the banquette, in the covered way, before the door of a magazine, or wherever there is room and their protection is necessary. See BASTION.

2. (*Ordnance.*) The horizontal sweep of a gun to command different points.

3. A barrier or sliding-screen.

4. (*Architecture.*) An elevated gallery or communicating loft in a building.

5. (*Nautical.*) *a.* The zigzag course of a ship.

b. To brace a yard aft.

6. (*Carpentry.*) To plane across the grain of a board.

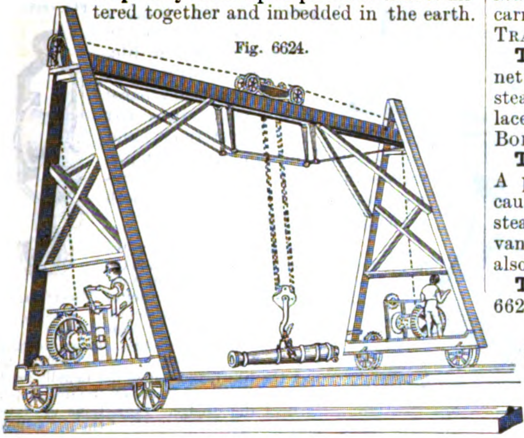
Trav'erse-board. (*Nautical.*) A circular board marked with the compass-points, and having holes and pegs to indicate the course by which the ship has been sailing.

It is used for recording the courses run during a watch.

Trav'erse-cir'cle. 1. (*Fortification.*) A circular track on which the chassis traverse-wheels of a barbette carriage, mounted with a center or rear pintle, run while the gun is being pointed; the arrangement enabling it to be directed to any point of the horizon. In permanent fortifications it is of iron,

and is let into the stone-work; in field-works it is frequently made up of pieces of timber mitered together and imbedded in the earth.

Fig. 6624.



Ordnance-Crane.

2. (*Nautical.*) A metallic circle let into the upper deck of a war-vessel for the wheels of a pivot-gun carriage to traverse on.

Trav'erse-drill. 1. A drill for boring slots. It or the work has a lateral motion after the depth is attained.

2. One in which the drill-stock has a traverse-motion for adjustment, as in the figure following.

The machine (Fig. 6625) is specially adapted for drilling the pin-holes at both ends of links for suspension-bridges at the same time, so as to secure perfect uniformity in the distance between them. The standards *a a* which support the boring-apparatus slide in the bed *b*, enabling them to be adjusted to the required length. The links are put in place on one side of the machine, and when done removed at the other. The driving is effected by horizontal belts passing over guide-pulleys and around a drum on the spindles.

Trav'ers-er. (*Railway Engineering.*) A device to shift a railway car or locomotive from one line of rails to another line parallel thereto. It is a platform supporting a section of the line of rails, and supported on wheels, which traverse on a transverse line of rails at a lower level.

Trav'erse-saw. A cross-cutting saw which moves on ways across the piece (Fig. 6626).

Trav'erse-ta'ble. 1. (*Nautical.*) A table by means of which the difference of latitude and departure corresponding to any given course and distance may be found by inspection.

It contains the lengths of the two sides of a right-angled triangle, usually for every quarter of a degree of angle, and for all lengths of the hypotenuse from 1 to 100.

2. (*Railway.*) A platform on which cars are *shunted* from one track to another in a station, being carried across instead of run out and *switched*. See TRAVERSER.

Trav'erse-warp Ma-chine'. A form of bobbinnet machine, so called from the warp traversing instead of the carriages. Principally used for spotted lace, blond edging, and imitation thread laces. See BOBBINET; LACE.

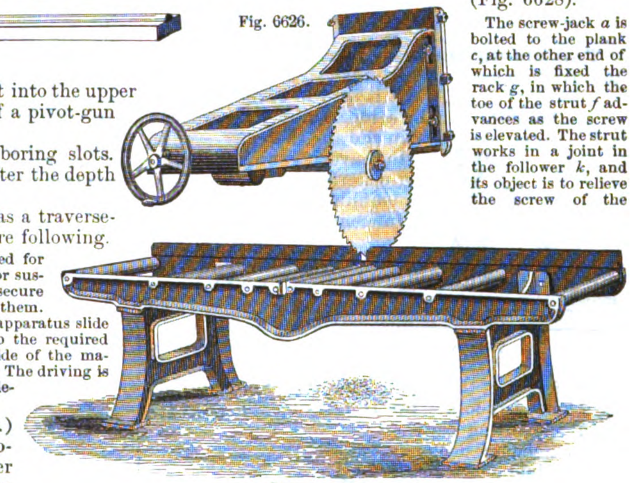
Trav'ers-ing-bed Plan'er. (*Wood-working.*) A planer in which the bed carrying the work is caused to traverse beneath the revolving cutters, instead, as is usually the case, of the work being advanced over the stationary table (Fig. 6627). See also PLANING-MACHINE, Fig. 3796, page 1728.

Trav'ers-ing-el'e-va'tor. See TRAVELER, Fig. 6620; and HAY-ELEVATOR, Fig. 2449.

Trav'ers-ing-jack. *a.* A jack used for engines or carriages upon the rails.

It is adapted for raising and then drawing (Fig. 6628).

Fig. 6626.



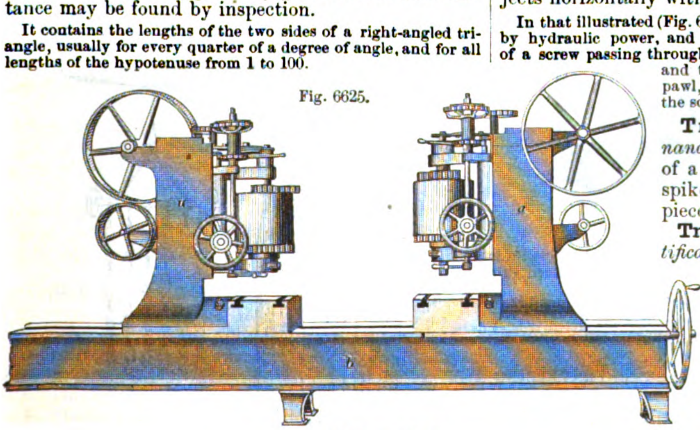
Traverse-Saw.

The screw-jack *a* is bolted to the plank *c*, at the other end of which is fixed the rack *g*, in which the toe of the strut *f* advances as the screw is elevated. The strut works in a joint in the follower *k*, and its object is to relieve the screw of the violent cross strain when the load is drawn forward on the sill-piece *d* by the vibration of the lever, which has its fulcrum in the rack *h*, and engages by its horn with the link *i* on the plank *c*.

b. A lifting-apparatus, the standard of which has a movement on its bed, enabling it to be applied to different parts of an object or used for shifting objects horizontally without moving the bed.

In that illustrated (Fig. 6629), the lifting movement is effected by hydraulic power, and the traverse is imparted by means of a screw passing through a nut in the foot of the standard, and turned by a lever provided with a pawl, which turns a ratchet on the end of the screw-shaft.

Fig. 6625.



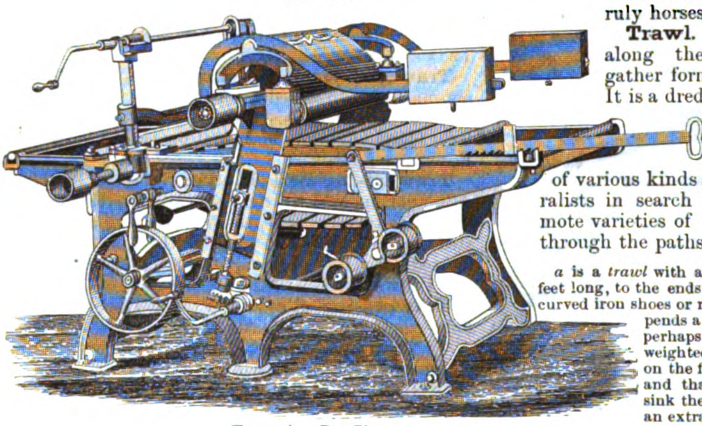
Double Traverse-Drill.

Trav'ers-ing-plate. (*Ordnance.*) A plate at the hinder part of a gun-carriage where the handspike is applied to traversing the piece.

Trav'ers-ing-plat'form. (*Fortification.*) A platform provided for guns which are pivoted so as to sweep the horizon, or a part of it.

The chassis has a pintle in front, and the rear portion has wheels, which traverse a curved track as the gun and its chassis are moved around by handspikes.

Fig. 6627.

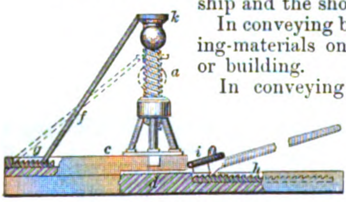


Traversing-Bed Planer.

Trav′ers-ing-pul′ley. A pulley so arranged as to traverse upon a rope or rod.

It is used in communicating by a rope between a stranded ship and the shore.

Fig. 6628.



Traversing-Jack.

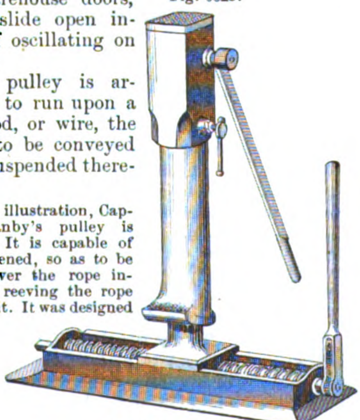
In conveying bricks or building-materials on to a scaffold or building.

In conveying freight upon a track wire (see WIRE-ROAD), — a mode which has lately come into use.

In conveying to a part of the barn or mow a load of hay lifted by a horse hay-fork. See HOISTING-MACHINE.

In supporting barn and warehouse doors, which slide open instead of oscillating on hinges.

Fig. 6629.



Traversing-Jack.

The pulley is arranged to run upon a rope, rod, or wire, the object to be conveyed being suspended therefrom.

In the illustration, Captain Manby's pulley is shown. It is capable of being opened, so as to be placed over the rope instead of reeving the rope through it. It was designed for the Captain's life-saving apparatus, in which a cradle is made to traverse on a rope stretched between a stranded ship and the shore.

In cases where the pulley is not liable to be unshipped, the pulley-block may have one cheek cut away like a snatch-block, to allow it to be placed in running order upon the rope.

Trav′ers-ing Screw-jack. See TRAVERSING-JACK.

Trav′er-tine. A calcareous tufa, used for building; also ground to form a hydraulic cement.

Trav′is. A confining frame for unruly horses while shoeing.

Trawl. A net dragged along the sea-bottom to gather forms of marine life. It is a dredge, and is made of heavy and coarse materials for oystermen, and of various kinds and sizes for naturalists in search of the more remote varieties of "all that passeth through the paths of the sea."

Fig. 6630.

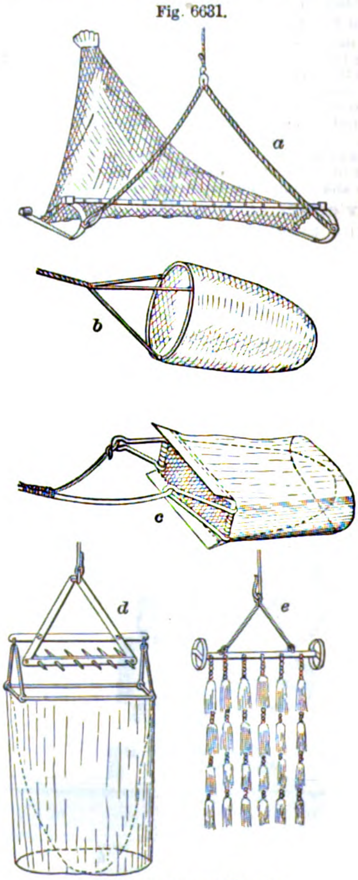
Traversing-Pulley.

a is a *trawl* with a beam ten or twelve feet long, to the ends of which are affixed curved iron shoes or runners. From it depends a funnel-shaped net of perhaps thirty feet in depth, weighted by a string of leads on the forward lower edge. These weights and that of the runners are sufficient to sink the trawl, and it does not usually need an extra weight in front, on the drag-rope, as does the dredge. Projections or webs proceeding from the inside of the net, called pockets, serve to prevent fishes captured in the net from getting out by the route that they go in.

b is a *bag-net* with distending hoop, used for catching floating creatures.

c is a *dredge*, the front of which is a rectangular frame of iron, about two feet by eight inches, the long sides extending forward as scrapers, the short sides furnishing points of attachment for handles. This frame forms the mouth of a fine meshed net about four feet long. Over the net a canvas bag, open at the bottom, is extended, which serves to protect the

Fig. 6631.



Dredges, Trawl, and Tangles.

net from injury while it is dragged over the rocks. To bring the scrapers down to their work, a weight of about 20 pounds is fastened on the drag-rope about one or two yards in advance of the dredge. The drag-rope is tied directly to one of the handles, but is attached to the other only by a light line.

The open iron frame acts as a scraper, and lifts from their bed all the strange forms of life that adhere to the bottom; they are simply scraped up by this contrivance, and, with a great quantity of mud, are caught in the net behind the frame.

d is the *rake-dredge*, whose mouth is preceded by an iron bar parallel with it, and bearing a set of sharp-pointed teeth capable of tearing up Neptune's stubbornest glebe. The "rake" is essentially a harrow; its especial use is in the case of bottoms of very tough mud or clay, where it is desirable to unearth the animals which are partly imbedded. Such bottoms are also frequently so serrated with the tough tubes of marine worms as to make the work of the ordinary dredge unsatisfactory: the rake-dredge readily tears through these tubes.

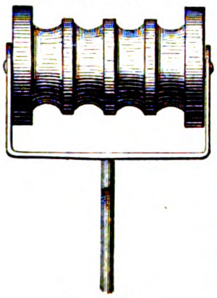
e are *tangles* or mops of hemp attached by chains to a bar which has runners and a towing cord. The *tangles* are used to catch small, delicate, or spinaceous forms of marine life. See TANGLES.

Trawl-boat. (*Nautical.*) One used in fishing with trawl-nets.

Trawl-net. See TRAWL.

Trawl-roll'er. A roller having a number of grooves cut in its periphery, and attached to the side of the wherry or dory, and over which the trawls are drawn into the boat.

Fig. 6632.



Trawl-Roller.

Trawl-warp. A rope passing through a block and used in dragging a trawl-net.

Tray. A flat receptacle for handing glasses, dishes, and what not. Known by names indicating *material* or *purpose*, as

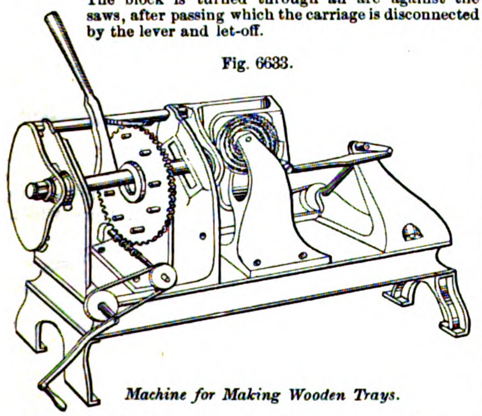
Papier-maché.	Tea.
Tin.	Bread.
Silver.	

Also known as a *waiter*, or *salver*.

The κιστη δειπνοφορος was the Greek dinner-tray.

Fig. 6633 is a machine for making oval trays or bowls of wood. The block to be cut into trays being secured to the carriage when in a horizontal position, the lever is placed against the wheel so that one of the pins thereon will catch it as the wheel revolves. As the pin strikes the lever, the carriage is started, and guided by the ends of the guide-pin in guide-way grooves. The block is turned through an arc against the saws, after passing which the carriage is disconnected by the lever and let-off.

Fig. 6633.



Machine for Making Wooden Trays.

Tread. 1. (*Carpentry.*) The flat part of a step. The vertical part is the *riser*.

2. (*Shipwrighting.*) The length of a ship's keel.

3. (*Vehicle.*) *a.* The bearing surface of the runners of a sled.

b. The bearing surface of a wheel.

4. (*Lathe.*) The upper surface of the bed between the headstock and the back center.

5. That part of the sole of a boot or shoe which touches the ground in walking.

6. (*Fortification.*) The top of the banquette, on which the soldiers stand to fire.

7. (*Railway.*) *a.* The part of a car-wheel which bears upon the rail.

b. The part of a rail upon which the wheels bear.

Tread'le. (*Machinery.*) A foot-lever connected by a rod to a crank to give motion to a lathe, sewing-machine, circular saw, or other small mechanism.

In Stewart's adjustable treadle for sewing-machines, the center of motion of the foot and the axis of the treadle coincide. There is scarcely any motion of the knee.

A *treadle* is distinct from a *pedal*, whose use is in musical instruments to raise a damper, open a valve, work a bellows, or what not, and is not designed to produce a rotary motion.

Tread-mill. A wheel driven by the weight of persons treading upon the steps of the periphery. It is usually employed in prisons, where it forms the "hard labor" of persons convicted of crime.

The usual form is a wheel 16 feet long and 5 in diameter, several such wheels being coupled together when necessary for the *accommodation* of the prisoners. The circumference of each has 24 equidistant steps. Each prisoner works in a separate compartment, and has the benefit of a hand-rail.

The wheel makes two revolutions per minute, which is equivalent to a vertical ascent of 32 feet. The power may be utilized in grinding grain or turning machinery.

The tread-mill is a feature of English prison discipline, and sometimes is not revolved to any useful effect, a brake being simply attached to the axle, forming a seat for the overseer, who graduates the work or speed by moving toward or from the outer end of the lever.

Our transatlantic cousins have an idea, their surplus of labor being so great, that it is poor economy to make prisoners work to any useful end, as it takes employment from the hands of workmen outside, and sets them to stealing, or sends them to the poor-house. The same idea is becoming current here. "There is something rotten in the state of (Denmark?)"

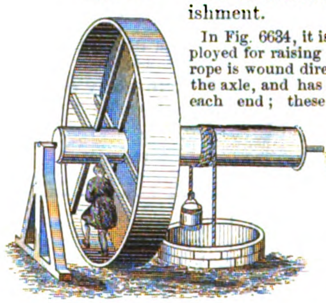
It need hardly be said that the labor comes rather unevenly upon the sick and the well, the weaver and the plowman, the fat and the lean, he that is "as subject to heat as butter, a man of continual dissolution and thaw," and he that "has a lean and hungry look." See TREAD-WHEEL.

The tread-mill was a Roman institution, and was used for raising water by the work of condemned criminals.

The Chinese also use it to irrigate lands. It was introduced into England as a means of prison discipline by Cubitt, 1817.

Tread-wheel. A wheel turned by men or animals, either by climbing or pushing with the feet. The tread-mill, formerly used as a means of punishment.

Fig. 6634.



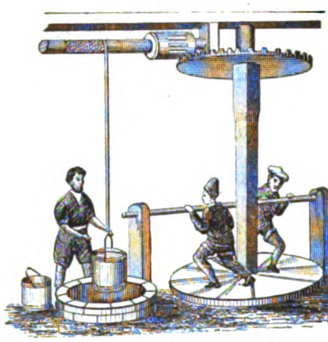
Tread-Wheel.

In Fig. 6634, it is shown employed for raising water. The rope is wound directly around the axle, and has a bucket at each end; these are alternately raised and lowered by reversing the movement of the wheel.

In Fig. 6635, from Agricola, also a water-raising device, the wheel is horizontal, and turned by pushing. A crown-wheel and rundle are interposed to rotate the axle carrying the bucket-rope. Agricola (Ger. *Bauer*, peasant) died at Chemnitz, 1555.

A form of tread-wheel in which animals walk inside of a large wheel is used in pumping from the deep well of Carisbrook Castle, England; turn-spit dogs were formerly used in turning the spit upon which meat is roasting; and dogs are employed in some dairies to turn the barrel-churns or agitate the vertical dashers of plunger-churns.

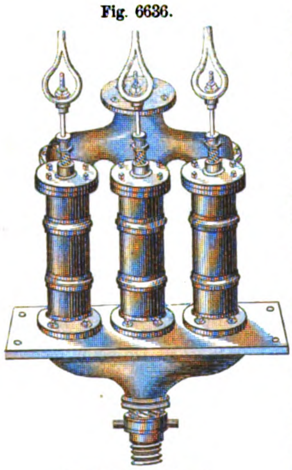
Fig. 6635.



Tread-Wheel (from Agricola).

Treb′le-bar′rel Pump. A pump having three barrels connected with a common suction-pipe. The pistons are operated by a three-throw crank, the cranks being set at angles of 120°, so that each piston is always at a different part of the stroke from either of the others, and a continuous flow produced.

Fig. 6636.



Treble-Barrel Pump.

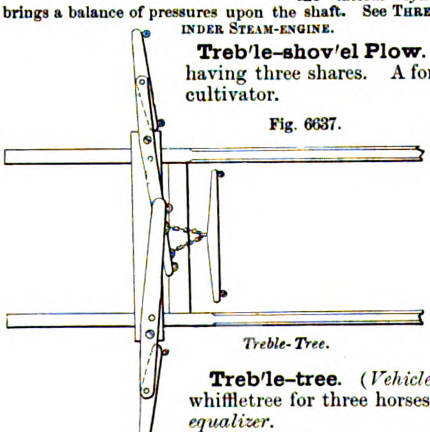
Treb′le-block. (*Nautical.*) A block with three sheaves; ordinarily used as a purchase-block.

Treb′le-cyl′in-der Steam-en′gine. (*Steam.*) An engine having a pair of large cylinders for the continuation of the expansion, one at each side of the small cylinder.

In the usual arrangement, the piston of the central small cylinder drives one crank, and those of the two lateral large cylinders drive a pair of cranks pointing the opposite way to the middle crank. Half the work being performed by the middle cylinder, and the other half being equally divided between the lateral cylinders, brings a balance of pressures upon the shaft. See THREE-CYLINDER STEAM-ENGINE.

Treb′le-shov′el Plow. One having three shares. A form of cultivator.

Fig. 6637.

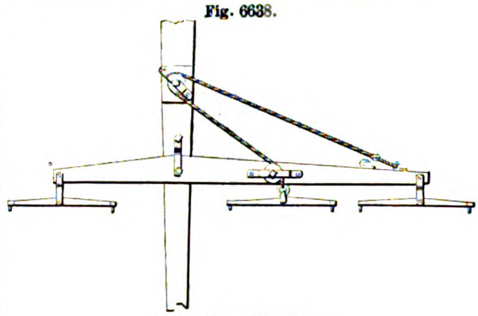


Treble-Tree.

Treb′le-tree. (*Vehicle.*) A whiffletree for three horses. An *equalizer.*

In Fig. 6637, the draft may be equally apportioned among the three horses if they are of equal energy and strength, but either of the outside horses may be favored by shifting the pivot-bolt of its double-tree.

Fig. 6638.



Three-Horse Equalizer.

In Fig. 6638, the third whiffletree is attached to a cord which runs around pulleys on the splinter-bar and tongue, and connects to the long end of the splinter-bar, to equalize the draft on its two ends.

Tre′buck-et. 1. A warlike engine formerly used for hurling stones. A heavy weight on the short end of a lever was suddenly released, raising the light end of the longer arm containing the missile, and discharging it with great rapidity.

2. A kind of balance used in weighing.

Tre-chom′e-ter. An odometer for vehicles.

Tree. A generic name for many wooden pieces in machines or structures.

1. (*Vehicle.*) *a.* The bar on which the horse or horses pull, as *single, double, treble, whiffle, swingle* trees.

b. The *axle;* also known as an *axletree.*

2. (*Harness.*) The frame for a saddle; a *saddle*-tree, *harness*-tree, *gig*-tree.

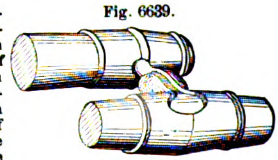
3. (*Shipbuilding.*) A bar or beam in a ship, as *chess*-tree, *cross*-tree, *rough*-tree, *trestle*-tree, *waste*-tree (which see).

4. (*Milling.*) The bar supporting a mill-spindle. See *f*, Plate XXII. G.

5. A frame on which a boot-leg is distended; a *boot*-tree.

Tree-coup′ling. A piece uniting a *single* to a *double* tree.

Fig. 6639.

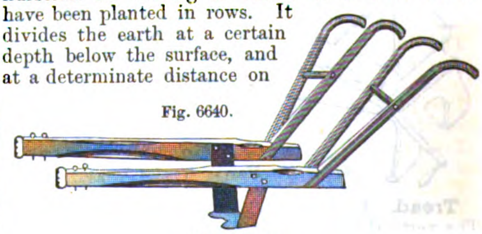


Tree-Coupling.

In Fig 6639, a ball is introduced through an opening in the thimble which clasps the mid-length of the single-tree and then takes its seat in the frustum of a sphere which forms the other portion of the universal joint. The neck is attached to the double-tree.

Tree-dig′ger. (*Agricultural.*) A kind of double plow employed in nurseries for cutting off the roots of trees which have been planted in rows. It divides the earth at a certain depth below the surface, and at a determinate distance on each side of the rows, to permit the tree to be readily removed from the soil.

Fig. 6640.



Tree-Digger.

Tree-ir′ons. (*Vehicle.*) The irons connecting single to double trees, or the latter to the tongue of

the vehicle. Also the hooks or clips by which the traces are attached.

Tree′nail. (*Shipbuilding.*) A cylindrical pin of hard wood used for securing planking to the frames, or parts to each other. Teak (*Tectona grandis*), a tree of India and Burmah, is much esteemed for this purpose, as it shrinks little and has no acrid juices to rust bolts. Oak is also much used.

Treenails are from 1 to 1¾ inches in diameter.

Compressed treenails are made by driving the steamed treenail through a tapering steel tube, so as to reduce them to $^2/_3$ of their original diameter.

The original words mean *wooden nail.* (Old English, *treen*, wooden.)

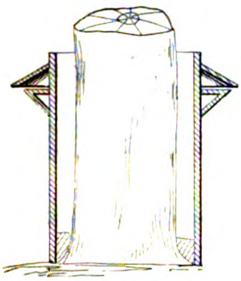
They are tightened by wedges driven into each extremity.

Tree-pro-tect′or. A device put around a tree to deter insects which crawl up the tree and bark.

Various means are tried, especially to stop the curculio (*Conotrachelus nenuphar*), a particularly energetic nuisance.

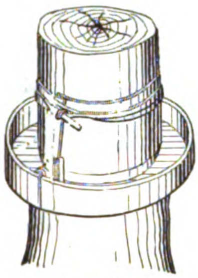
Fig. 6641 has a fluid-containing trough, situated at the upper end of a tubular support which rests upon the ground at its base.

Fig. 6641.



Tree-Protector.

Fig. 6642.



Tree-Protector.

Fig. 6642 has a pair of semi-annular troughs, united by clamps so as to embrace the tree, to which it is slung by a flexible band.

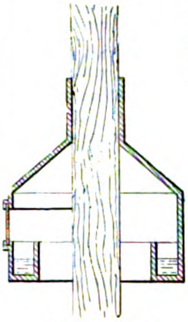
Fig. 6643 has a suspended trough, also full of water.

Fig. 6644 has a pair of frustums which together form a trap and trough.

Tree-re-mov′er. A truck used for transplanting trees of considerable size. It is so constructed as to be readily taken apart and put together, so that it may be brought centrally over the roots of the tree with its frame surrounding the trunk, and is provided with ten sling-chains for raising the temporary platform placed beneath the roots, by which the tree is lifted out of the ground.

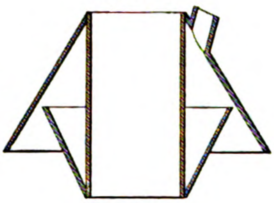
A circular trench is dug sufficiently wide and deep to include the roots, and within this circle the earth is carefully removed, leaving a quadrangular mass, as shown below, somewhat longer than broad. Beneath this in a longitudinal direction a trench is dug to receive two stout poles *a*, over which is placed a stout plank *b*. A strong chain is then passed over the poles at each end, and by means of the screw-jack at the front of the carriage the poles and board are lifted so that the latter bears against the bottom of the clod of earth. Two channels are then cut at the ends to receive the boards *c c*, and two others at the sides for the boards *d d*. Litter is then stuffed in with a spade between the planks and the soil, so that it may have a firm bearing on the platform when raised. Guy-ropes are attached to a

Fig. 6643.



Tree-Protector.

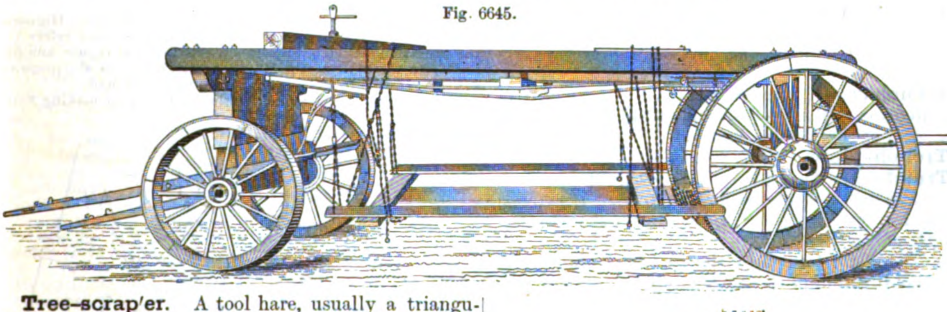
Fig. 6644.



Tree-Protector.

collar as high upon the tree as practicable, and the tree with the mass of earth attached to the roots is lifted clear of the ground by turning the jack-screw. It is then conveyed to the spot where a pit has been prepared to receive it, is lowered into place, and the carriage taken apart and removed. The pieces composing the platform are then withdrawn, the necessary filling in with earth around the roots done, and guys carried out and attached to pieces of wood buried in the earth, or in other convenient manner, if necessary for the temporary support of the tree. A smaller machine of the kind has but one front wheel, and is operated by a lever and ratchet windlass. See also TRANSPLANTING-APPARATUS.

Fig. 6645.



Tree-scrap′er. A tool hare, usually a triangular blade, to remove old bark and moss from trees. Also used in gathering turpentine.

Tref′le. (*Fortification.*) A mine with three chambers, like a *trefoil.*

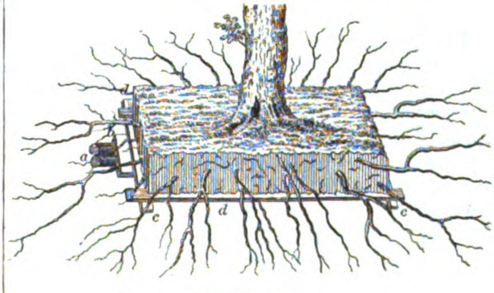
Treil′lage. (*Husbandry.*) A light frame of posts and rails to support espaliers. A *trellis.*

Treil′lis. A coarse kind of quilted linen.

Trel′lis. 1. A gate or screen of open-work; lattice-work either of metal or wood.

2. (*Husbandry.*) A support for vines, creepers, or espaliers. Used especially for grapes, hops, and ornamental climbing-plants.

Structurally, they may be posts or poles, isolated, grouped, or connected by wires or slats, — poles with branches or with fan-shaped or pyramidal tops; posts with wires on horizontal



Tree-Remover.

slats, and resembling fences or walls; screens or walls of slats, or wires forming panels of network between posts; devices consisting of arbors, covered paths, or extended overhead network, forming a ceiling of vine-supporting trellis; arrangements of posts and slats for espalier apple, cherry, pear, quince, or for other trees, known in England as *wall-fruit*, from the fact that such are nailed fan-wise against walls to conserve the heat and enable the fruit to ripen in a latitude north of Quebec. Such trees are the apricot, peach, and nectarine, most of which, if not all, came from Persia.

Smaller trellises, for garden work, are network frames, for tomatoes, peas, and many ornamental climbers; cylindrical, pyramidal, columnar, or fan-like trellises for climbers.

Special devices are formed for permanent ground-sockets with shifting poles. For upper structures, hinged so as to be laid down on the ground to be covered up with matting or straw for winter protection of tender grapes, or covered with earth as practiced by General Worthington of Chillicothe, Ohio, with his fig-trees. Other devices are for anchoring posts, or staying them with guys, or straining the wires of the trellis; guards to keep insects from climbing posts; claw bars and jacks for pulling posts and poles.

The devices are numerous in each specific line, and we must be content with this mere hint of the direction of invention.

Tre′loob-ing. (*Mining.*) See TOSSING.

Trem′o-lo. (*Music.*) A pulsative tone in a wind instrument produced by a variation in the volume of air admitted from the bellows. It is produced by a fluttering valve which commands the air-duct.

Tre′nail. A wooden pin employed in certain situations in preference to iron or copper bolts. See TREENAIL.

Trench. 1. (*Fortification.*) An excavation to cover the advance of a besieging force. It generally proceeds in a zigzag form, connecting the parallels and advanced batteries, and is 6 to 10 feet wide, 3 feet deep, the earth excavated forming a parapet on the side exposed to the fire of the fortress. 70 miles of trenches were excavated at Sevastopol. See APPROACH; ZIGZAG.

The approach to fortified places by *trenches* or *parallels* was used by Mahomet II. They were mentioned, however, by Cæsar in the siege of Marseilles; by Diodorus Siculus in that of Ægina; by Livy; and are represented on the column of Trajan and arch of Severus.

2. A ditch for drainage.

Trench-cart. (*Fortification.*) A cart adapted to traverse the trenches with ordnance, stores, and ammunition.

Trench-cav-a-lier′. (*Fortification.*) A high parapet made by the besiegers upon the glacis to command and enfilade the covered way of the fortress.

Trench′er. A wooden platter. The *quadra* of the Romans. Made of sycamore or maple. The *cissorium* of the Middle Ages.

Trench-plow. A *ditching-plow.*

Trend. 1. (*Nautical.*) *a.* The thickening of an anchor *shank* as it approaches the *arms*. It extends upward from the *throat* a distance equal to the length of the *arm*.

b. The angle formed by the line of a ship's keel and the direction of the anchor-cable.

2. (*Fortification.*) The general line of direction of the side of a work or a line of works.

Tre-pan′. 1. (*Surgical.*) A crown saw used principally in removing portions of the skull. The *trephine* is an improved form. See TREPHINE.

One boring instrument of the Romans was the *trypanon*, whence our name *trepan*. Whether it was really a crown-saw does not clearly appear.

2. (French.) A workman's name for the steel at the foot of a boring rod. *Trepang.*

A trepan in the Belgian section of Machinery Hall, Centennial Exhibition, Philadelphia, 1876, was 10 feet in length of face, and weighed 10 tons. It was rotated 6 inches after each stroke, and dug a hole 10 feet in diameter. Sand buckets and claws removed the mud and large stones from time to time; the instrument being intended to work in water and dispense with a caisson. A second reamer, 15 feet face and weighing 15 tons, followed the former to enlarge the hole, which was then tubed with cast-iron sections.

Tre-pan′ning. (*Brush-making.*) The tufts or bristles are drawn into the holes in the stock by means of wire inserted through holes in the edge, which are then plugged, concealing the mode of operation.

Tre-pan′ning-el′e-vat′or. (*Surgical.*) *e*, Fig. 6647. Also known as a lenticular knife. A lever for raising the portion of bone detached by the trephine.

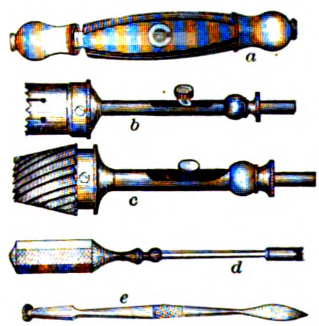
Tre-phine′. (*Surgical.*) An instrument for taking a circular piece out of the cranium. It is a cylindrical saw, with a cross-handle like a gimlet and a center-pin (called the *perforator*), around which it revolves until the saw has cut a kerf sufficient to hold it. The center-pin may then be retired.

a b, Mott's socket-handled trephine and handle.
c, Galt's conical trephine.
d, antrum-drill.
e, trepanning-elevator.

Fig. 6646.

Trepang.

Fig. 6647.



Trephines.

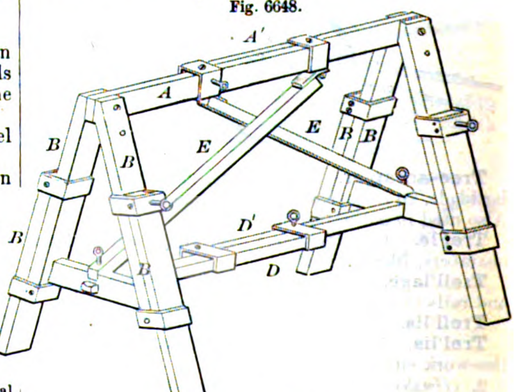
The *trephine* is sometimes worked by a revolving brace like that of the carpenter, and has even been socketed upon a stem with three legs, and turned by one hand while the socket is held by the other.

The *trephine* for the *antrum* (*d*) is a small crown-saw set in the end of a handle. It is used for entering the *antrum* through a tooth-socket.

Trepanning instruments were used by the ancients; Hippocrates (d. 357 B. C.) gives directions for their use, and refers to the operation as widely known. It was in great repute among the Greeks and during the Middle Ages. Fabricius *ab aquapendente* is referred to as an improver of the instrument.

The Kabyles of Africa practice the operation by making four kerfs in the shape of a square: the eight overlapping extremities of these kerfs show unmistakably the nature of the operation among the native African surgeons; the same marks are

Fig. 6648.



Trestle for Scaffolding.

present in some ancient Peruvian skulls presented by Mr. Squier to the Anthropological Society.

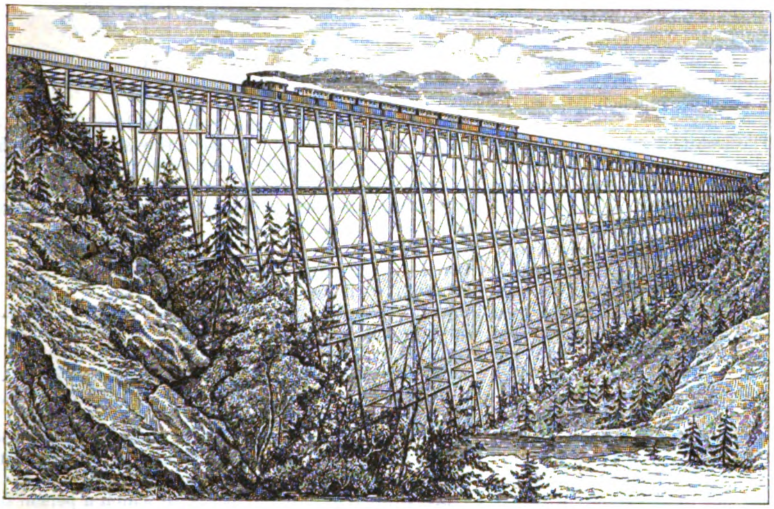
The native surgeons of the South-Sea Islanders trepan by laying back a flap of the scalp and scraping away the skull until an inch in diameter of the *dura mater* is exposed. This is supposed to let out the demon of vertigo or neuralgia. Jupiter was cured of a headache by a blow of Vulcan's hammer, and Minerva sprang from the opening. So the Feejee and the Ægean seas meet.

The most wonderful (?) story of skill in surgery connected with cranial contusions is related by Ellis, the traveler in Oceanica and Polynesia. "It is related, although I confess I scarcely believe it, that on some occasions (in the Society Islands), when the brain has been injured as well as the bone, they have opened the skull, taken out the injured portion of the brain, and, having a pig ready, have killed it, taken out the pig's brains, put them in the man's head, and covered them up." (ELLIS, Vol. II. page 343.) Result not stated.

The article "Cranial Amulets," by Dr. Bertillon, in "La Nature," gives some curious particulars in regard to the practice of trepanning among the people of the Stone Age in Western Europe. He particularly noticed some skulls from the dolmens of Lozere, by Dr. Prunières of Marvejois. The orifices were frequently about the size of a silver dollar, and were evidently made during life, as the edges were cicatrized, and in some cases the substance was entirely restored.

Perforated skulls have also been taken from ancient Peruvian graves and from the Canary Islands.

Fig. 6649.



Lyman Viaduct, Pacific Railway.

Tre-phine′-saw. A *crown*-saw. A cylindrical saw with a serrated end, to make a circular kerf by the rotation of the saw on its longitudinal axis. See TREPHINE.

Tres′tle. 1. A beam or bar supported by divergent legs. It is commonly used by carpenters to support a board while being sawed, or work while being put together, as a door. A *horse.*

The relation of the horizontal piece and oblique supports has caused various kinds of structures to be named from it.

Trestle-work of bridges consists of vertical posts, horizontal stringers, oblique braces, and cross-beams.

Trestle-trees of a ship's mast are horizontal timbers which support the *tops.*

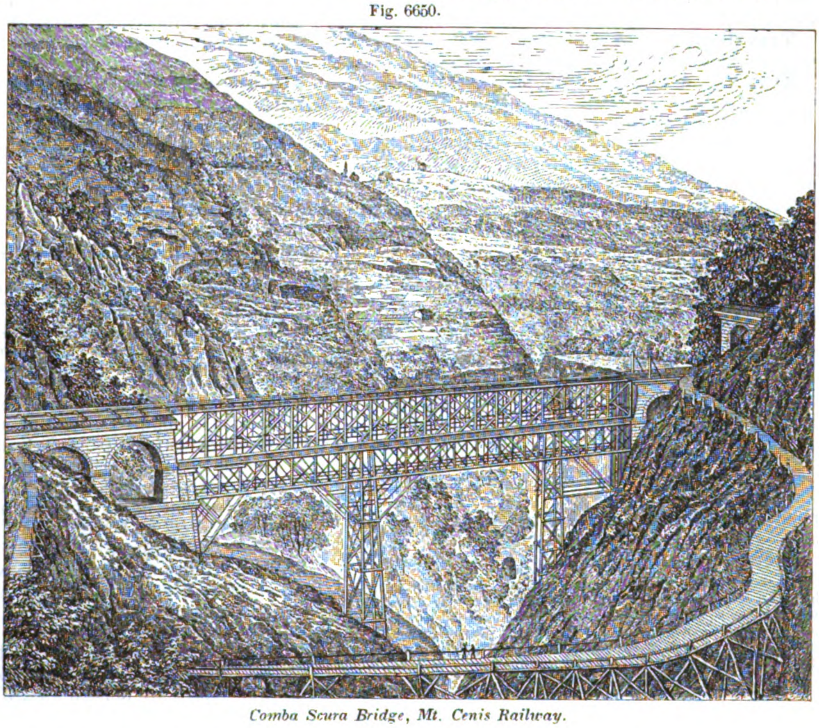
In the trestle and scaffold-supporter (Fig. 6648), the legs *B B*, connecting-bars *A A′ D D′*, and braces *E E*, are each in two parts, sliding past each other in collars, and fixed in any position by set-screws, rendering the devices adjustable as to length and hight.

2. The frame of a table.

3. (*Engineering.*) A road-bed or stringer supported by posts or pillars and framing in the intervals. See TRUSS; LATTICE.

Fig. 6649 is the Lyman Viaduct on the Pacific Railway.

Fig. 6650.



Comba Scura Bridge, Mt. Cenis Railway.

Fig. 6650 shows the Comba Scura Bridge, on the Mt. Cenis Railway, spanning a picturesque ravine in a spur of the Piedmontese Alps. It crosses at a hight of 395 feet above the bottom of the valley, and has a span between the abutments of 185 feet 2 inches.

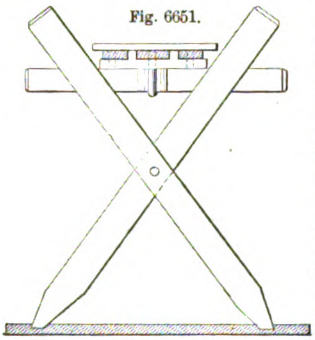
4. (*Leather.*) The sloping plank on which skins are laid while being curried.

5. (*Founding.*) In making loam cores on perforated barrels, the latter are made to revolve slowly by hand in V's of various sizes cut in the upper edge of a pair of iron trestles. From trestle to trestle the loam-board lies, the whole arrangement constituting a crude sort of lathe, but one sufficiently good for the purpose.

Tres'tle-board. The architect's designing-board. Formerly supported on trestles.

Tres'tle-bridge. (*Engineering.*) One in which the bed is supported upon framed sections which rest on the soil or river-bed. A military expedient, or one used in constructing works of a temporary character. The one shown in Fig. 6651 is understood to have been used in making roads over the Southern marshes and rivers; notably where the "swamp-angel" off Charleston poured her notes. See TRESTLE.

Fig. 6651.



Trestle for Bridges.

Tres'tle-tree. (*Nautical.*) (*Pl.*) Horizontal fore-and-aft timbers, resting on the *hounds* and secured to a lower mast or topmast on each side below the head. They serve to support the *cross-trees* and the *top*, if any.

Tres'tle-work. A viaduct or scaffold supported on piers, and with braces and cross-beams.

Tre'vat. A weaver's knife for cutting the loops of velvet pile.

Trev'et. A three-legged stool; a *trivet.*

Tri'al-bit. (*Saddlery.*) A skeleton-bit used to determine the exact width of the horse's mouth, also the breadth as well as the hight of the *port.*

Tri'al-jar. A tall glass vessel used for containing liquids to be tested by the hydrometer. The mouth is preferably enlarged, to prevent capillary adhesion of the hydrometer.

Fig. 6652.

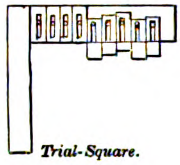
Trial-Jars.

Tri'al-square. A *test*-square; a *try*-square.

Fig. 6653 is a square for testing an edge which is not straight, having a set of slides which may be considered ordinates. One arm of the square has two parallel blades inclosing slotted pieces, which have a motion within certain limits transversely to the said arm, and which rest against the work and indicate its outline along the upper edge of the square.

Tri'an-gle. 1. (*Music.*) An equilateral bar of steel suspended by one angle and having an opening at one of the lower angles, so that the legs are of unequal length. It is struck with a small rod, and is sometimes introduced in brilliant musical passages.

Fig. 6653.



Trial-Square.

Possibly the *shalisbim* of the Hebrew Scriptures.

The *triangulum* of the Romans. They had several forms of metallic instruments of percussion; the *cymbalum* plates, used in pairs; *kymbala* of the Greeks; the *crotala* and *crusmata*, kinds of castanets; *krotala* of the Greeks; the *sistrum*, which had jingling rods; the *tintinnabula*, or bells in a frame; the *crepitaculum*, a hoop with rings. See list of PERCUSSION-INSTRUMENTS on page 1501, and under each head there noted.

2. (*Drafting.*) A three-cornered straight-edge, used in conjunction with the T-square for drawing parallel, perpendicular, or diagonal lines. It has one right angle, the two others being each of 45° (*b*), or one of 30° and the other of 60° (*a*).

Fig. 6654.

Triangles.

3. (*Building, etc.*) A gin formed by three spars. A staging of three spars.

4. (*Pottery.*) A small piece of pottery, placed between pieces of biscuit ware in the *seggar*, to prevent the adherence of the pieces when fired.

5. A frame of three halberds to which a person is (was) lashed to undergo military punishment.

Tri-an'gu-lar Com'pass-es. A compass having three legs, two opening in the usual manner, and the third turning round an extension of the central pin of the other two, besides having a motion on its own central joint.

By this instrument three points may be taken off at once, and it is very useful in constructing maps and charts.

Fig. 6655.

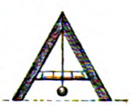
Triangular Compasses.

Tri-an'gu-lar File. The ordinary, tapering hand-saw file of triangular cross section. Also known as a *three-square* file.

Tri-an'gu-lar Lev'el. A light frame in the shape of the letter A, and having a plumb line which determines verticality.

It is used in leveling for drains. One leg being placed on a peg driven flush with the surface of the soil, the other leg is brought round till it touches the surface in another place; here another peg is driven. The inclination, say half an inch in the span of the frame, being determined, a peg is driven at the second station, half an inch below the level at that point. This gives another point of departure, and the process is a repetition of the former procedure.

Fig. 6656.



Triangular Level.

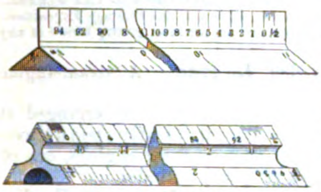
Tri-an'gu-lar Scale. Used by draftsmen and engineers for laying down measurements on paper. Each edge is differently divided, giving a variety of scales to select from. The rule being laid flat on the paper, the distances required to be laid down can at once be pricked off, dispensing with the use of dividers.

They are commonly made of boxwood, but sometimes of metal silver, or nickel plated, or of steel.

Tri-at'ic Stay. (*Nautical.*) A rope connected at its ends to the heads of the fore and main mast, and having a thimble spliced to its bight for the attachment of the stay-tackle, by which boats, heavy freight, and *speck* are hoisted aboard.

Trib'ble. (*Paper-making.*) A large horizontal

Fig. 6657.



Triangular Scales.

frame in the loft or drying-room of a paper-mill, having hairs or wires stretched across it for the suspension of sheets of paper while drying.

Trib'let. 1. (*Forging.*) A mandrel used in forging tubes, nuts, and rings, and for other purposes. The nut having been cut from the bar, the hole is punched and enlarged by the triblet, which also serves as a handle while the nut is being finished on the anvil. In the case of a ring, the parts hav-

Fig. 6658.

Triblet.

ing been joined, the ring is fashioned and shaped on the *triblet* (*tribolet*, Fr.).

2. The mandrel in a machine for making lead-pipe.

Trib'o-let. See TRIBLET.

Tri-bom'e-ter. An apparatus resembling a sled, used in estimating the friction of rubbing surfaces.

Trib'ute. (*Mining.*) *a.* Work performed in the excavation of ore in a mine; as distinguished from *tut-work*, which is upon the non-metalliferous rock, as in sinking shafts and the driving of adits and drifts.

b. The proportion of ore which the tributer or workman receives for his labor.

Trib'ute-pitch. (*Mining.*) The limited portion of a lode which is set to a "pair" of tributers, beyond which they are not for the time being permitted to work.

Tri'cing-line. (*Nautical.*) One for raising an object out of the way for head-room, or to stow it.

Tri'dent. 1. A three-pronged spear formerly used by the *retiarius* in the gladiatorial contests.

2. A three-pronged fish-spear.

Trig. A shoe for a wheel to ride on, in descending a hill. A form of brake.

Trig'ger. 1. (*Fire-arms.*) A catch which, being retracted, liberates the hammer of a gun-lock. See illustrations, Plates XVII., XVIII.

A *hair-trigger* is a duplication of parts; the supplementary trigger is released with very slight force, and liberates a spring which instantly retracts the main trigger from the *sear* of the hammer.

2. (*Shipbuilding.*) A piece of wood placed under a dog-shore to hold it up until the time for launching. The dog-shore buts against cleats on the bilgeways, and is knocked away when the signal is given for launching.

3. (*Vehicle.*) A catch to hold the wheel of a carriage in descending a hill.

Trig'ger-line. The line by which the gun-lock of ordnance is operated.

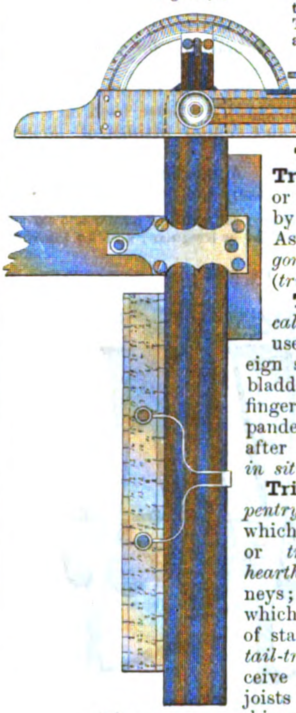
Tri'glyphs. (*Architecture.*) Ornaments repeated at equal intervals in the Doric frieze. Each triglyph consists of two entire gutters or channels cut to a right angle, called *glyphs*, and separated by their interstices, called *fermona*, from each other as well as from two other half-channels that are formed at the sides.

Tri'gon. A triangular lyre. See TRIGONON.

Trig'o-nom'e-ter. An instrument for plotting angles and laying down distances upon paper, and for solving problems in plane trigonometry by inspection.

It has a semicircular protractor with a long arm carrying a T-square and graduated sliding-scale. The protractor may be read to minutes of arc and the scale to thousandths of an inch. The arrangement enables the distance to be pricked off at the same time the angle is set off.

Fig. 6659.



Trigonometer.

Tri'go-non, or **Tri'gon.** A small harp or triangular lyre used by the ancients; the Assyrians, Greeks (*trigonon*), and Romans (*trigonum*).

Tri'labe. (*Surgical.*) An instrument used in extracting foreign substances from the bladder. It has three fingers, which are expanded and contracted after the instrument is *in situ.*

Trim'mer. 1. (*Carpentry.*) A joist into which others are framed or *trimmed;* as the *hearth-trimmer* of chimneys; *stair-trimmers*, into which the rough-strings of stairs are framed; the *tail-trimmers*, which receive the ends of floor-joists on the side of the chimney, when they cannot be inserted into the wall on account of flues.

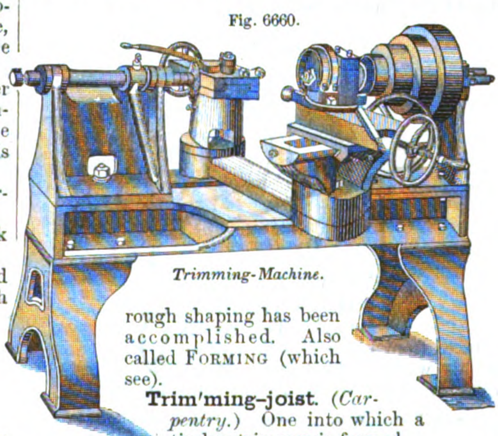
2. (*Bricklaying.*) *Brick-trimmer;* a flat brick arch, turned from the face of the chimney to the timber-trimmer to support the slab. See CHIMNEY.

3. A tool to pare or trim; as, —

Lamp-wick trimmer,	Hog's-nose trimmer,
Welt-trimmer,	Sheep's-foot trimmer, etc.
Hedge-trimmer,	

Trim'ming. (*Shipbuilding.*) The final shaping of ship-timbers, etc., after the *conversion* or rough shaping has been accomplished. Also called FORMING (which see).

Fig. 6660.



Trimming-Machine.

Trim'ming-joist. (*Carpentry.*) One into which a timber-trimmer is framed.

Trim'ming-ma-chine'. 1. (*Metal-working.*) A species of lathe for trimming the edges of stamped hollow-ware, such as sheet-metal pans. The article

is chucked on the rotating-head; and while one portion of the edge is turned off smooth by a cutter, a part already trimmed is turned over, forming a bead around the wire, by which the rim of the pan is stiffened.

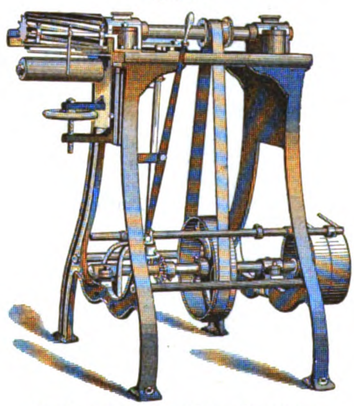
2. (*Boot-making.*) A machine for trimming the edge of uppers.

Trim'mings. A general name for ornaments and fittings; such, for instance, as those used on a harness, the hardware and similar fittings of houses, etc.

Trim'ming-shear. A machine for trimming wool borders on Coir, Sisal, and other mats.

It has various adjustments: for width of border not exceeding ten inches, either straight or irregular; and for thickness of material.

Fig. 6661.



Curtis and Marble's Trimming-Shear.

Trin'gle. 1. A curtain-rod of a bedstead.

2. (*Architecture.*) A little member over the Doric triglyph.

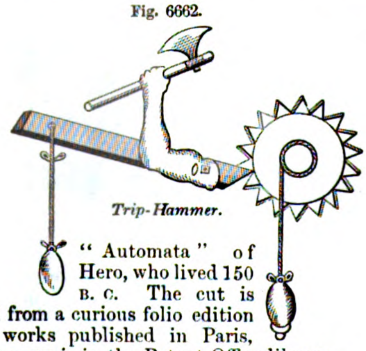
Trin'glette. A pointed stick used in opening the cames of fretwork and diamond-paned windows.

Trin'ket. (*Nautical.*) The royal or topgallant sail. The upper sail in a ship.

Trip-ham'mer. A hammer tripped on its axis by the contact of cam, wiper, or tooth with the tail of the helve.

The annexed cut is perhaps the earliest illustration of the trip-hammer movement. It is from the

Fig. 6662.



Trip-Hammer.

"Automata" of Hero, who lived 150 B. C. The cut is reduced from a curious folio edition of his works published in Paris, 1693; a copy is in the Patent Office library.

The old French form, the *marteau frontal*, was lifted by projecting arms fixed in a cam ring and falling through a certain space by its own gravity. The *tilt*-hammer which succeeded it, instead of being raised at the front, had its tail depressed by a cam in the rear. Various modifications were known, as the *tennant-helve* and the *belly-helve*, but the *steam*-hammer and various forms of *drop* and *dead-stroke* are rapidly superseding the pivoted helve. See list under HAMMER; see also TILT-HAMMER.

The Cubberly trip-hammer, shown at the Chicago Exposition, 1875, is said to run 200 strokes per minute, giving blows of any degree of intensity.

Trip'le-cyl'in-der En'gine. A steam-engine employing three cylinders.

In one form it has three cylinders arranged at angles of 120°, so as to act coincidently upon a three-throw crank. In the Thames River engines, one of these cylinders is an air-pump cylinder.

In Alden's (patented, May, 1875), two small cylinders alternately receive steam at each revolution, and alternately exhaust into an auxiliary large cylinder, while their pistons are balanced by the exhaust steam. See also THREE-CYLINDER ENGINE.

Trip'le-in'grain Car'pet. A carpet made of wool or worsted, dyed in the grain (before manufacture), and consisting of three webs interchangeably united, so that either of the three warps may be brought to the surface to give the color required by the pattern. Each web is woven at the same time, and the warps are governed by the Jacquard arrangement. A *three-ply carpet.*

Trip'le-shov'el Plow. A cultivator-plow with three shovels.

Trip'let. (*Optics.*) An arrangement of lenses in a microscope, invented by Holland.

In Wollaston's doublet two plane concave lenses were used, but in Holland's two lenses are substituted for the first in the *doublet*, and the *stop* is placed between them and the third lens. The object is the correction of spherical aberration and chromatic dispersion. See LENS.

Tri'pod. A three-legged support for a table, chair, surveyor's compass, candelabra, brazier, or other object.

Tri'pod-jack. A screw-jack supported on three legs, connected to a common base-plate to give them a sufficient bearing.

Fig. 6663.

Tripod-Jack.

Trip'o-li. 1. A siliceous polishing-material first imported from Tripoli, Africa.

The *tripoli* of Bilin in Bohemia has been ascertained by Professor Ehrenberg of Berlin to consist of the siliceous plates or frustules of animalculæ and diatomaceæ. They are divested of everything but silex, are hard but fragile, and are of different species. Of one kind there are 41,000,000,000 in a cubic inch, weighing 220 grains; 187,000,000 to a single grain.

Infusorial earth has been employed in the manufacture of fire-brick and for the lining of furnaces; its adaptation for this purpose is owing to the fact that it contains but a very small proportion of material capable of acting as a flux, being composed of nearly pure silica.

Floating bricks were made by the ancients, according to Posidonius, from a kind of argillaceous earth, which was employed for cleaning silver-plate. As tripoli is too heavy to float in water, M. Fabbroni experimented with a number of mineral substances, which it seemed might be adapted for making brick of this kind, and at last succeeded in producing them by using fossil meal, a kind of earth abundant in Tuscany, containing, according to M. Fabbroni, 55 parts of siliceous earth, 15 magnesia, 14 water, 12 alumina, 3 lime, and 1 iron.

It is infusible in the fire, loses about $\frac{1}{6}$ of its weight in baking, and but little of its volume.

Bricks made of this substance float in water, either burned or unburned, and $\frac{1}{20}$ of clay may be added without destroying this property. They resist water, unite readily with lime, and are nearly as strong as common bricks, with but about $\frac{1}{6}$ of their weight. They are such bad conductors of heat that one end may be made red-hot while the other is held in the hand, and are well adapted for furnaces and where great heat is to be sustained, as well as in constructions where extreme lightness is desirable, as for domes, etc.

2. Rotten-stone. A light-brown siliceous earth used as a polishing-material. Sometimes made from *clunch* or *septaria.* One analysis gives: —

Silica	81
Alumina	1.5
Iron	8
Sulphuric acid	3.45
Water	4.55
	98.55

It is now found in numerous localities. It is prepared by calcining and grinding, and has various colors.

Trip'pet. (*Machinery.*) A projection intended to strike some object at regularly recurrent intervals. A *cam, lifter, toe, wiper, foot,* etc.

Trip'ping-line. (*Nautical.*) A rope used in lifting a spar while disengaging it from its usual attachments, previous to sending it down.

Trip'ping-valve. One moved recurrently by the contact of some other part of the machinery.

In Cartwright's steam-engine (Fig. 5664), the valves were moved by the contact of the stems with the cylinder foot, the piston, etc. One valve was in the piston, and was tripped by the contact of the valve-stem with the bottom of the cylinder. Another poppet-valve was at the head of the cylinder, and controlled the eduction. It was tripped in one direction by the contact of the piston, and in the other by the descent of the cross-arm on the piston-rod.

Trip-shaft. (*Steam-engine.*) A supplementary rock-shaft, used in starting an engine.

Tri-spas'ton. A tackle with three blocks.

Trit-u-ra'tion. Reducing to a fine powder or magna by grinding or stamping. The action may be in a mill, a mortar, or arrastra, or on a slab by a muller. The latter is specifically *porphyrization.*

Trituration is generally conducted dry; *levigation* is comminution assisted by a liquid.

Trituration of grain is usually conducted between stones, as in GRINDING-MILLS (which see).

Of spices and allied articles, such as coffee, pepper, etc., by *steel mills.* See COFFEE-MILL; PAINT-MILL; etc.

Of drugs and snuff, by *pestle and mortar.* See MORTAR.

Of ores and rocks, by edge-rollers (see CHILIAN MILL), stamps, or by horizontally rotating mullers in pans. See AMALGAMATOR; ARRASTRA. See also Plates XXXIV., XXXV., and pages 1567-72.

The variety of mills or grinders is very great, and a list may be found under MILL (page 1440).

Triv'et. 1. The knife wherewith the loops of *terry* fabrics are cut. Velvets and Wilton carpets, for instance, are woven with loops, the warp being carried over wires in the shed.

On the top of each wire is a groove which forms a guide for the *trivet,* which, by a dexterous motion of the operator, is thus driven along the wire, cutting all the loops and making a *pile* fabric; or *cut-pile* fabric, as it is more specifically called.

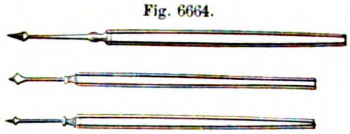
2. A *tripod.* A three-legged arrangement for supporting an object, as a pot or kettle; this may be effected by slinging it from a hook suspended from the point of junction of the three legs, or the legs may be set 120° apart, straddling outward from and supporting a ring sufficiently large to receive the bottom of the pot.

Tro'car. (*Surgical.*) (Fr. *Troiscarré,* three-faced.) An instrument consisting of a perforator or stylet and a cannula. After the puncture is made the stylet is withdrawn, and the cannula remains and affords a means of evacuating from the cavity. Used in case of dropsy, hydrocele, etc.

Tapping for the dropsy was practiced by the ancients.

Fig. 6664 shows forms of trocars for puncturing the eye in cases of dropsy of that organ.

Fig. 6664.

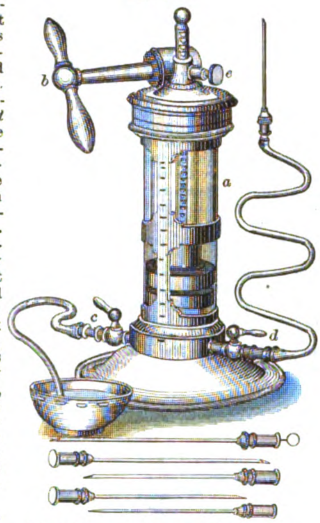


Paracentesis Trocars.

The instrument (Fig. 6665) invented by Dr. Dieulafoy of Paris is designed to remove fluids from cavities by means of capillary tubes and a suction-pump, so as not to leave an open wound nor admit air to the cavity.

It consists of a glass cylinder *a* about 7 inches in hight and 2 in diameter, partly covered with a silver-plated casing, and having a tightly fitting piston which is raised or lowered by turning the handle *b*. Near the bottom of the cylinder are the induction and eduction openings *d c,* fitted with rubber tubes. The capillary tubes or trocars are six in number, and of different sizes; one is shown attached to the induction-tube *d,* and five below the instrument. In addition to these there should be two or three small blunt cannulas with trocars and a detachable handle, so that when the trocar is withdrawn the cannula may be attached to the instrument.

Fig. 6665.



Dieulafoy's Aspirator, with Trocars.

In using the instrument, the cocks *c d* are closed and the handle *b* turned, producing a nearly perfect vacuum in the cylinder; the piston is held in raised position by a spring *e*. The trocar is introduced with a rotary motion into the part from which the fluid is to be withdrawn; on opening the cock *d* it flows into the cylinder, which is emptied when full by closing *d*, opening *c*, pulling out the spring *e*, and lowering the piston; when this is done, both cocks are again closed, and the operation repeated.

The cylinder is provided with a scale graduated to grammes, for showing the amount of contained fluid, and a glass tube is inserted near the outer end of the induction-tube, through which the fluid while passing may be inspected.

The instrument is useful for removing fluids from the pleural and cranial cavities and the knee-joint; for withdrawing pus from abscèsses; gas and the fluid contents of the intestines; and it has been employed for puncturing the bladder above the pubes in cases of retention of urine. Local anæsthetics may be applied to the part under treatment.

Tro-chei'do-scope. An instrument designed for displaying the effect of the combination of colors.

It consists of a whirling table operated by a crank, and painted of different colors, having a spindle arising from its center, by which are suspended disks having the outlines of various patterns cut out of them. The patterns are, one at a time, attached to this disk and to a branch projecting from the side of the table, which is rotated with sufficient rapidity to cause them to appear blended, though each is distinctly visible in the pattern disk, owing to its receiving a constant vibratory motion from the table. Were this not the case, the distinction of colors would not be visible. — *Mech. Mag.*, N. S. Vol. III. p. 268.

Tro-chom'e-ter. An *odometer.* A *trechometer.*

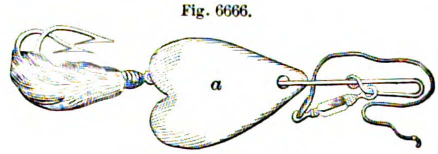
Trogue. (*Mining.*) A wooden trough forming a drain.

Trol'ley. A vehicle on the ways or tracks of iron works.

Troll'ing-spoon. A bait trailed behind a boat to attract and catch fish.

The name is derived from the frequent use of a silvered spoon bowl to which the hook is soldered, and which is connected by a snood to the line. In the example, the bright piece *a* is rotated as it is drawn through the water, and reflects the light in different directions, like the silvery scales of a small fish in motion.

Fig. 6666.



Mann's Trolling-Spoon.

Troll-plate. (*Machinery.*) A rotating disk employed to effect the simultaneous convergence or divergence of a number of objects; such as screw-dies in a stock, or the jaws of a universal chuck.

Trombe. See TROMPE.

Trom-bone′. 1. (*Music.*) A wind-instrument of metal, whose middle piece slides telescopically upon the *mouth-piece* and *pavilion* ends. Its capacity for modulation of tone by means of its slide gives it command over every tone within its compass, without keys or valves. It is made *en suite*, that is, of varying sizes and compass. See HORN, *h*.

The English *sackbut* of the ninth century could be drawn out to alter the pitch of sound. The French name in the fifteenth century was *sacquebutte* or *sacqueboute;* from *sambuca*.

Trombones are of four kinds, each of which bears the name of the human voice to which it bears the nearest resemblance in quality of tone and compass. The *soprano* is the smallest and highest; it doubles the soprano voices of the chorus, but is but little used. The other trombones are the *alto*, *tenor*, and *bass* trombones, and double those voices.

The *alto trombone* has a compass of more than two octaves and a half, and is also known as the trombone in $E\flat$. It is written on the C clef, third line.

The *tenor trombone* is also known as the trombone in $B\flat$. It is written on the C clef, fourth line.

The *bass trombone* is the lowest of all in its range of notes, and is known as the $E\flat$. It is written on the F clef; is an octave lower than the alto, and a fifth lower than the tenor.

Fig. 6667.

Tromba Spezzata.

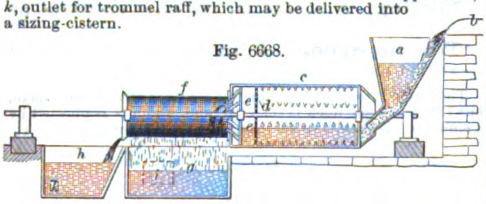
Fig. 6667 is an illustration of a trombone, from the curious work of Père Bonanni, "Description des Instrumens Harmoniques," Rome, 1776. It is there called the *tromba spezzata*, or Trompette Rompüe. It has two tubes, one slipping in the other, to vary the note. It is described as held by the left hand, and the movable section operated by the right; also as the most harmonious and versatile of all instruments. It is described by Père Mersenne in his book on harmonic instruments, called by the French *sacquebule*, and having 15 feet total length of pipe. Scacchi Mirot attributes the invention to the Egyptians, but without sufficient apparent reason.

2. A form of blunderbuss for boat-service.

Trom′mel. (*Metallurgy.*) A form of *buddle* or machine for separating the richer portions of slimes from the worthless.

a, Fig. 6668, is the hopper in which the slimes are lodged; *b*, *launder*, delivering clean water into the hopper; *c*, *trommel*, having spikes in the interior for the purpose of dividing the stuff; *d*, perforated disk, to prevent the passage of chips or bits of stone; *e*, Archimedean pipes fitted into a disk of sheet-iron to convey water to the gauze or perforated trommel *f*; *g*, slime-cistern; *h*, cistern for receiving the rough stuff; *i*, slime-outlet, communicating with round buddle or other suitable apparatus; *k*, outlet for trommel raff, which may be delivered into a sizing-cistern.

Fig. 6668.



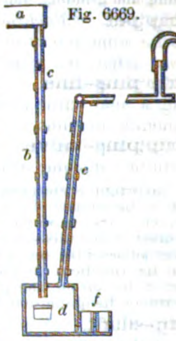
Slime-Trommel.

Trompe. The water-blowing engine; used as a furnace-blast in Savoy, Carniola, and some parts of America.

Water from a reservoir *a* flows through the pipe *b*, which is contracted just below the reservoir to divide the stream into a shower, and has oblique perforations at *c*, through which air enters and is carried down by the water, which impinges upon a plate in the drum *d*, separating the air which is compressed in the upper part of the drum, flowing through the pipe *e* to the tuyeres or blast-pipes. At the bottom of the drum *d* is an orifice for the escape of water, which flows into the chest *f*, divided into two parts by a slide to prevent the air from issuing with the water. By raising or lowering the slide, the water within the drum may be retained at any required level to give the air a greater or less compression. The cistern has a flood-gate to regulate the admission of water. The contracted portion of the tube *b* is termed the *etranguillon*.

See Lewis's "Glossary of Commerce," page 267; see also Carl, "Repositum Phys. et Tech."

Fig. 6669.



Trompe.

Tron. 1. A steelyard balance.

2. A wooden air-shaft in a mine.

Tro′phy. A commemorative or triumphal erection.

The trophies of the Greeks were decked out with the arms of the vanquished for land victories; with the shatters of the enemy's vessels, for naval engagements. It was deemed sacrilege to demolish them, as they were consecrated to some deity; and a crime to repair them, as it prolonged quarrels. The erection of stone pillars was deprecated, as making animosities eternal.

Troub′le. (*Mining.*) A difficulty in a coal-mine, arising from the interposition of a layer of sandstone dividing the seam into two portions; a *fault*, or the gradual closing in of the strata above and below, terminating the seam. The latter is called a *nip*.

Trough. 1. (*Electricity.*) *a.* The tray or vat containing the metallic solution used in electroplating.

b. The array of connected cells in which the copper and zinc plates of each pair are on opposite sides of the partition. See GALVANIC BATTERY.

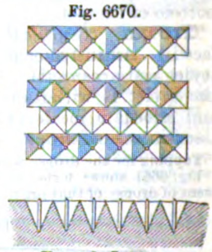
2. (*Chemistry.*) The vat or pan containing water over which gas is distilled. See PNEUMATIC TROUGH, Fig. 3855, page 1755.

3. (*Metallurgy.*) A *frame*, *vat*, *buddle*, or *rocker* in which ores or slimes are washed and sorted in water. See list under METALLURGY.

Trough-bat′ter-y. A compound voltaic battery consisting of a number of cells in a trough; the plates being united by a bar of wood and electrically connected by wires, the copper of each pair to the zinc of the next pair. See GALVANIC BATTERY.

Trous-de-loup. (*Fortification.*) Rows of pits in the shape of inverted cones with a pointed stake in each; intended as a defense against cavalry.

Fig. 6670.



Trous-de-Loup.

Trow. A boat with an open well between the bow and stern portions; used in spearing fish.

Trow′el. 1. A tool *e*, like a small scoop, used by gardeners in potting plants, etc.

2. A mason's and plasterer's flat triangular tool *d* for spreading mortar.

The *trua* (diminutive *trulla*) of the Romans was a tool with a handle and flat blade, used in plastering. The same name was applied to a perforated ladle or skimmer.

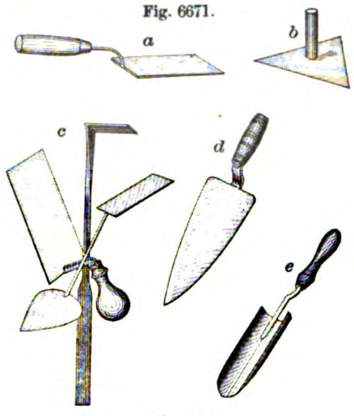
3. (*Founding.*) A tool for smoothing the loam in molding.

They are of different shapes and sizes, as *a b c*. They are employed in the foundry for restoring broken corners or parts which become ruptured when drawing a mold away from the pattern after ramming; and for smoothing the surface of the sand or loam composing the mold.

Fig. 6672 illustrates trowels and kindred tools used by molders in forming the molds of loam or sand employed in casting metals.

a, square trowel.
b, heart-trowel.
c, dog-tail.
d, heart and square.
e, lifter.
f, flange-lifter.

Fig. 6671.

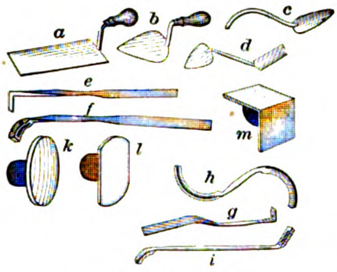


Trowels.

g, "Yankee" slick. *k*, button-slick.
h, bead-slick. *l*, pipe-slick.
i, circular and flat flange. *m*, square corner.

Trow'el-bay'o-net. A bayonet resembling a mason's trowel, used as a weapon, and as a light in-

Fig. 6672.



Molders' Trowels, etc.

Fig. 6673.

Trowel-Bayonet, with Handle.

trenching-tool, or as a hatchet when detached from the rifle. Invented by Lieutenant-Colonel E. Rice, U. S. A.

The bayonet shown in the cut is fastened to the rifle by a spring clamp. It weighs about 15 ounces. As an intrenching-tool it has been found very useful in light soils, and 10,000 bayonets of this pattern are now making at the Springfield Armory, to be placed in the hands of troops in the field.

Fig. 6674 shows a section of trench capable of sheltering two ranks. It has a width of 7 feet; depth, 1 foot 3 inches; hight of parapet, 1 foot 6 inches.

The plan of a shelter-pit for skirmishers indicates

Fig. 6674.

Shelter-Pit.

the dimensions; depth of excavation, 6 inches; hight of parapet, 1 foot 2 inches.

The depth of the ditch and hight of the parapet will vary according to the form of the ground at the spot; the object being to completely protect the soldier while lying down, from a direct fire.

Trow'eled. The finishing-coat of plaster in the best three-coat work. It is smoothed with the trowel, and forms *stucco*. The action of traveling has an important specific effect in the quality of the work.

Trow'sers. A bifurcated garment for the legs and lower portion of the body.

They were called *braccæ* by the Romans, and regarded by them as barbarous (*tegmen barbarum*). They were not worn by the Greeks or republican Romans, but were afterward used by the emperors. They were the native dress of the Medes, Persians, Phrygians, Sarmatians, Dacians, Belgians, Britons, and Gauls. The Latin word *braccæ* still survives in the English *breeches* and Scottish *breeks*.

The European *braccæ* were of wool, linen, and leather; the Asiatic, of silk or cotton.

Strabo says that the Persian attire was derived from the Medes. "A hat, a tunic with sleeves reaching to the waist, and trowsers, are proper to be worn in cold and northerly places, such as Media. The custom of the vanquished appeared so noble to the conquerors that they adopted it.

Breeches were worn by Augustus, who had a habit of taking cold; they reached a little below the knees, and were called reproachfully, *feminalia*. They were worn by the Roman horsemen of the Empire; are shown on the Column of Trajan, the Arch of Constantine, and elsewhere.

Truck. 1. (*Nautical.*) *a.* A small wooden disk at the extreme summit of a mast. It may contain the pulleys for the signal halyards.

b. A circular perforated block like a wooden thimble, and acting as a *fair-leader*.

2. A roller at the foot of a derrick or gin by which the position of the hoisting-apparatus may be shifted.

3. (*Ordnance.*) A small solid wheel on which a certain description of gun-carriage is based.

4. A low two-wheeled vehicle for conveying goods and packages.

The hand-truck is an efficient vehicle for removing single packages of considerable weight; the curved bar in front being insinuated under the box, for instance, which is then tipped so as to balance back slightly against the bed, in which position it is transported upon a pair of heavy wheels of small diameter.

It is an indispensable assistant in warehouses, express-offices, etc.

The term *truck* is sometimes applied to certain hand-carts and two-wheeled barrows. It is not easy to make the distinction in some cases, and perhaps not very important. See WHEELBARROW.

Fig. 6675.

Hand-Truck.

5. A wagon with a low bed, for moving heavy packages.

Fig. 6676 illustrates what is known as the *crane-neck* truck. The fore part is connected to the body by an arched bar, which permits the fore wheels to turn beneath it.

6. A low platform on wheels for moving buildings, heavy stone block, safes, etc. Fig. 6677.

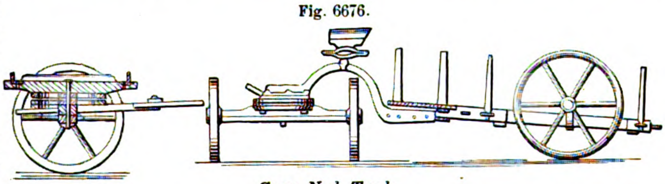
7. (*Railway.*) A swiveling carriage with four or six wheels beneath the forward part of a locomotive, or supporting one end of a railway-car, either passenger or freight.

The long car supported on swiveling trucks is one of the peculiar features of American railway rolling-stock.

Fig. 6678 is a truck for street-cars, and shows a peculiar mode of bracing the pedestals.

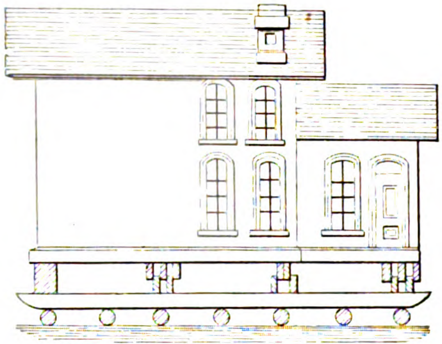
Fig. 6679 is for railways, and shows a system of bracing and transferring the imposition of weights until they eventually

Fig. 6676.



Crane-Neck Truck

Fig. 6677.



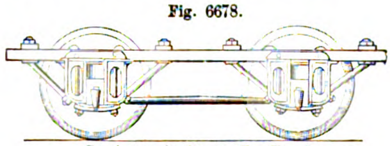
Truck for Moving Buildings.

come upon the brasses, which rest on the axles. See CAR-TRUCK, pages 488 - 90.

Truck-jack. A lifting-jack suspended from a truck-axle to lift logs or other objects so that they may be loaded on to a sled or other low-bodied vehicle. The calipers that embrace the log are hooked to the catch on the end of the ratchet-bar. The bar is raised by the lever, and is dogged by its attendant pawl.

Truck'le. A small wheel. A caster.

Fig. 6678.

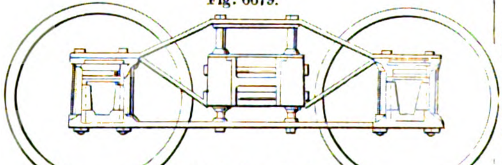


Stephenson's Street-Car Truck.

Truck'le-bed. One running on casters, out and in beneath an ordinary bed. A TRUNDLE-BED (which see).

The truckle-bed was formerly appropriated to the squire or serving-man. See "Merry Wives of Windsor," Act IV. sc. 5;

Fig. 6679.

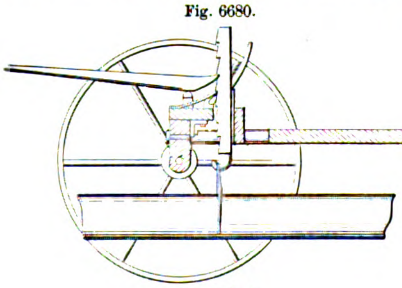


Allen's Car-Truck.

where the landlord of the Garter Inn says of Falstaff's room, — "There's his chamber . . . . his standing-bed, his truckle-bed."

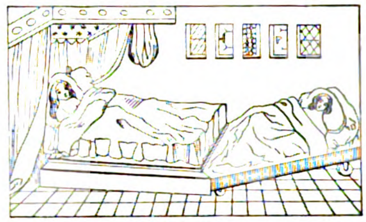
The illustration is from the manuscript of the "Comte d'Artois," and shows the count in one bed, his wife, disguised

Fig. 6680.



Truck-Jack.

Fig. 6681.



Truckle-Bed.

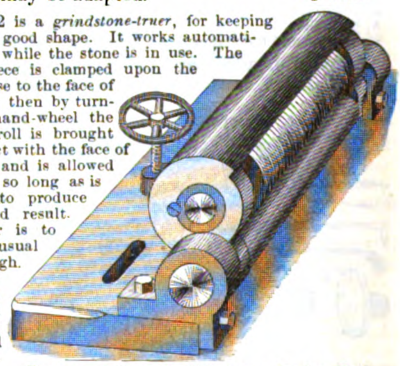
as his valet, in another. See also Hudibras, Part II., Canto II., where Hudibras

"With knocking loud and bawling,
He roused the squire in truckle lolling."

Trug. A mortar hod.

Tru'ing-tool. A device for truing the face of a grindstone, or any other surface for which it may be adapted.

Fig. 6682.



Brown and Sharpe's Grindstone Truing-Tool.

Fig. 6682 is a *grindstone-truer*, for keeping the face in good shape. It works automatically, and while the stone is in use. The bottom piece is clamped upon the trough close to the face of the stone; then by turning the hand-wheel the threaded roll is brought into contact with the face of the stone, and is allowed to remain so long as is requisite to produce the desired result. The water is to be left as usual in the trough. When by long use the thread on the hardened roll becomes worn it is re-cut.

Trum'pet. 1. (*Music.*) An instrument of the horn kind, in various keys, some having lengthening pieces by which the key is changed. It is written on the C clef.

Trumpets with pistons and cylinders give all the intervals of the chromatic scale. Valved trumpets have a movable valve similar to that of a trombone.

Wilkinson states that the drum and trumpet frequently occur in the battle-scenes of Thebes. The trumpeters are represented standing still, summoning the troops to form, or in the act of charging with the troops. Fig. 6683.

"The people of Busiris and Lycopolis, in Egypt," says Plutarch, "objected to the trumpet, considering that its sound resembled the braying of an ass and reminded them of the evil genius."

The trumpet was known in Egypt before the siege of Troy. Homer seldom mentions it, but speaks frequently of the flute, lyre, and pipe.

They were in common use among the Israelites, and were employed in the ceremonials at the new moon and other sacred occasions. They are mentioned in the Book of Job. The Israelites probably derived the use of them from their Egyptian associations, as they had but little use for them when they went down into Egypt as a nation of shepherds, 1706 B. C. They appear to have been carried by the officer in command of what we might call a regiment, "the captain of their thousand," as Jesse said to David when he sent ten cheeses to the colonel Gideon's fifty trumpets signified fifty bodies of troops, — no mean body for a night attack.

By the command of Joshua the priests blew the trumpets at Jericho. (Joshua vi. 8.) Ehud and Gideon marshaled their men by trumpets.

The Hebrews had three kinds of trumpets, *keren*, *shophar*, *chatzozerah*. The first two were more or less curved, and were horns. The last mentioned was a straight trumpet, about two feet in length. It is shown on the Arch of Titus, where a triumphal procession, after the fall of Jerusalem, is depicted. The *salpinx* of the Greeks; the *tuba* of the Romans.

The *keras* was the brass curved horn of the Greeks; the *cornu*, of the Romans.

Fig. 6683.

Egyptian Trumpeters (Thebes).

Xenophon mentions, in the "Anabasis," the ceremonies at the Thracian banquets: —

"And after this came men who played on horns, such as are used for giving orders with, and also on trumpets made of raw bull's-hide, in excellent tune, as if they had been playing on a magadis" (a harp with twenty strings, arranged in octaves).

The Greeks had six varieties of trumpets in their armies; the Romans but four. The Greeks had lyres, pipes, flutes, and cymbals for martial music; the Romans, only the trumpet.

The famous lines in the "Æneid," which are considered as onomatopoetic, are, —

"*At tuba — terribi — lem soni — tum procul — œre ca — noro.*"

The equally famous ones which are held to resemble the cadence of a gallop are, —

"*Quadrupe — dante pu — trem soni — tu quatil — ungula — campum.*"

The Roman *tuba* (trumpet) was straight; the *cornu* (horns or shells), curved; the *lituus* had a straight stem, and curved near the bell-mouth. It was shaped much like a tobacco-pipe, but was much larger. It was for cavalry, harsh and shrill in its tones.

The invention of the trumpet is by the Romans uniformly ascribed to the Tyrrheni (Etruscans).

Fig. 6684 is an illustration of a trumpet, from the curious work of Père Bonanni, "Description des Instrumens Harmoniques," Rome, 1776. It is referred to under the name of

Fig. 6684.

Tromba.

Fig. 6685.

Brazilian Trumpet (Native).

the *Courbée Antique*, or Roman trumpet, and is described as so large that it could only be carried by means of a bar resting upon the shoulder. It is taken from sculptures on ancient tombs.

Lilius Geraldus says that the bodies of mature persons were carried to the grave with the sound of trumpets; those of juniors, with the sound of flutes.

In the museum of Rio Janeiro is preserved the trumpet of one of the aboriginal Caziques. The substance of which it is formed is hard and black, and appeared to be handsomely carved. The divergent orifice is furnished with a double row of red and scarlet feathers, which add to its length, and may, by vibration, affect the tones. It is made of the end of an alligator's tail.

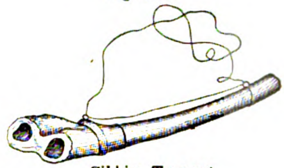
The trumpets of the Araucarians were of wood, and one described by Gumilla was found among the Indians of the Orinoco. A trumpet much venerated by the Indians of a tributary of the Rio Negro is made of strips of palm-wood, the mouthpiece fitted with clay to the smaller end of the tube. Another trumpet of the Amazon Indians is called the *turé*, and is used in war. It is made of a long and thick bamboo, and has a split reed in the mouthpiece like an *oboe*.

The funeral trumpet, or *botuto*, of the Orinoco Indians has a number of enlargements on the tube, is made of baked clay, and is three or four feet long.

The Peruvians also possessed *flutes* of various sizes; the *tinga*, a guitar with five or six strings; the *tambourine;* and the *syrinx*.

The trumpets of the Lamas of Sikkim are made of human thigh-bones; and as the corpses of the lamas of this province are usually burned, the necessary bones are obtained from Thibet, where the bodies of

Fig. 6686.



Sikkim Trumpet.

the defunct are cut to pieces and thrown to the kites or into the water. The bone is perforated through both condyles.

The trumpet of the Lamas of the Tartarian temples is a conch-shell, blown by turns toward the four cardinal points, — south and north, east and west. The south has the place of honor and precedence in statement in China.

Maelzel's automaton flute-player was exhibited about 1800. It was dressed as a trumpeter of Austrian dragoons, and when wound up by a key, played several marches, gave the trumpet-calls of the Austrian and French cavalry, and several other pieces.

The longest Anglo-Saxon trumpets were placed on a stand when blown. Specimens of the *oliphant* are still preserved.

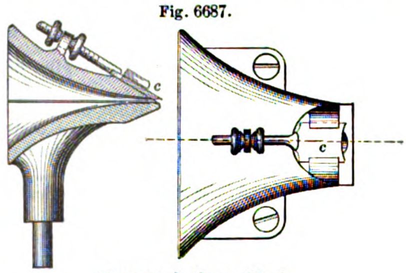
2. (*Music.*) A stop of an organ having reed-pipes tuned in unison with *open diapason*. The *octave-trumpet* or *clarion* stop is an octave higher. See STOP.

3. An ear-tube or conductor of sound. See ACOUSTIC INSTRUMENTS; EAR-TRUMPET.

4. (*Spinning.*) *a.* The funnel which leads a sliver to the cylinders of a *drawing-machine*, or which collects a number of combined rovings, and leads them to condensing cylinders, as in Fig. 1751, page 744, for instance.

Fig. 6687 shows a sectional and a top view of a trumpet for railway draw-heads, which has a throat made adjustable by a

Fig. 6687.



Trumpet for Draw-Head.

plate *c*, which is closed or opened by a set-screw, so as to allow a sliver of not exceeding a given thickness to pass.

b. A funnel-shaped conductor used in many forms of thread-machines and stop-motions in braiding, knitting, spinning, and doubling machines.

5. (*Railway.*) The flaring mouth of a railway-car draw-head which directs the entering coupling-link.

Trum'pet-ing. (*Mining.*) A small channel cut behind the brickwork of the shaft.

Trun-cat'ed Roof. One with a nearly level top surface and canted sides. See CURB-ROOF; MANSARD ROOF; etc.

Trun'dle. A pair of round disks united by round bars or *rundles* which act as teeth. A form of pinion; also known as a *wallower* or *lantern* wheel. A *trundle-wheel.* See also LANTERN-WHEEL.

Trun'dle-bed. A low bed on small wheels *trundled* under another in the daytime, and at night drawn out for a servant or children to sleep on. A TRUCKLE-BED (which see).

"My wife and I on the high bed in our chamber, and Willet [the maid] in the trundle-bed." — PEPYS'S *Diary*, 1667.

Trun'dle-head. 1. (*Nautical.*) The head of a capstan into whose peripheral sockets the capstan-bars are inserted. The trundle-head is from 3 to 5 feet in diameter, and has a handspike-socket for each foot of its periphery. The length of the bars is nearly three times the diameter of the trundle-head, say from 8 to 14 feet.

2. (*Gearing.*) One of the end disks of a *trundle-wheel.*

Trun'dle-shot. (*Projectile.*) A bar of iron, 12 or 18 inches long, sharpened at both ends, and a ball of lead near each end. It upsets during its flight.

Trun'dle-wheel. A wheel acting as a pinion, in which the cogs consist of *rounds* or *trundles* fastened in disks which are secured to an axle. A LANTERN-WHEEL (which see).

Trunk. 1. A long narrow box; a square tube, usually of boards.

A tube, usually wooden, to convey air, dust, broken matter, grain, etc., as, —

a. An *air-trunk* to a mine or tunnel.

b. A *dust-trunk* from a cotton-cleaner, smut-machine, or factory floor.

c. A *broken-material trunk*, to convey graded coal to a wagon or heap, broken quartz from a mill to the stampers, etc.

d. A *grain* or *flour trunk* in an elevator or mill, up which the said articles are conveyed by cups on a traveling-band, a spiral screw, or an air-blast, or down which they pass by gravity.

2. (*Mining.*) *a.* A miner's flume or sluice in which the slimes (finely comminuted ore) suspended in water are settled and collected. See TRUNKING.

b. A *flume* for conveying water to a gold-washing or silver works. See FLUME.

c. An upcast or downcast air-passage in a mine.

d. The box-tube in which attle or rubbish is sent out of the mine.

e. A wooden spout for water, or the pipe of the draining-pump.

3. (*Hydraulics.*) A trough made of planks to conduct water from a race to a water-wheel, a stream to a gold-digging, bleachery, factory, tannery, or mill. A *flume* or *penstock.*

4. (*Pneumatics.*) A boxed passage for air to or from a blast apparatus or blowing-engine, in smelting, or ventilation of mines and buildings. An *air-shaft.*

5. (*Hatting.*) The conduit, tube, or guiding-box which confines the air-currents and directs the fur fibers from the picker to the cone, in hat-body forming-machines.

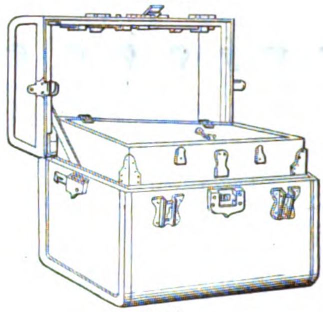
6. (*Railway.*) The main line of a railway.

7. (*Architecture.*) The shaft or body of a column.

8. (*Fishing.*) An iron hoop with a bag to catch crustaceans.

9. (*Steam.*) A tubular piston-rod used to enable the connecting-rod to be jointed directly to the piston or to a very short piston-rod, so as to save room in marine steam-engines. The width of the trunk must be sufficient to give room for the lateral motion of the connecting-rod. See TRUNK STEAM-ENGINE.

Fig. 6688.



Trunk.

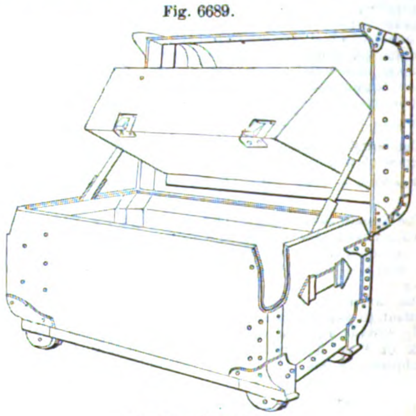
A *double trunk* goes completely through the cylinder, which has a stuffing-box at each end.

10. A chest covered with leather or its substitute, for conveyance of a traveler's clothes and toilet articles.

The trunk-makers of France were incorporated into a company in 1596.

Fig. 6689 shows a trunk with angle-pieces to strengthen the corners; guards to project from the corners of the body when shut. The corner longitudinal strips are bent at right angles at their ends, to lap over the vertical and transverse corner strips. The lower corner guards have projections for attachment and protection of the casters. The hinges are bent to lap around the ends of the trunk. A spring-catch holds the lid-case into the lid.

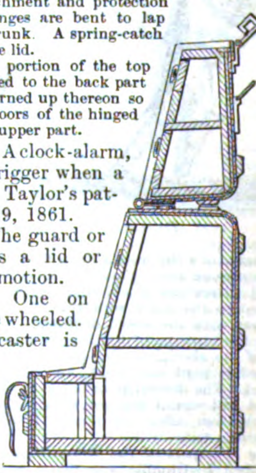
Fig. 6689.



Roulstone's Trunk.

In Fig. 6690, the front portion of the top part of the trunk is hinged to the back part at the lid, and may be turned up thereon so as to expose the falling doors of the hinged and fixed portions of the upper part.

Fig. 6690.



Burnett's Trunk.

Trunk-a-larm'. A clock-alarm, or one sprung by a trigger when a trunk-lid is opened. Taylor's patent, 31,754, March 19, 1861.

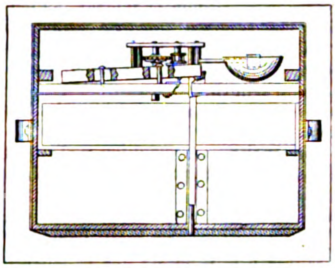
Trunk-brace. The guard or stay which supports a lid or checks its backward motion.

Trunk-cas'ter. One on which a trunk may be wheeled. In the figure, the caster is journaled in the corner bracket.

Trunk-en'gine. See TRUNK STEAM-ENGINE.

Trunk'ing. An operation for separat-

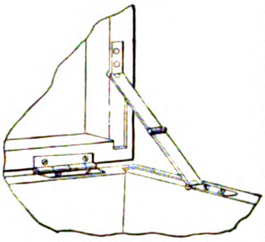
Fig. 6691.



Trunk-Alarm.

ing the *slimes* of ores into heavier or metalliferous and lighter or worthless portions.

Fig. 6692.



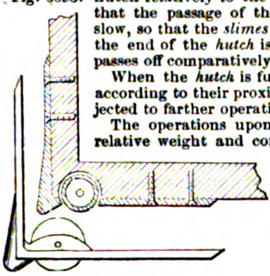
Trunk-Lid Supporter.

The *trunk* has three divisions: the *streke*, the *cover*, and the *hutch*.

The *slimes* are placed on the inclined floor of the *streke*, and exposed to the action of a small current of water, say as much as will pass through a ⅜-inch pipe with a foot or two of head. The stream carries the slime gradually down into the *cover*, which is a box about 3 feet long and 1 foot wide and deep. In the *cover* the slimes are agitated by a shovel, so as to become regularly disseminated in the water, and thence they pass into the *hutch*, which is a wooden box 8 feet long, 3 feet wide, and 1 foot deep.

The skill consists in sending over the water and suspended slimes in a regular manner. The capacity of the hutch relatively to the size of the stream is such that the passage of the water and *slimes* is but slow, so that the *slimes* have time to settle before the end of the *hutch* is reached, where the water passes off comparatively clear.

Fig. 6693.



Trunk-Caster.

When the *hutch* is full, the contents are sorted according to their proximity to the cover, and subjected to farther operations.

The operations upon ores dependent upon the relative weight and consequent richness of their particles are conducted in a variety of machines, in which water is used as a means of dissemination and suspension.

Some of these machines are fixed, and the ore is agitated by the current, aided by paddles or shovels. Among these are

Buddles,	Tyes,
Trunks,	Keeves, etc.

Other machines which agitate the stamped ores in water are dependent upon the motion of the vessel itself. Such are

Rockers,	Frames,
Dilluing sieves,	Racks.
Jiggers,	

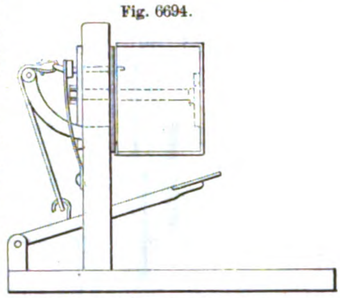
Some of these names are local, and peculiar to a certain ore or mode of treatment. The Cornish ores of tin, copper, and lead are treated with a variety of machines, and the comparative richness of the ore, as well as local customs and prejudices, gives a preference to one or another of the machines, the object being to separate the *ore* from the *gangue*; to concentrate it, in fact, ready for smelting.

Trunk-light. A skylight; sometimes at the upper end of an aperture, whose curb or lining is a trunk or square boxing.

Trunk-lock. A lock specifically adapted for trunks. It is commonly a snap-lock, which is self-fastening when the lid is shut. There are, however, many forms. See list under LOCK.

Trunk-mak'er's An'vil. The trunk is placed upon an anvil-block covered with sheet-iron and mounted on a horizontal pivot on a vertical frame. The rivets are clinched against the sheet-iron plate. Pins working through the frame enter corresponding holes in the block, to hold it at any desired point; the pins are held in operative position by springs, and are withdrawn by a treadle.

Fig. 6694.



Burnett's Trunkmaker's Anvil.

Trunk-nail. A nail with a head shaped like a segment of a sphere, so as to make a rounded boss when driven. Used for ornamenting coffins and trunks. See NAIL.

Trunk-roll'er. A roller journaled in a plate which may be attached to the bottom of a trunk or the like. See TRUNK-CASTER.

Fig. 6695.

Trunk-Roller.

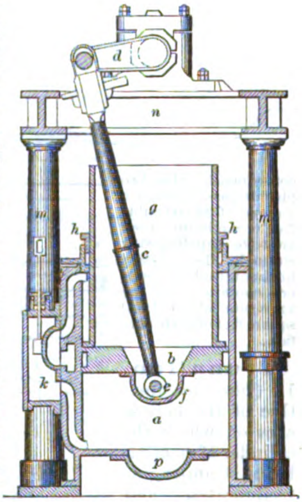
Trunk-stay. See TRUNK-BRACE.

Trunk Steam-en'gine. The trunk steam-engine was so named by its inventor, Humphrey, 1835. It is designed to obtain the direct connection of the piston-rod with the crank without the intervention of a beam or oscillating the cylinder. Attached to the piston is a tube or *trunk*, which is packed in the cylinder-heads, and has sufficient interior diameter to allow the vibration of the piston-rod by the throw of the crank.

It is used especially for marine and propeller engines.

The *trunk-engine* differs from the annular cylinder steam-engine in the regard that the piston of the latter moves in the space between fixed outer and inner cylinders. See ANNULAR CYLINDER STEAM-ENGINE.

Fig. 6696.



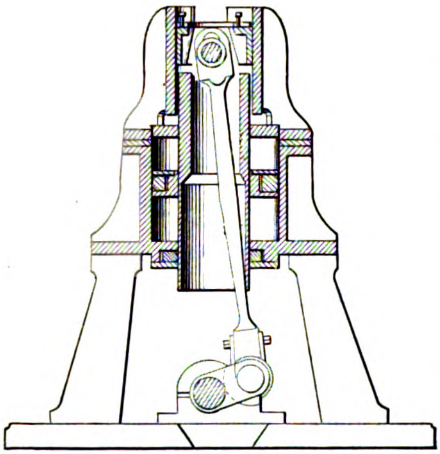
Trunk-Engine.

In Humphrey's trunk-engine, *a* is the cylinder; *b*, the piston; *c*, the connecting-rod, the upper end of which is connected to the crank *d*, and the lower end passes through an aperture in the piston, and carries a pin *e*, the ends of which work in bearings attached to the under side of the piston; *f* is a bonnet inclosing the bearings and end of the connecting-rod. The connecting-rod works within a trunk *g*, which is bolted at the bottom to the top of the piston, and which slides in a stuffing-box *h* in the cylinder cover. The sides of the trunk are straight and parallel to each other, and the ends are semicircular; the width is just sufficient to receive the connecting-rod without rubbing, and the distance between the semicircular ends is such as to allow the vibration of the connecting-rod during the revolution of the crank. *k* is the slide-valve, and *m m* the columns supporting the entablature *n*, which carries the plummer-blocks in which the shaft revolves. *p* is a bonnet covering the manhole in the cylinder bottom.

Engines of this description have been made up to 90 horse-power.

As the effective area of the upper side of the piston is less than the lower, the steam has been used first above, and then allowed to pass below, where it acts expansively in giving the upward stroke.

Fig. 6697.



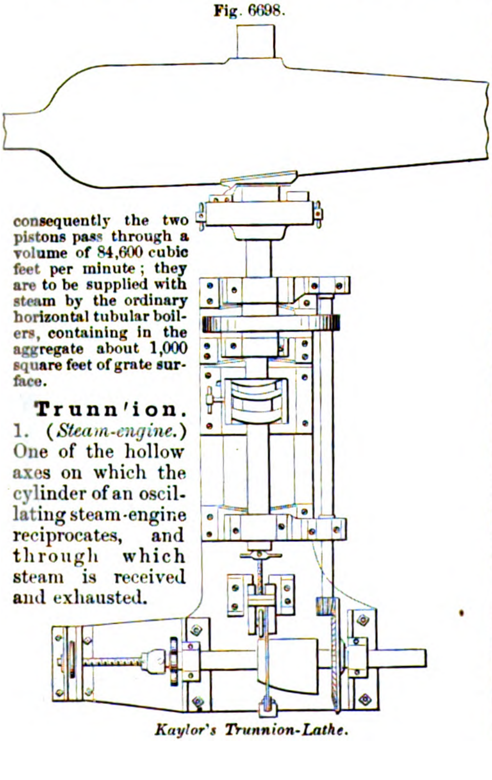
Root's Trunk-Engine.

See also Whitham's United States patent, September 4, 1841, using live steam on annular head, and expanding same steam on circular head. See also Henderson's patent, April 5, 1870, No. 101,617. In Root's engine, August 7, 1866, No. 56,993, the piston is attached to an elongated trunk extending through both heads of the cylinder. The pitman passing through the trunk is attached to the end thereof most remote from the crank-shaft, and this end works in guides secured to the cylinder-head.

The double-trunk engines constructed by John Penn and Sons, Greenwich, England, for the English iron-clad "Hercules," are said to be the largest pair of screw-engines ever built. There are two cylinders, each 127 inches in diameter, by 4 feet 6 inches length of stroke of piston; the diameter of the trunks is 47 inches, whose area, being deducted, gives the pistons an effective diameter of 118 inches.

These engines are intended to run 60 revolutions per minute,

Fig. 6698.



consequently the two pistons pass through a volume of 84,600 cubic feet per minute; they are to be supplied with steam by the ordinary horizontal tubular boilers, containing in the aggregate about 1,000 square feet of grate surface.

Trunn'ion. 1. (*Steam-engine.*) One of the hollow axes on which the cylinder of an oscillating steam-engine reciprocates, and through which steam is received and exhausted.

Kaylor's Trunnion-Lathe.

2. (*Ordnance.*) One of the cylindrical projections from the sides of a cannon or mortar, which rest in the *cheeks* of the carriage, forming supports for the piece and an axis on which it turns during elevation or depression. The trunnion is usually one caliber in diameter and length.

3. A general term for an axis of similar character to the above.

Trunn'ion-lathe. A machine-tool for turning off the trunnions of ordnance or oscillating steam-cylinders.

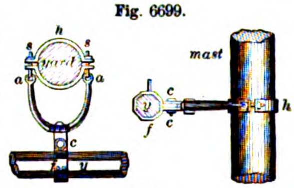
The machine employs a shaft, carrying a revolving cutter, which is susceptible of feed-motion to and from the axis of the shaft upon which it revolves. The shaft is arranged to slide up to and from the article to be planed, and is operated by a revolving former at its rear end, working upon a shaft at right angles to the one carrying the tool, which also has a sliding motion to bring the different parts of the former to act upon the tool-carrying shaft.

Trunn'ion-ring. A ring around a cannon next before the trunnions.

Trunn'ion-valve. A valve attached to or included in the trunnions of an oscillating-cylinder steam-engine, so as to be reciprocated by the motions of the cylinder.

Truss. 1. (*Nautical.*) The iron hoop, stirrup, and clasp by which the middle of a lower yard is secured to the mast.

Fig. 6699.



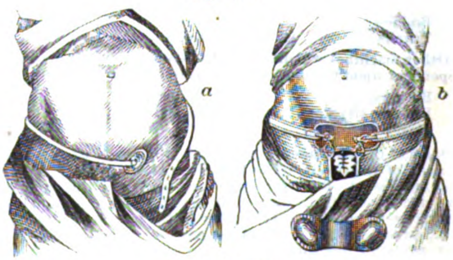
Truss.

It consists of a hoop *h* on the mast, tightened by means of the screws *s*, whose open heads engage the eyes *a* of the stirrup, which is swiveled to the hoop *f* on the yard *y*. The hoop *f* has jaws *c*, by whose closure it is tightened on the yard *y*. Upper yards are secured by a *parral*, a strap of rope or iron, fitting loosely around the mast, so as to slip readily up and down when the yard is raised and lowered.

2. (*Surgical.*) An instrument to keep hernia reduced, that is, to retain the intestines within the abdominal cavity. The essential feature is a spring or bandage resting on a pad, which is kept above the orifice of protrusion. The pad is usually kept to its seat by a spring which reaches around the body terminating opposite to the ruptured part. The spring is cushioned, and sometimes has pads to give it bearing on special parts.

Advertisement in the "London Gazette," 1665: "Rowland Pepin, famous for the cure of *rupture* or *broken-belly* these fifty years, makes easy trusses of all kinds, and lives in Naked-boy

Fig. 6700.



Hernia Trusses.

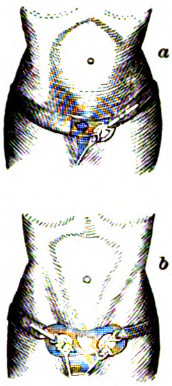
Court, near Strand Bridge, without Temple-bar, London, where the poor may be relieved for charity."

The modern forms of truss are very numerous; a few are illustrated.

In Fig. 6700, *a* shows mode of application of the hard rubber truss in treatment of inguinal hernia. The spring is passed across the body from the well side, and the longest diameter of the adjustable pad is placed in the line of rupture.

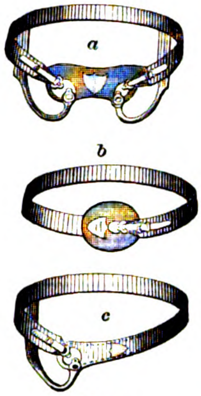
b, "hard rubber elastic night truss," useful in cases where from corpulency or otherwise there is a tendency to hernia. A stout elastic web passes around the body, and is attached to

Fig. 6701.



Trusses.

Fig. 6702.



Trusses.

the pad in front by metallic loops engaging studs on the pad; elastic bands pass from the body band, under the limbs, to studs upon the rupture pads.

Fig. 6701, *a*, left-side truss.

b, elastic abdominal supporter, — for preventing rupture, — adapted for those having constitutional tendency to hernia, or to be used while taking violent exercise.

Fig. 6702, *a*, double truss, with supporter-brace.

b, umbilical or *navel* truss.

c, single truss, with brace right side.

Fig. 6703.

Trusses.

Fig. 6703, *a*, single truss, for adults or infants.

b, convex pad, with ball and socket attachment.

c, convex pad, with ball and socket attachment, and set-screw for giving any desired position to pad.

d, double truss.

e, reversible-pad single truss, applied from ruptured side, the pad having a sliding-arm attachment secured by set-screw.

f, truss similar to foregoing, with ball and socket and set-screw.

g, double truss, on the same plan as single trusses *e f*.

h, "Hood" pattern truss.

i, umbilical truss.

k, hard rubber pile pipe.

l, *prolapsus ani* supporter.

m, abdominal supporter.

n, "French" pattern truss.

o, combination pad truss.

p, suspensory, for supporting the scrotum in hydrocele, variocele, etc.

q, elastic abdominal belt.

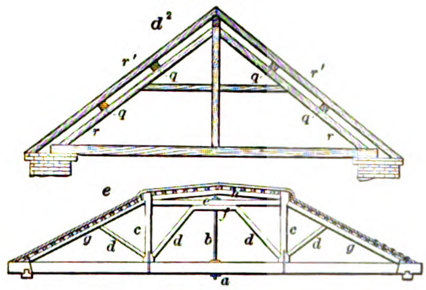
r, "Philadelphia" abdominal belt.

3. (*Carpentry.*) A frame to which rigidity is given by staying and bracing, so that its figure shall be incapable of alteration by turning of the bars about their joints.

The simplest frames are of wood and of few parts. More imposing structures are more complicated, the parts being employed in resisting extension or compression. Composite trusses employ both wood and iron; in fact, few of any importance are destitute of bolts and tie-rods. The principal simple forms are shown in ROOF, Figs. 4420–23, pages 1971–73. Railway bridges of the present day exhibit many remarkable structures of this class. See TRUSS-BRIDGE; also TUBULAR BRIDGE, and list under BRIDGE.

d^2, Fig. 6704, shows secondary rafters r' r', which are added to receive the sheathing, and connected to the principal rafters

Fig. 6704.



Roof-Trusses.

r r by purlins q q. The king-post is extended down to support the center of the tie-beam, into which the principal rafters only are mortised.

In Fig. 6704, *e* is a queen-post wooden roof-truss at the Greenwich Hospital, England.

a is the tie-beam, 57 feet long, spanning 51 feet clear.

c c, queen-posts.

d, braces.

e, truss-beam.

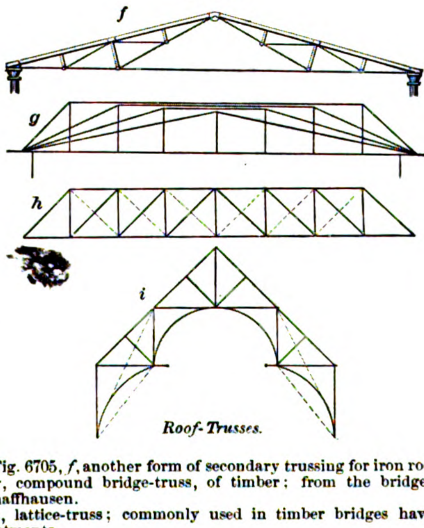
f, straining-piece.

g, principal rafters.

h, a cambered beam for the platform.

b, an iron string supporting the tie-beam.

Fig. 6705.



Roof-Trusses.

Fig. 6705, *f*, another form of secondary trussing for iron roofs.

g, compound bridge-truss, of timber; from the bridge at Schaffhausen.

h, lattice-truss; commonly used in timber bridges having abutments.

i, open truss; used in Gothic roofs. In this the lateral thrust is not entirely removed.

Fig. 6706.

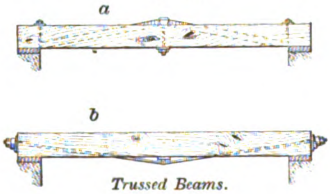
Truss.

4. (*Architecture.*) An ornamented corbel serving to support an entablature or balcony, or to conceal the ends of the beams which really support the structure; in the latter case it is frequently made of galvanized sheet-iron.

Truss-beam. An iron frame serving as a beam, girder, or summer.

A wooden beam or frame with a tie-rod to strengthen it against deflection. This trussing may be done in two ways: 1st, by inserting cast-iron struts, as in *a*, thus placing the whole, or nearly the whole, of the wood-work in a state of tension; 2d, by wrought-iron tension-rods, as in *b*, which take the whole of the tension, whilst the timber is thrown entirely into compression.

Fig. 6707.

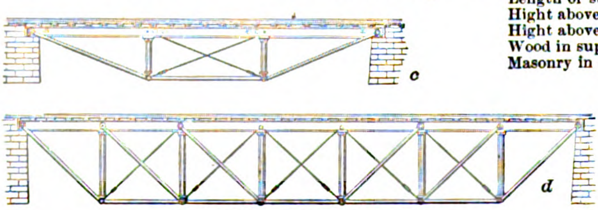


Trussed Beams.

For various other forms of truss, see BRIDGE; TRUSS; RAFTER; ROOF; TRUSS-BRIDGE; etc.

Truss-bridge. A bridge which depends for its stability upon the application of the principle of the truss. Short bridges of this class may be formed by a single truss; larger structures are composed of a system of trusses or bays so connected that the spaces between the abutments and the piers may each be regarded as constituting a single compound truss. Fig. 6708 shows several trusses for bridges of short span.

Fig. 6708.



Deck-Bridge Trusses.

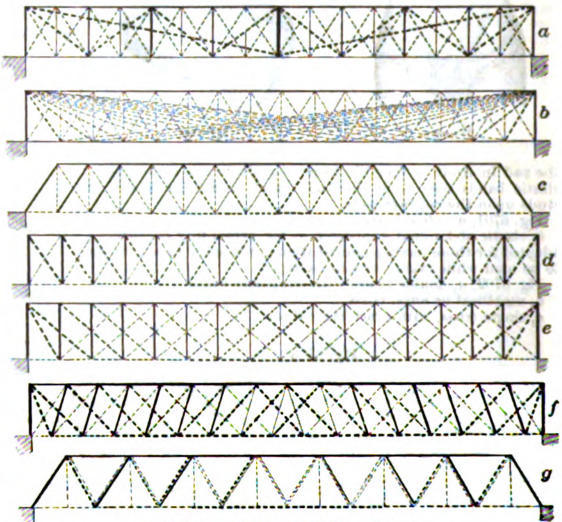
a, deck-truss for 30 feet span.
b, deck-truss for from 24 to 48 feet span.
c, deck-truss for 70 feet span.
d, deck-truss for 100 feet span.

The extensive use of wrought-iron is a characteristic feature in bridges of this kind, that material being generally employed in all parts which have to resist a tensile strain, and the various systems each aim to solve the problem of combining the maximum of strength with the minimum of lightness, by dispensing as far as possible with compressive forces, and relying as little as may be on the rigidity of materials.

Rider's, one of the earlier American forms, is composed of an upper and a lower chord, — the former of cast, and the latter of wrought, iron, — connected by upright posts of cast and diagonal braces of wrought iron, and has been successfully employed in bridges of moderate span.

In Fink's, which has been extensively used upon railways in this country, the foot of each principal strut, or king-post, is connected with the ends of the top-chord by a pair of diagonal bars which support the weight of one half the truss; each half-span is again subdivided by a strut and two diagonal tension-bars, extended one to the nearest end of the top-chord, and the other to the top of the center-post; each quarter-span is similarly divided into eighths, and these, again, for spans of more than 100 feet, into sixteenths.

Fig. 6709.



Principles of Through-Bridge Trusses.

In Bollman's truss, the load upon each panel is transferred to the end of the truss by a pair of suspension-bars. The former railroad bridge at Harper's Ferry was of this kind, having four parallel trusses for a double line, with a clear span of 124 feet, the span being divided into eight panels. The depth of the truss was 17 feet 6 inches, and with a weight of 122 tons, at a speed of 8 miles an hour, the deflection at the center is stated to have been but 1¾ inches.

a (Fig. 6709), Fink system. *e*, Linville system.
b, Bollman system *f*, Post system.
c, Howe or Jones system. *g*, system of triangles.
d, Murphy-Whipple system.

The Louisville railway-bridge is of iron trusses, and has

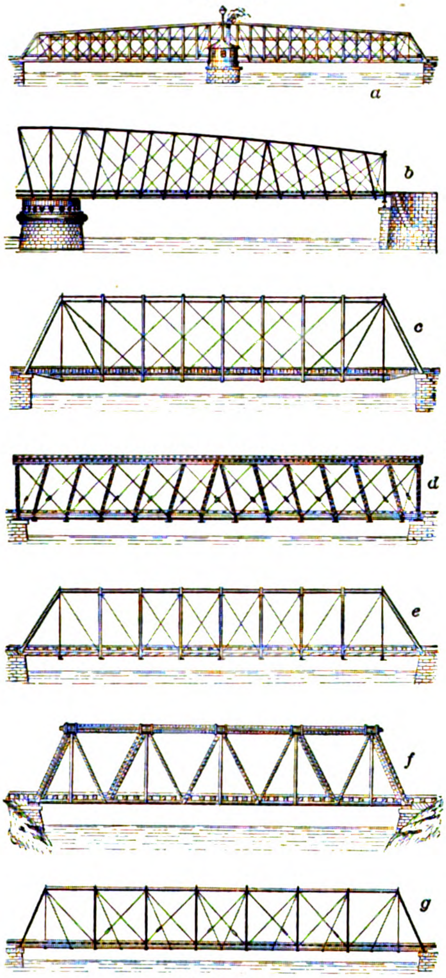
Piers .... 28.
Spans .... 29, from 30 to 400 feet.
Length of superstructure, 5,294 feet.
Hight above high water, 50½ feet.
Hight above low water, 101 feet.
Wood in superstructure, 610,000 feet, board measure.
Masonry in piers, 30,000 cubic feet.
Iron in bridge, 8,723,000 pounds.
Cost, $ 1,555,000.

The railway bridge of the Susquehanna, at Havre de Grace, was built from the plans of George A. Parker. Its cost was about $ 1,500,000. The work occupied about 1,000 men for 4 years. The piers which support the superstructure are 13 in number, and are of stone carefully laid in cement, within caissons of boiler-iron, which reach a point above the line of running ice. From this hight the piers are finished with cut-stone, laid in courses. The draw-pier is circular, with a diameter of 24 feet 8 inches at the top of the caisson, while each of the other piers has a width of 8 feet, and a length of 35 feet 4 inches at top of caisson, and a width of 7 feet 3 inches at top of cut-stone. Beside the piers which carry the superstructure, there are at the draw 2 guard-piers, one above and one below, which serve to protect the draw from injury, and to aid vessels in passing. It is substantially the Howe truss.

The bridge across the entrance to the Niagara River, at Black Rock, designed for the use of the Grand Trunk, Great Western, Canada Southern, New York Central, Erie, and New York West

Shore, and Chicago Railways, has a total length of 3,550 feet, 1,300 feet of which are over trestle-work upon Squaw Island, 450 feet over Black Rock Harbor, and the remainder over the main branch of the river. The river portion of the bridge has 8 piers and 2 abutments. Owing to the depth of water, from 12 to 45 feet, and a current of from 5¼ to 10 miles an hour, varying with the state of the wind, considerable difficulty was experienced in the construction of the piers, which were founded upon caissons. Four of the spans are 190, and three others 240 feet wide, in the clear, and there are two draw-openings, each 160 feet wide. In Black Rock Harbor are two draw-openings, each of 90 feet, and a fixed span of 220 feet; these are supported on 2 piers and 2 abutments. The masonry is of sandstone, and the superstructure of wrought-iron, from the Phœnixville works, the whole amount of iron used being over 2,000 tons. The 190-foot spans weigh 130, and the 240-foot spans 208 tons each. After completion, one of the 190-foot spans was loaded with 210 tons of rails, equally distributed over the floor-beams, — a weight greater than that of a continuous line of locomotives covering the span, — and left in that condition for three days; the deflection amounted to but one inch, and, on the removal of the load, the truss resumed exactly its former position. The entire cost of the bridge was about $1,500,000.

Fig. 6710.

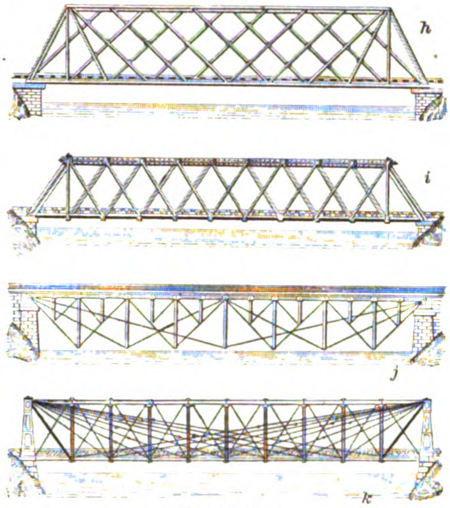


Bridge-Trusses.

Figs. 6710, 6711, show several forms of trusses adopted by the principal bridge-building firms in the United States. See also Iron Bridge.

a, Kellogg Bridge Company, Buffalo, N. Y.
b, American Bridge Company.
c, Phœnixville Bridge Company, Philadelphia.
d, Watson Manufacturing Company, Paterson, N. J.

Fig. 6711.

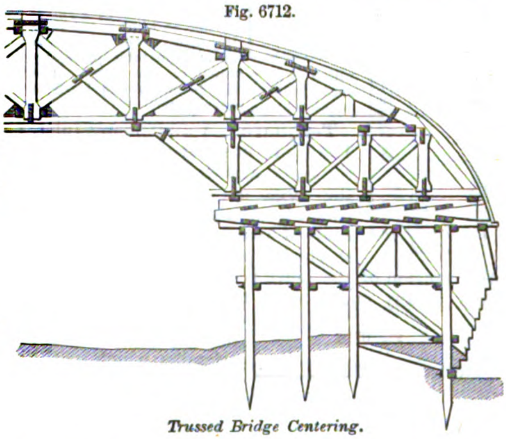


Bridge-Trusses.

e, Detroit Bridge and Iron Works, Detroit, Mich.
f, Baltimore Bridge Company, Baltimore, Md.
g, Kellogg and Maurice, Athens, Pa.
h, Niagara Bridge Works, Niagara, N. Y.
i, Macdonald, New York.
j, Louisville Bridge and Iron Company, Louisville, Ky.
k, Patapsco Bridge and Iron Works, Baltimore, Md.

Trussed Gird'er. A construction having special application in centering, as shown in the annexed

Fig. 6712.



Trussed Bridge Centering.

cut, which exhibits a portion of the centering of one of the London Bridge arches. See Truss.

Trussed Roof. One involving the principles of a truss; containing principals, purlins, struts, and ties. See Roof; Truss.

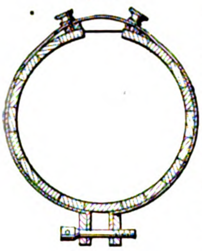
Truss-hoop. (*Coopering.*) One placed around a barrel to strain the staves into position, collapsing them toward the chine, leaving the bulge at the middle portion.

The example (Fig. 6713) is a device for binding and preserving the integrity of the barrel when the hoops are removed, in order to replace a broken or decayed stave without removing the contents.

Truss'ing-ma-chine'. (*Coopering.*) One for drawing the truss-hoops upon casks, to draw the ends of the staves together at the chines. A *hoop-driving* machine.

Truss-piece. A piece of filling between compartments of a framed truss.

Fig. 6713.



Truss-Hoop.

Try'ing-plane. (*Joinery.*) *Try-plane.* The second in order of fineness of the joiner's bench-planes. The first is the jack-plane, which prepares the surface. The *trying*-plane is long, and levels the surface, *trying* it for straightness. It is succeeded by the *panel* and the *smooth* planes.

Try'ing-square. See TRY-SQUARE.

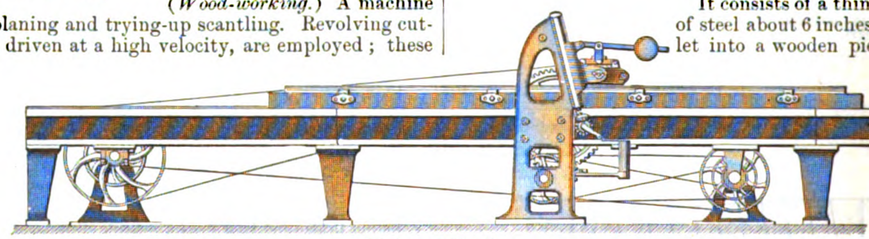
Try'ing-up Ma-chine'. (*Wood-working.*) A machine for planing and trying-up scantling. Revolving cutters, driven at a high velocity, are employed; these may be of suitable shapes for molding beading, rabbeting, etc. The stuff may be secured on the cast-iron feed-table by cramps at intervals of 3 feet, and the cutter-block carriage is provided with two pressure-rollers to keep down the stuff when the cramps are not required, and is raised or lowered by a handle in connection with two side-screws. The feed-motion is self-acting.

Try'sail. (*Nautical.*) A storm-sail of strong material and relatively smaller area.

A fore-and-aft sail set with a boom and gaff in ships. Similar to a *spencer, spanker, driver.* For the names of its parts, see FORE-AND-AFT SAIL.

Try-square. An instrument used by carpenters and joiners for laying off short perpendiculars, etc.

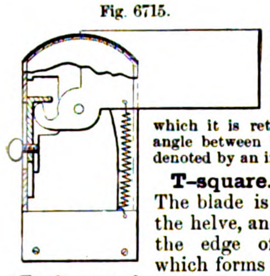
Fig. 6714.



Trying-up Machine.

It consists of a thin blade of steel about 6 inches long, let into a wooden piece of similar length and securely fastened at right angles thereto, the edges of both being accurately straight. See SQUARE.

Fig. 6715.

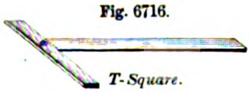


Try-Square and Bevel.

Fig. 6715 shows a try-square and bevel in which the pivoted blade is drawn in one direction by a spiral spring, and has a toe resting against the projection of an adjustable plate, by which it is retained to any angle. The angle between the head-bar and blade is denoted by an index-plate.

T-square. A draftsman's ruler. The blade is set at right angles to the helve, and the latter slips along the edge of the drawing-board, which forms a guide. The helve is made of two parallel pieces, in one of which the blade is mortised. The other portion of the helve is adjustable on the set-screw to any angle, so as to rule parallel oblique lines, or to form an oblique base for the triangles, which are the usual rulers in plotting and projecting.

Fig. 6716.



T-Square.

Fig 6716 has a shifting member on one side of its tongue, so as to give the latter any angle with the base line of the drawing. The tangent-screw and protractor admit accurate angular adjustment.

Tub. 1. (*Domestic, etc.*) A small cask, half-barrel, or piece of cooper work, with one bottom and open above; as a *wash*-tub, *meal*-tub, *mash*-tub, etc.

2. (*Mining.*) *a.* A corve or bucket for raising coal or ore from the mine.

b. A casing of wood or of cast-iron sections bolted together, lining a shaft.

3. (*Metallurgy.*) One form of chamber in which ore or slimes are washed to remove lighter refuse. See JIGGER; FRAME; TRUNK; etc.

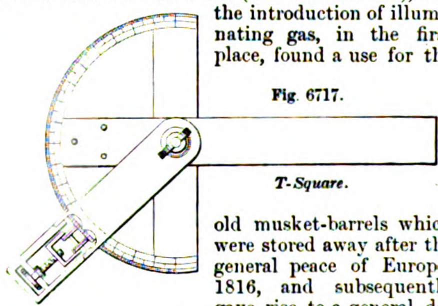
Tu'ba. (*Music.*) A brass wind-instrument, the lowest as to pitch in the orchestra. It has five cylinders, and its compass is four octaves.

Tub'bing. (*Mining.*) Lining a shaft with casks or cylindrical caissons, to avoid the caving in of the ground. Especially used in shafting through quick-sand. See CAISSON.

Tube. 1. A metallic pipe, of many kinds and uses.

The first wrought-iron tubes made on a large scale were for barrels of fire-arms (see GUN-BARREL), but the introduction of illuminating gas, in the first place, found a use for the old musket-barrels which were stored away after the general peace of Europe, 1816, and subsequently gave rise to a general demand for tubing of various lengths and sizes, for which the old barrels would have been unsuited had they not already been exhausted.

Fig. 6717.



T-Square.

Under Russell's patent, 1824 (English), the tubes were first bent up by hand-hammers and swages, to bring the edges near together, and then they were welded between semicircular swages, fixed respectively in the anvil and the face of a small tilt-hammer worked by machinery, by a series of blows along the tube, either with or without a mandrel. The tube was completed by being passed between rollers, with half-round grooves, which forced it over a conical or egg-shaped piece at the end of a long bar, to perfect the interior surface.

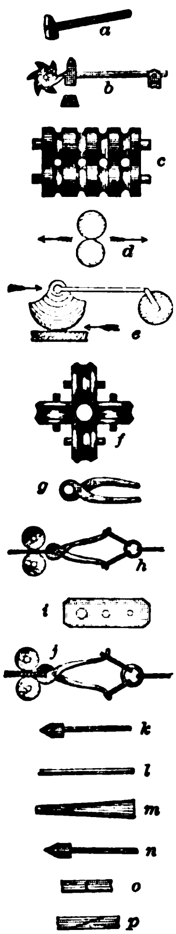
Various improvements were afterward made, as, for instance, bending the skelps, first to the semi-cylindrical and then to the tubular form, preparatory to welding, by swage tools, worked by machinery. The whole process was afterward carried on by rollers, which were abandoned on account of the difference in velocity between the greatest and least circumferences of the rollers.

Subsequently, the plan was adopted of bending the end of the skelp to the circular form, and heating the whole skelp to a welding heat in a furnace. It is then dragged by the chain of a draw-bench through a pair of tongs, with bell-mouthed jaws, which are opened at the moment of introducing the skelp. No mandrel is employed. By this means wrought-iron tubes, from $\frac{1}{4}$ inch diameter and $\frac{1}{10}$ inch bore up to those of 6 inches internal diameter and $\frac{1}{8}$ to $\frac{3}{8}$ inches thick, are made with a perfect weld.

The following table shows the progress of invention in this direction: —

Draw-bench introduced into England....................1565
Rolls invented for rolling iron, by Henry Cort.............1783
Draw-bench and rolls used for making lead-pipe, by Wilkinson..1790
Combination of 2, 3, or more pairs of rolls, by Hayledine..1798

Fig. 6718.



Principles of Action of Tube-Making.

Welding.

a, hand-hammer.
b, power-hammer.
c, rolls with several passes.
d, alternating holes.
e, segment moving on a bed.
f, three or four rolls making one hole.
g, drawing through holes or tongs.
h, drawing through rolls.

Finishing.

i, draw-bench and rolls.
j, draw-bench and rolls.

Drawing over a Mandrel.

k, no mandrel.
l, parallel and in motion.
m, taper and in motion.
n, enlarged end and at rest.

Form of Joint.

o, but or jump.
p, scarf or lap.

The excellence attained in making tubes has been owing to the persistent attempts at perfection in manufacturing two articles, — gun-barrels, and tubes for steam-engine boilers and condensers.

The series of English patents on this subject may be thus enumerated, — the letters in parentheses have reference to the diagram, Fig. 6718: —

Cook, 1808 (*a i j l p*). 1. Forge a round bar, drill a hole longitudinally; elongate by draw-plates, or grooved rollers, over a mandrel.

2. Turn a skelp over a mandrel; weld, and draw as before.

3. Force a circular plate of iron through a series of holes in a die, giving it a cup-shape, which is eventually opened at bottom and elongated to a cylinder, by drawing as before.

James and Jones, 1811 (*b e m p*). 1. The heated skelp is turned over a mandrel, and swaged by a hammer, while resting in a grooved anvil.

2. Welded and rolled by grooved rollers.

Osborne, 1817 (*b c d e n p*). The skelp is turned and welded on a mandrel, which has a shield to prevent its passing between the rollers, so that the barrel is drawn off the mandrel. This is repeated with progressively smaller mandrels and grooves.

Russell, 1824 (*b j k l o*). The skelp welded by grooved anvil and top tool.

Whitehouse, 1825 (*g k o*). The skelp was turned into position for welding, and was then drawn between dies, or passed between grooved rollers, without mandrel or internal support.

Royl, 1831 (*c i k o*). Two grooved rollers, which received bent and heated skelp, and drew it out of the mouth of the furnace.

Harvey and Brown, 1833 (*c n o p*). The mandrel was a short instrument, just in front of the rollers, so that the enlarged head came just beyond the pinch of the rollers. In working, the heated tube was forced over the short, cranked stem of the mandrel, the unclosed seam of the tube being sufficiently open to allow it to pass the fin by which the stem of the mandrel was carried.

Russell, 1836 (*h i j k o*). The end of the skelp being turned around, so as to make the edges lap, it is pulled at a welding heat between dies, or rollers, without a mandrel or central support.

Prosser, 1840 (*f n o p*). Four rollers, each having a groove equal to the quarter of the circumference, and driven by gearing, so as to travel at the same velocity. The end of the skelp was bent around, entered between the rollers, and discharged on to a straight mandrel, smaller than the bore.

Cutler, 1841 (*g h i k n o p*).

Russell Whitehouse, 1842 (*g l p*). The skelp, bent into an oval form, was placed on a small mandrel, which filled it across the minor diameter. The pressure was applied at the other edge of the lap, then at the inner, and lastly in the middle. Drawing between dies restored the circular form and loosened the mandrel.

Russell, 1845. The edges of the skelp are lapped on a long bar, which is then drawn beneath a grooved roller, to close the weld.

Banister, 1849. Has a combination tube, brass inside, then iron, copper outside, so that the former is exposed to the fire, the copper to the water, and the iron stiffens both. The annealed tubes, of proper size, are telescoped, and then drawn between dies, to elongate and attenuate them.

Ostrander's tubular iron is rolled with a compound mandrel, 30 feet long, of required diameter and shape, and with a hole from 1/16" to any required size. It is used for stay-bolts for boilers, where it indicates, by leaking into the fire, if the bolt-head has given way; also used for hollow pump-plungers, etc.

Fig. 6720 is a machine for making sheet-metal tubes from blanks or skelps. A series of pairs of rolls is used in connection with a stationary mandrel of peculiar shape, by which the sheet of metal is first bent to the form of a trough, with one edge higher than the other; then into a tube, with its marginal surfaces bent up and in contact. The projecting edge is next bent over, and, lastly, the lap is bent down upon the tube and flattened.

Telescope-tubes are made of brass skelps, turned over and soldered. They are then forced on to a steel mandrel and drawn through a die.

Fluted tubes are drawn through ornamental dies of the required form. The mandrel is frequently cylindrical.

Joint wire is a fine tube used by silversmiths and watch-case makers. A small pipe is threaded on a piece of steel-wire, and both are drawn through a die, like a piece of solid wire. See PIPE; LEAD-PIPE.

For *lead-pipe making* and *lining with tin*, see pages 1271, 1272.

For *making of gun-barrels*, see pages 1032, 1033.

For *bushing*, see page 413.

See also PIPE, pages 1707, 1708, and list under that head.

For tubing for oil-wells, see WELL-TUBING.

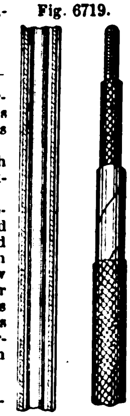
2. India-rubber tubes are made: —

1. By wrapping slips of rubber or rubber-cloth around a mandrel of glass, which is afterward withdrawn, the layers and the edges being joined by solvents or heat.

2. By driving the pastry mass out through an annular die-opening, in the manner of making LEAD-PIPE (which see).

The flexible tube (Fig. 6719) has a frame-work of flattened wire, wound spirally round a mandrel. This tube or coil is then covered with a braided or woven coating saturated with oil or varnish. Another coating of a narrow strip of leather is then wound spirally over this and oiled or varnished, over which is woven or braided another coat which forms the outside, and which is then oiled or varnished. The mandrel is then withdrawn from the finished tube.

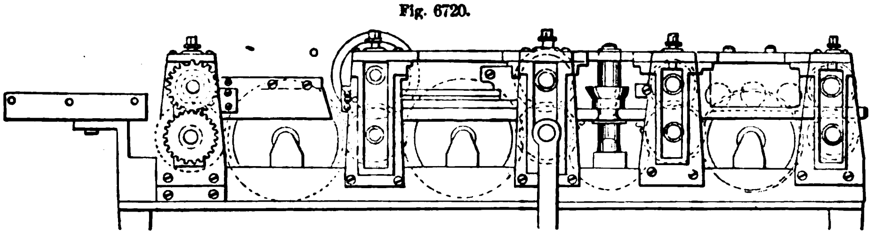
Fig. 6719.



Flexible Tubing.

3. (*Ordnance.*) A primer for ordnance. A small cylinder placed in the

Fig. 6720.



Machine for Making Sheet-Metal Tubes.

vent of a gun, and containing a rapidly burning composition, whose ignition fires the powder of the charge. See PRIMING-TUBE.

The *friction-primer* or *friction-tube* is a variety of *priming-tube*. See FRICTION-PRIMER.

4. (*Hydraulics.*) The barrel of a chain-pump.

5. (*Steam.*) A pipe for water or fire in a steam-boiler. It would be well to call water-pipes *tubes*, and fire-pipes *flues*, if it were not too late to attempt careful nomenclature now. The present practice is to call them flues or tubes, according to their relatively large or small diameter respectively. See TUBULAR BOILER.

Fig. 6721.

Tube-Brush.

Tubes, in locomotive-boilers, are of brass or iron, about two inches outside diameter. They extend between the tube-sheets of the boiler, and are fixed in them by ferrules driven in at each end, which make them steam-tight.

6. (*Surgical.*) *a.* An esophageal tube, capable of being passed into the stomach.

b. An elastic gum tube passed *per ano* into the colon, to discharge air or introduce enema.

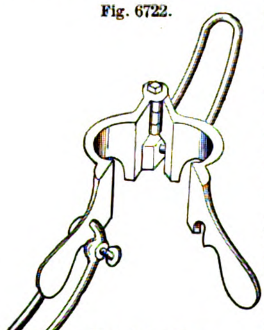
c. A tracheal tube.

Tube-brush. (*Steam.*) A wire brush for cleaning fire-tubes (flues) of steam-boilers.

Stillwell's tube-brush, patented March 20, 1864, has a screw-shank at one end and an eye at the other, so that it may be operated by pulling and pushing from the respective ends of the tubes.

The wires are flat on the ends, so as to act as cutters, and are soldered to the shaft, which consists of a twisted rod between whose strands the wires are held. The bottle-brush has a similar construction, with bristles instead of wires.

Fig. 6722.



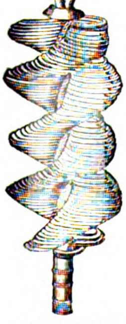
Well-Tube Clamp.

Tube-clamp. (*Well-boring.*) A device used in lifting and withdrawing well-tubing. It has a pair of jaws which are tightly clamped around the tube, and a bail to each jaw, for the engagement of the hook of the tackle.

Tube-clean'er. (*Steam.*) A device for cleaning the interior of boiler and other tubes.

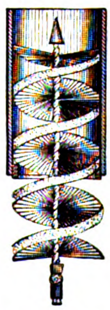
Fig. 6723 is composed of two spiral coils of steel wire, both coils being spirally arranged around and connected with a central twisted stem, having a screw-thread at one end for the attachment of a handle, and a loop at the other, through which a cord may be passed for the purpose of drawing it through the tube.

Fig. 6723.



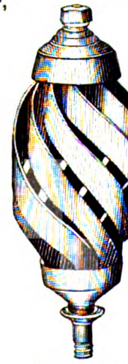
Steel-Wire Tube-Cleaner.

Fig. 6724.



Tube-Cleaner.

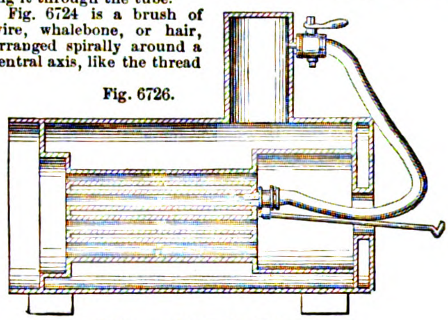
Fig. 6725.



Steel-Spring Tube-Cleaner.

Fig. 6724 is a brush of wire, whalebone, or hair, arranged spirally around a central axis, like the thread of a screw; used for cleaning out tubes.

Fig. 6726.



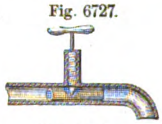
Illingworth's Boiler-Tube Cleaner.

The boiler tube-cleaner (Fig. 6725) consists of a number of flat steel springs, which have a spiral twist and act as scrapers. These are secured between two caps on a screw-threaded rod. By varying the distance of the caps, the scrapers are elongated or spread out to fit tubes of varying bores.

Fig. 6726 shows a flexible pipe and nozzle for blowing steam through the tubes for removing soot and scale. McDowell, March 6, 1866, uses jointed pipes for the same purpose.

Tube-clip. A kind of tongs used for holding test or other heated tubes in chemical manipulations.

Fig. 6727.



Tube-Cock.

Fig. 6728.

Tube-Compass.

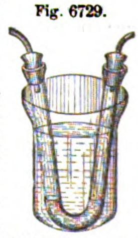
Tube-cock. A species of cock consisting of an india-rubber tube, which is fitted within a pipe and compressed by a screw-valve when it is desired to stop the flow of liquid.

Tube-com'pass. A draftsman's compass, having tubular legs containing sliding extension-pieces adjustable to any required length by means of set-screws. One leg carries a reversible needle-point and pencil-holder, and the other a reversible needle-point and pen.

Tube-con-dens'er. A bent tube, provided with a stopper at each end, through which a small tube is inserted; used in obtaining solutions of ammonia and other gases which are absorbable in water.

Tube-cut'ter. A device for cutting gas and other metallic pipes. The example (Fig. 6730) has a fixed jaw which grasps the pipe, and a slider which carries a rotary circular cutter and is advanced by a screw, while the instrument is turned about the pipe by means of its handle. See also PIPE-CUTTER, page 1711.

Fig. 6729.



Tube-Condenser.

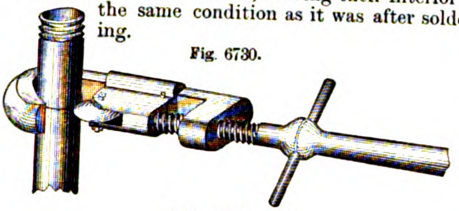
Fig. 6731 is a special tool for cutting off boiler-tubes when their exterior cannot be reached. The lower end of the stock is inserted into the tube; the tool projects radially from the revolving-stock and cuts off the boiler-tube from the inside.

Tube-door. (*Steam.*) A door in the outer plate of a smoke-chamber, which may be opened to allow the tubes to be examined or cleaned.

Tube-draw'ing. Metallic tubes are drawn in a manner similar to that employed for wire. Many

brass tubes for common purposes are bent, and, having the edges soldered together, merely drawn through a hole, which makes them tolerably round and smooth on the exterior, leaving their interior in the same condition as it was after soldering.

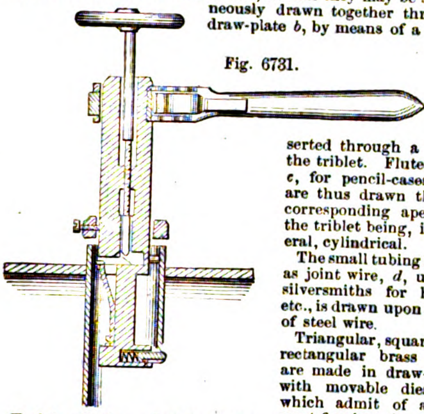
Fig. 6730.



Roller Tube-Cutter.

Sliding-tubes, for telescopes, etc., are *drawn inside and out*, rendering them very hard and inelastic, by inserting within them a steel cylinder, or triblet *a*, and setting down the end upon the shoulder of the triblet, so that they may be simultaneously drawn together through a draw-plate *b*, by means of a key in-

Fig. 6731.



Tool for Cutting off Boiler-Tubes.

serted through a slot in the triblet. Fluted tubes *c*, for pencil-cases, etc., are thus drawn through corresponding apertures, the triblet being, in general, cylindrical.

The small tubing known as joint wire, *d*, used by silversmiths for hinges, etc., is drawn upon a piece of steel wire.

Triangular, square, and rectangular brass tubes are made in draw-plates with movable dies *e f*, which admit of adjustment for size; the dies are rounded on their inner edges, are contained in a square frame, with adjusting screws, and the whole lies against a solid perforated plate.

Tubes of small diameter are generally completed in two drafts; sometimes three are used, by which time the maximum degree of hardness is attained.

When finished, the triblet is withdrawn by inserting the key at its other end and drawing it through a collar which exactly fits it.

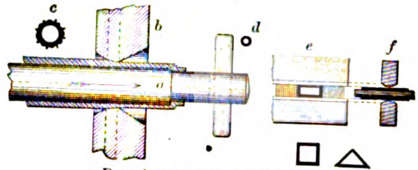
Large tubes are drawn vertically by means of a chain wound upon a barrel, turned by gear-wheels, as in a crane. This is the case with Donkin's machine for drawing the cylinders used in paper-making and other machinery, having a diameter of 26½ inches, and length of 6½ feet; a vertical screw is used, the nut of which is turned by toothed wheels, driven from a windlass.

Lead and tin pipes are cast in tubular form, and afterward drawn out upon triblets. The same course is adopted with brass boiler-tubes, which are sometimes drawn upon a taper-triblet, so that the tube may be thicker at the more exposed end, or that next the fire-box.

Rand's collapsible tin tubes, for artists' colors, having a thickness of but $^1/_{170}$ of an inch, were formerly drawn out in this way from the hollow cast pipe, the ends being cast and soldered in; for this purpose ten drawings were required, which were, however, owing to the ductility of the metal, conducted as one continuous operation.

At present, they are formed by a screw, or hydraulic press. A disk of tin having the external diameter of the

Fig. 6732.



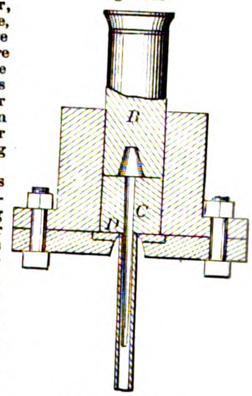
Drawing-Plates and Triblets.

intended tube is punched out, disked, and perforated by one blow. The blank thus formed is converted into a finished tube by a second blow between two dies, the lower one of which has a hollow cylindrical cavity of the same diameter as the blank, and terminates in a hollow screw; the upper die is a cylinder of greater length than the tube, and having a small tapering spindle. The cylinder is just so much smaller than the lower die as to leave an annular space equal to the intended thickness of the tube.

When the two dies are brought together, the tin instantaneously flows through this annular aperture up and around the cylindrical mandrel, almost after the manner of a fluid, forming the body of the tube, while the nozzle, with its screw to receive the cap, is shaped by the screw and spindle. The ascent of the cylinder leaves the tube behind, and the screwed extremity of the mold is then driven up by a ram and lever from below, forcing up the tube, which is left free by the screwed portion of the mold dividing into two halves. See also LEAD-PIPE.

In Fig. 6733, a tapering mandrel *C* fixed in the ram *B* is employed in conjunction with the die *D* to form leaden tubes of uniform exterior diameter, but having a tapering bore, for water-pipes, which have to resist a greater pressure toward their lower ends. The pipe and its mandrel pass down together, and the former is cut off, and removed when the stroke is over; the smaller end of the mandrel being downward, the tube slips off.

Fig. 6733.

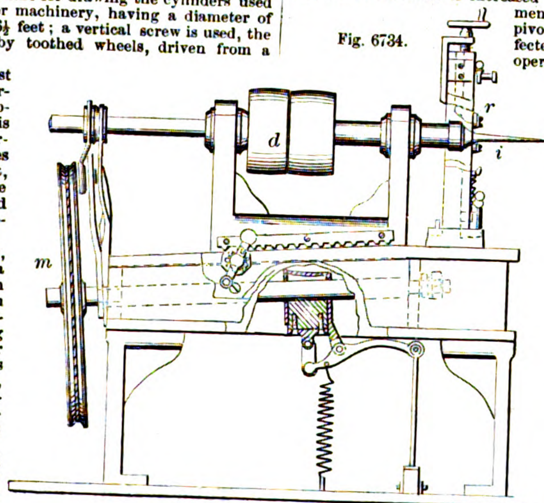


Taper-Tube Press.

The machine (Fig. 6734) has a *spinning* action, and is intended for forming tapering pipes, such as spouts or nozzles, from hollow cylinders of block metal. The cylinder is placed upon the spindle *i*, to which a rotary and backward movement is imparted by the pulleys *d m*, while the tool *r* is pressed against the metal, spinning it into tapering form corresponding to that of the mandrel.

In Fig. 6735, the faces of the series of *wordles* form a circular die, whose diameter is increased or diminished by the movement of the *wordles* upon their pivots. This movement is effected by a rack and gearing operated by the longitudinal movement of the dies.

Fig. 6734.



Machine for Spinning Tapering Tubes of Sheet-Metal.

Tube-ex-pand'er. (*Steam.*) A tool for setting the *tubes* in the *tube-sheets* of locomo-

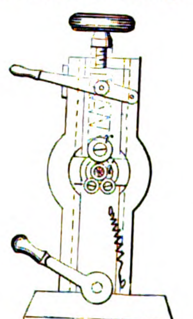
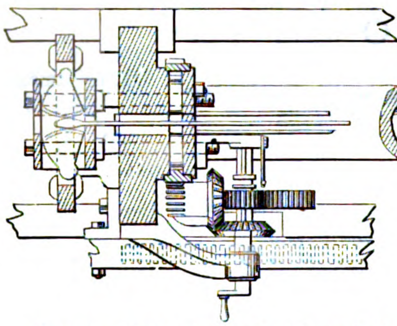


Fig. 6735.

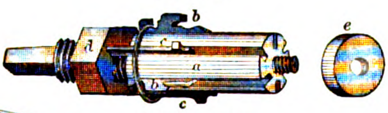


Harding's Machine for Drawing Tapered Tubes.

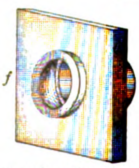
tive and other similar boilers. A collar is formed on the tube by expansion, on the inner or water side of the sheet, and the ends of the tube are then turned over upon the sheets at the fire-box and the smoke-box ends respectively. The collar and outer flange thus formed constitute the water and steam-tight joint by which each tube is secured to the sheets.

The mandrel *a* has several longitudinal grooves whose bottoms form inclined planes in which the beading dies *b b* and upsetting dies *c c* slide. The mandrel is inserted in the end of the tube, and the beading dies are pushed in until the ends of their projecting arms, which are exterior to the tube, bear against the face of the tube-sheet. The mandrel is then turned by a wrench which is slipped over its square projecting shank, the

Fig. 6736.



Tube-Expander.



Tube in Tube-Sheet.

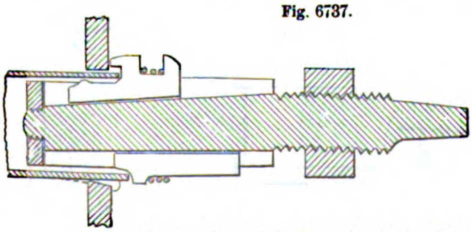
interior projections on the dies *b* expanding the tube so as to form a collar. By turning the nut *d* the dies *c c* are forced against the projecting end of the tube, upsetting it against the face of the tube-sheet. *e* is a ring which is screwed on to the end of the mandrel to prevent the dies from slipping out of their grooves when the tool is not in use.

f is part of the tube-sheet with a tube inserted as described.

Tube-fas'ten-er. (*Steam.*) A machine for fastening tubes in *tube-sheets*, by expanding them against the edge of the hole to make a steam-tight joint.

The cylindrical mandrel or shank has a number of longitudinal grooves in its periphery, increasing in depth from its outer to its inner end, the bottom of the grooves forming a tapering or wedge-shaped foundation for a corresponding number of bits or sliding dies, part of which are for forming the bead on the tube inside of the tube-sheet, the other for flanging or turning out the end of the tube against the sheet.

Fig. 6737.

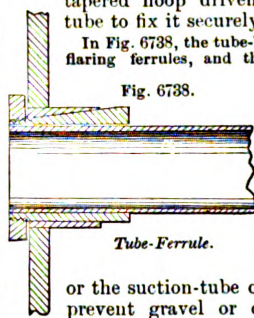


McConnel's Tool for Fastening Boiler-Tubes.

Tube-fer'rule. (*Steam.*) A short sleeve for fastening tubes in tube-sheets. Usually a slightly tapered hoop driven in at the end of the tube to fix it securely in the boiler.

In Fig. 6738, the tube-holes are bushed with inward flaring ferrules, and the tube end is surrounded with a ferrule whose outward surface is brought in contact with the inner surface of the bushing by a nut screwing on its outer end.

Fig. 6738.



Tube-Ferrule.

Tube-fil'ter. (*Wells.*) A foraminous chamber at the end of a driven well-tube, or the suction-tube of a pump, to prevent gravel or other foreign matters from getting into and choking the pump.

That shown in Fig. 6739 is composed of sections of any kind of common wire, arranged in a tubular form, forming an open grate. The ends of the wire sections are welded together and form a drill. It relates to that class of wells formed by driving a tube into the earth and allowing it to remain.

Fig. 6739.

Tube-Filter.

Tube-flue. (*Steam.*) A furnace-tube through which flame passes.

A *tube* in a furnace, properly speaking, is traversed by water ; a *flue*, by fire.

Tube-pack'ing. (*Wells.*) A bag of flaxseed or ring of rubber to occupy the space between the tube of an oil-well and the bored hole, to prevent access of water to the oil-bearing stratum.

In Fig. 6740, it consists of an elastic tube embracing the pump-barrel ; its upper end, being flaring, expands under the pressure of water from above, and is thus pressed into the irregularities of the shaft.

Tube-plate. (*Steam.*) A sheet into which fire-tubes are set. See STEAM-BOILER FURNACE ; TUBE-SHEET.

Tube-plate Stay. (*Steam.*) An iron rod passing across the boiler and having heads or nuts on the outsides of the respective sheets to tie the plates together and prevent their disruption by the pressure of steam.

Fig. 6740.

Moulton's Oil-Well Pump-Packing.

Tube-plug. (*Steam.*) A tapered plug of iron or wood, used for driving into the end of a tube when burst by the steam.

Tube-plug Ram. (*Steam.*) A long rod with a socket end, into which the plug fits, and is thus driven into the burst tube, and the plug-ram withdrawn.

Tube-pouch. The artilleryman's leather pouch for carrying friction-primers. It has two loops, by which it is fastened to the belt. The *priming-wire* and gunner's gimlet are carried with it.

Tube-re-tort'. A retort made from a glass tube, closed at one end, and sometimes having a swelled bulb.

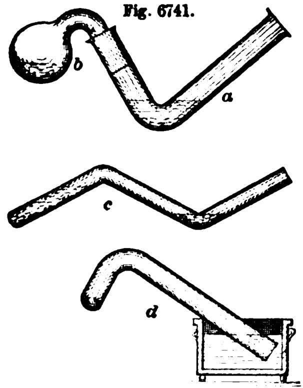
a (Fig. 6741), Clark's retort, and *b*, receiver, for the distillation and condensation of small quantities of acid.

c, Faraday's retort and receiver in one piece.

d, Gay Lussac's bent-tube retort, used when a solid is to be heated in a gas confined over mercury.

Tube-scal'er. (*Steam.*) A tool for removing soot and incrustation from the insides of flues of

Fig. 6741.



Tube-Retorts.

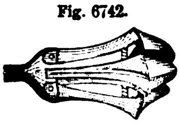
steam-boilers. See TUBE-CLEANER.

Tube-scrap′er. (*Steam.*) An implement for removing rust, sediment, etc., from boiler and other tubes.

The example is adapted for attachment to piece of gas-pipe as a handle. The blades, which are curvilinear in outline, are expanded by springs. See TUBE-SCALER; TUBE-CLEANER.

Tube-sheet. (*Steam.*) A boiler-plate into which the ends of boiler tubes or flues are inserted securely. See FLUE-BOILER; TUBULAR BOILER; STEAM-BOILER; etc.

Fig. 6742.

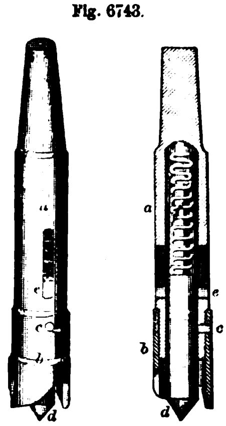


Tube-Scraper.

Tube-sheet Cut′ter. (*Steam.*) A tool for cutting holes to receive the tubes in the tube-sheets of boilers. Fig. 6743 is designed to obviate the preliminary labor of drilling holes to receive the pin by which the cutter is usually steadied.

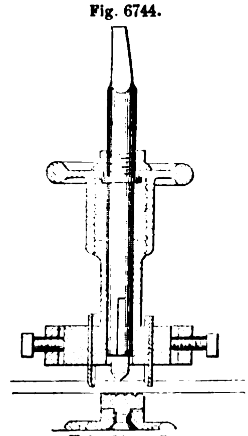
The socket *a* may be fitted in the drilling-machine in the usual way. It carries a circular cutter *b* secured by the lantern lock-pin *c*. The center *d* is retained in the socket by the key *e*, and is pressed outward with sufficient

Fig. 6743.



Tube-Sheet Cutter.

Fig. 6744.

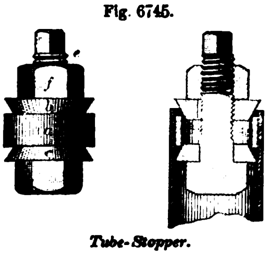


Tube-Sheet Cutter.

force to resist lateral displacement by means of the spring *f*, but yields to the pressure by which the cutter is advanced to penetrate the sheet.

Fig. 6744 is on the principle of the center-bit, the tool turning on a point while the cutters take a disk out of the plate. The cutters are adjustable to and from the center-pin to vary the size of hole, and are held in a sleeve which slips upon the mandrel, being fed by a screw as the cutters revolve, to force them against the metal.

Fig. 6745.



Tube-Stopper.

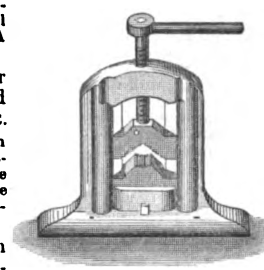
Tube-stop′per. (*Steam.*) A device for plugging boiler, condenser, or other tubes in case of leakage or for other reasons.

That shown consists of an expansible ring *a*, two frusto-conical disks *b c*, a bolt *e*, and nut *f*. The device is inserted into the end of the tube, and the square-ended foot of the bolt is turned by using a wrench, causing the two disks to approach each other and expand the ring *a*, so as to fill the bore of the tube. A *tube-plug*.

Tube-vise. One for grasping tubes and pipes. See PIPE-VISE.

Fig. 6746 is an English tube-vise, designed to be attached to a bench. The pipe is clamped between the serrated jaws by the depression of the screw.

Fig. 6746.



Tube-Vise.

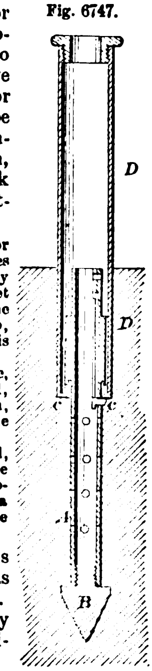
Tube-well. An iron pipe of small diameter, pointed, and having a number of lateral perforations near the end, driven into the earth by a small pile-driver hammer until a water-bearing stratum is reached. Where the depth exceeds 14 feet, two or more sections of pipe are screwed together. A small pump is attached to the top. The device is said to have been originally used in America for obtaining brine; but in what may be termed its domestic form, it was invented by Colonel Nelson W. Green, of the 76th Regiment, New York Volunteers, when stationed at Cortland, N. Y., 1862.

In Minneapolis, a supply of water for extinguishing fires is obtained in localities beyond the reach of the city water-works by sinking four drive-wells at distances 15 feet from a center. The pipes (2¼ inches) of the four wells are brought together at the top, where the suction-hose of the fire-engine is attached.

In Fig. 6747, the tube *D* is imperforate, and contains a smaller perforated tube *A*, having an enlarged conical head *B*, which, in driving, rests against a collar *c c*, at the bottom of the exterior tube.

An enlarged water-chamber is thus formed, and, when a sufficient depth is reached, the tube *D* is lifted, leaving the tube *A* protruding, in which position it is held by a spring-catch, its sides being free from the surrounding ground.

Fig. 6747.



Tube-Well.

Tub′ing. Length of tubes, as well-tubing; or kind of tubes, as brazen, leathern, or flexible tubing.

Tub-ma-chine′. The machinery of a cooper's shop embraces the following: —

Lathe, for three sizes.	Churn-lathe.
Matcher.	Churn-matcher.
Bottom-planer.	Hollow mandrel to turn rods.
Bottom-lathe.	Machine to cut the screws.
Hoop-punch.	Lathe to turn covers.
Cast-steel hoop-rolls.	Butter-tub lathe.
Ear-punch.	Butter-tub matcher.
Irons for making tub-ears.	Lock-cutter for hoops.
Paint-reels.	Kit-lathe.
Sand-papering pad.	Kit-matcher.
Riveting-horn.	Keeler-lathe, for five sizes.
Shears for cutting wire.	Keeler-matcher, for five sizes.
Paint-mill.	Piercing-bench for bottoms.
Setting-up plate.	Bottom-jointer.
Patent hoop driver.	Pail-ear machine.
Spoke-shaves.	
Chisels.	

Tub-saw. A cylindrical saw for cutting staves from a block, giving them the transversely rounded shape. See CYLINDRICAL SAW; BARREL-SAW.

Tub′u-lar-arch Bridge. A bridge supported by a tubular archway of iron or steel. The first arched iron bridge was one over the Severn at Colebrooke Dale, erected by Abraham Darby in 1777; the arch-

ribs were in two pieces, each 70 feet in length and meeting at the keys, the clear span being 100 feet 6 inches, and the rise 45 feet; the ribs were solid, not tubular.

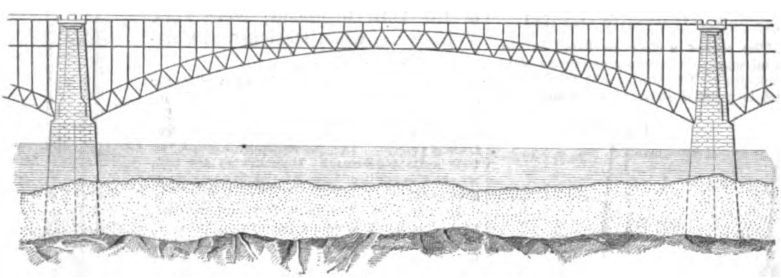
The aqueduct bridge over Rock Creek, at Washington (Fig. 6748), has a span of 200 feet between the abutments, with a rise of 20 feet. The arch consists of two ribs, each composed of 17 cast-iron pipes, with flanged ends, which abut and are firmly united by screw-bolts; the joints are water-tight, without packing or cement, under a head of 120 feet water. The two series of pipes are strongly connected together by diagonal ties and tubular cross-braces, and support a framework of heavy rolled-

Fig. 6748.

Tubular-Arch Bridge over Rock Creek, D. C.

iron H-beams, carrying two continuous horizontal iron girders, upon which rest cross-beams of timber, on which the roadway of the bridge is laid. All the water for the supply of the city of Washington passes through these pipes, which, to guard against freezing, are lined with staves and pitch-pine, leaving a clear water-way in each of 3 feet 6 inches. A water-pressure engine is located in a vault in the western abutment, capable of pumping 10,000 gallons of water per hour into the reservoir on Georgetown Hights, 204 feet above, supplying that part of the town which is above the level of the distributing reservoir.

Fig. 6749.



Illinois and St. Louis Bridge (Center Arch).

The Illinois and St. Louis Bridge, shown in Plate LXXI., and one span of which is shown in Fig. 6749, has three spans, each formed with four ribbed arches made of cast-steel. The center span has a length of 515 feet, the rise being one tenth the span; the two end spans are each 497 feet in the clear, and have a rise of 47 feet 10 inches.

The four arches forming each span each consist of an upper and lower curved member or rib extending from pier to pier, each being composed of two parallel steel tubes 9 inches in exterior diameter, placed side by side. The upper and lower members are 8 feet apart from center to center, and are held apart by cast-steel braces secured to cast-steel plates, formed somewhat like the voussoirs of a stone arch, against which the ends of the tube sections, 9 feet in length, abut. Horizontal and diagonal braces give lateral support, and serve to secure the upper and lower parts together. The car-tracks are below the level of the crowns of the arches, and are supported by them. The roadways are formed by transverse iron beams, supported by iron struts of cruciform section resting on the arches at the points where the vertical bracing of the latter is secured. The upper roadway is 34 feet wide between the foot-walks, which are each 8 feet wide, making the bridge 50 feet between the railings. The railway passages beneath the carriage-way are each 13 feet 6 inches wide and 18 feet high, extending through arched openings in the piers and abutments. The railways are carried over the wharves on each side of the river upon stone arches, and are inclosed by a cut stone arcade supporting the roadway. The railway at the St. Louis end passes immediately into a tunnel 4,800 feet in length, and at the Illinois end is continued on an easy down grade for 3,000 feet.

Tubular arches are also shown in some of the illustrations under IRON BRIDGE; TRUSS-BRIDGE. Arched beams not tubular are shown under ARCHED BEAM-ROOF; ROOF.

The piers of the bridge are founded upon the solid rock beneath the bed of the river, which is covered by sand to a depth of 78 feet at the eastern, and 50 feet at the western pier, the depth of water being in each case about 20 feet. The sinking of the piers was accomplished by the *plenum pneumatic* process; that is, by means of a caisson from which the water is expelled by a pressure of air sufficient to overcome the hydrostatic pressure. See PNEUMATIC CAISSON; CAISSON; AIR-LOCK.

Tub′u-lar Boil′er. (*Steam.*) A name properly applicable to a steam-boiler in which the water circulates in pipes, vertical, horizontal, or inclined, the fire encircling them. See TUBULAR STEAM-BOILER; TUBULOUS BOILER.

When the fire passes *through* the tubes, they are properly *flues*. The term is, however, applied to pipes, whether *water*-tubes or *fire*-tubes, below a certain diameter; the term *flues* belonging to those of a relatively larger diameter. See STEAM-BOILER, Plate LXI., in which are numerous illustrations of each kind; also LOCOMOTIVE, page 1346; and other places noted in the list under STEAM-ENGINE.

Tub′u-lar Bridge. A bridge formed by a great tube or hollow beam, through the center of which a roadway or railway passes.

A similar principle — that of the truss-beam — had been applied, varying, of course, in details of construction, to timber bridges, both in Switzerland and America; but the idea of the wrought-iron tubular bridge, and the carrying out of the details of construction which made it a success, are due to Fairbairn, to whom is due the credit of devising the form and proportions of the tubular bridges of Conway and Menai. The rectangular cellular beam laid on its edge and constructed of wrought and cast iron in their respective places was Fairbairn's, as was also the idea of making it self-supporting. Stephenson very reluctantly gave up the idea of supporting it by chains.

The most remarkable one ever constructed is that across the Menai Straits, on the Chester and Holyhead line of railway, and which unites the island of Anglesea with the mainland of Wales.

Plate LXXII. is a general view of the Britannia Bridge from the Caernarvon side, showing also the Menai suspension-bridge. A mile distant from it is the famous Telford suspension-bridge, built in 1829 by that prince of road-makers. Telford died in 1834.

Several requirements were made in regard to the tubular bridge to be erected over the strait.

Trains of all kinds were to cross it at full speed.

The Lords of the Admiralty stipulated that it should not be less than 105 feet above high-water level.

And that neither scaffolding nor centering should be used, as they would temporarily impede navigation at all points.

Stephenson, at first, designed a cast-iron bridge of two arches, in which the necessity for centering was obviated by connecting together the half-arches on each side of the center pier, on the principle suggested by Brunel. The two half-arches would thereby counterbalance each other, and be prolonged until they met their counterparts, which would spring from the abutments on each side of the straits.

This plan was rejected by the Admiralty, as it gave the specified hight at the *crowns* only of the arches.

The idea of the *beam* was then conceived, and the question arose how to build it. The round, or elliptical, form naturally presented itself, and, after the spans were determined, the three towers were commenced, and an expert board was appointed to determine the shape and structure. The board consisted of Messrs. Fairbairn, Hodgkinson, and Clark.

The points determined were, —

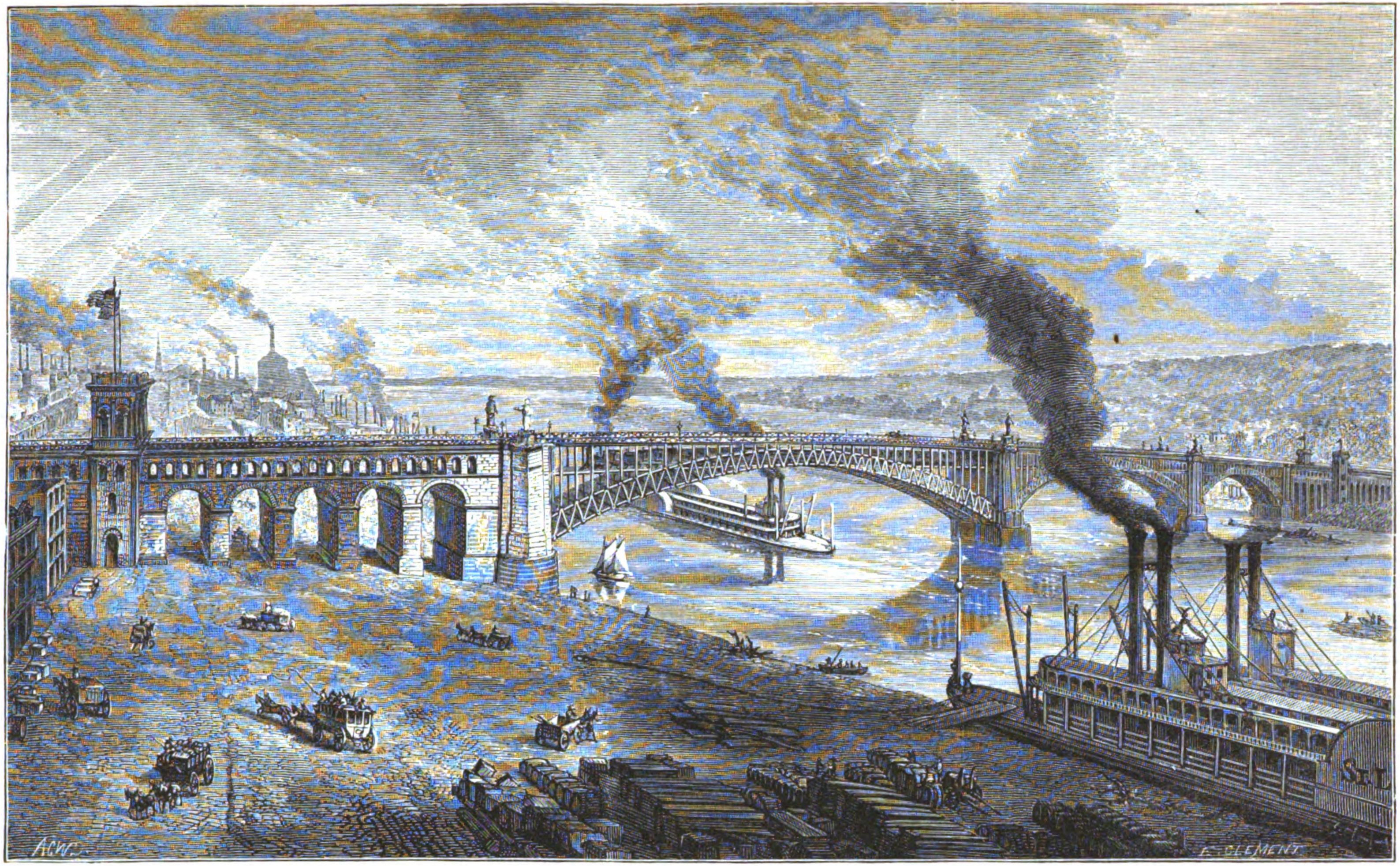
The tube must resist compression on its upper portion and extension on its lower portion.

The material should be principally accumulated above and below, and the middle should be hollow, whether it was of iron or wood.

Several evident reasons indicated iron as the material, and it was eventually determined to run the trains *through* the hollow iron beam instead of *upon* it.

Experiments determined that, while a cylindrical tube, with a given weight, was rent asunder beneath, and an elliptical tube was crushed at the top, a rectangular tube was more rigid than either.

Then followed the discovery that, instead of riveting together



ILLINOIS AND ST. LOUIS BRIDGE ACROSS THE MISSISSIPPI RIVER.

PLATE LXXI. CAPTAIN JAMES B. EADS, ENGINEER. See page 2646.

layers of plates, the same amount of material in a cellular form would give greater strength; so the layers were divided, and the spaces between them subdivided, by upright plates, into cells extending throughout the top and bottom of the tube.

The plate-iron sides and angle-irons formed ribs and skin to the double spine.

Chains for assistant support were contemplated, but eventually discarded. The tube was calculated to bear a distributed weight of 4,000 tons (2,240 pounds each), or 2,000 tons in the center; being 9 times the calculated load it would have to bear.

The piers are 3 in number, and the land abutments 2; the tubes 4, in appearance (or rather they appear continuous), but they were made in pairs, one for *up trains*, the other for *down trains*, so that there are actually 8 tubes, forming parallel bridges of 4 tubes each. The tubes next to the shore, on each side, were built upon scaffolding, and are each 230 feet long. The two spans in the middle of the strait are each 472 feet in length, and rest upon 3 towers or piers; the outer ones have each a base of 55 feet × 32 feet, and are 198 feet high. Each contains 210 tons of cast-iron beams and girders.

The central, or "Britannia," pier is 460 feet distant from its fellows, and is founded upon a rock. It is 230 feet high, and has a base 62 × 52 feet. It weighs 20,000 tons (English). Its exterior has 148,625 cubic feet of granite, filled in with 144,625 cubic feet of sandstone. 387 tons of cast-iron beams, or girders, are worked into it.

The tubes are composed of wrought-iron plates, from $\frac{3}{8}$ to $\frac{3}{4}$ of an inch thick, the largest being about 12 feet in length, strongly united by rivets, and stiffened by angle-irons, and vary in exterior hight, which is 30 feet at the center of the bridge, diminishing to 22 feet 9 inches at the abutments. Their exterior width is 14 feet 8 inches, or 13 feet 8 inches in the clear, inside.

The tubes were built upon platforms on the Caernarvon shore, and floated on pontons into spaces between the piers. One side of a tube was floated into a vertical recess in one side of the tower formed for its reception, and then the other was floated down into a similar recess in the other tower, a portion of the lower masonry being omitted to allow it to pass in. These vertical recesses in the sides of the tower formed guides for the ends of the tubes while being raised to their elevated position. 800 men were employed in the removal of a tube, which was deposited on ledges of masonry on the piers.

The raising of each tube was separately performed by means of powerful hydraulic presses. The larger press had a cylinder 11 inches thick, the piston 20 inches in diameter, and a lift of 6 feet. The cylinder weighed 16 tons, the machine 40 tons (English, 2,240 pounds). See Fig 2627, page 1156.

Two smaller presses had rams 18 inches in diameter, and acted at one of the tubes, while the larger one operated at the other end. They stood on the piers, and lifted by chains. The chains and lifting-frames added 400 tons to the weight to be lifted.

The power was derived from 2 steam-engines of 40 horse-power each, delivering water through a $\frac{1}{2}$-inch pipe into the cylinder below the ram. As the tube rose it was secured beneath. It was raised by successive lifts of 6 feet each, each occupying 30 minutes. The ends rest on rollers so as to allow the tube to expand and contract without grinding the coping of the pier.

The bridge contains 9,480 tons of wrought-iron, 1,988 tons of cast-iron, and 1,500,000 cubic feet of masonry. Its cost was about $3,000,000. It was first crossed by a railway train, March 1, 1850.

Some other data are given under BRIDGE (which see).

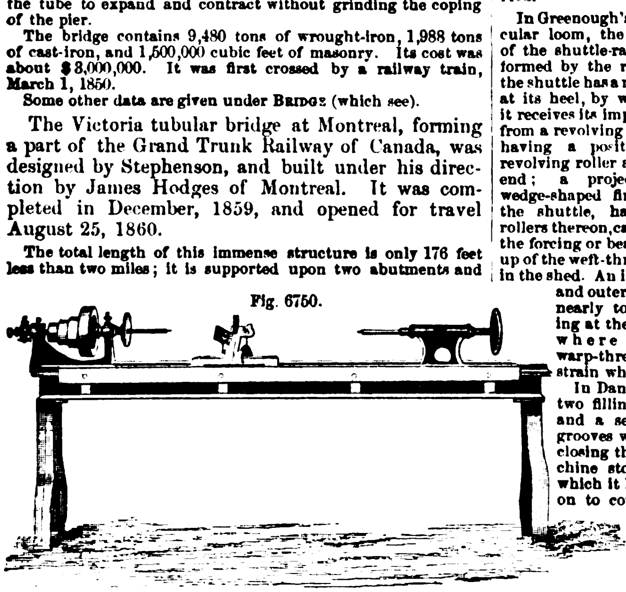
The Victoria tubular bridge at Montreal, forming a part of the Grand Trunk Railway of Canada, was designed by Stephenson, and built under his direction by James Hodges of Montreal. It was completed in December, 1859, and opened for travel August 25, 1860.

The total length of this immense structure is only 176 feet less than two miles; it is supported upon two abutments and 24 piers, having 25 spans of tubing, the center one of which is 330, and each of the others 242 feet long. The hight of the central tube is 60 feet above the summer level of the water. The bridge has a slight descent from the center toward each end. The two center piers are 24 feet wide, the others being 16 feet, and each presents a wedge-shaped cutwater up stream to break the ice, which on the St. Lawrence frequently attains a thickness of 3 to 5 feet, often becoming piled to the hight of 50 feet or more on breaking up in the spring. The tubing of this bridge differs principally from that of the Britannia Bridge, before described, in not being cellular at top and bottom. Each plate and piece of iron was punched in England before being sent to Canada, so that little, except putting them together and placing them in position, remained to be done on the spot. This, however, was a work of great labor, requiring the erection of a rigid timber stage or trussing supported by massive temporary piers of wood, on which the tubes were built up plate by plate. These trusses were removed when the work was completed, leaving the tubes resting at each end on the piers and abutments alone. Expansion and contraction are provided for by rollers underneath the end of each span. The total cost was £1,250,000. The first stone of this bridge was laid July 22, 1854; and on December 17, 1859, the first train passed over.

Tub'u-lar Crane. A crane whose hollow jib is made of riveted boiler-plate. See CRANE; STEAM-CRANE; TRAVELING-CRANE.

Tub'u-lar Cut'ter. Fig. 6750 illustrates a lathe for turning broom-handles or similar objects. The sliding head has a tubular cutter, which passes along and rounds the stick; it acts as cutter and guide, the piece being too thin and pliable to work well unless supported on the side opposite to the tool.

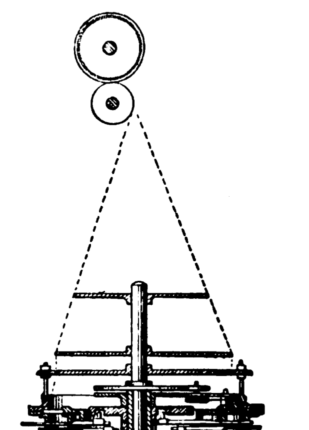
Fig. 6750.



Broom-Handle Lathe.

Tub'u-lar Fab'ric-loom. (*Weaving.*) A machine for weaving hollow goods, such as bags, skirts, and other tubular fabrics.

Fig. 6751.



Greenough's Circular Loom.

In Greenough's circular loom, the sole of the shuttle-race is formed by the reed; the shuttle has a roller at its heel, by which it receives its impulse from a revolving arm having a positively revolving roller at its end; a projecting wedge-shaped fin on the shuttle, having rollers thereon, causes the forcing or beating up of the weft-threads in the shed. An inner and outer ring nearly touching at the line where the warp-threads cross each other, relieve the warp from strain when the shuttle is beating up.

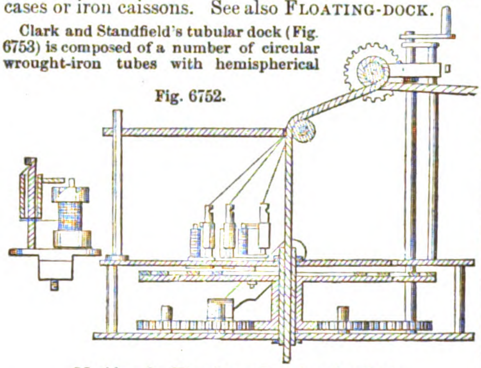
In Danby's machine for weaving a covering for cords, two filling-thread carriers travel in a circular groove, and a series of weft-thread carriers travel in radial grooves which cross the circular one, thus opening and closing the shed. When a weft-thread breaks, the machine stops automatically, thus: the weight or slide which it has held up drops, allowing a projection thereon to come in contact with an arm and unlatch the weighted lever, whose upper arm in rising lifts the cog-wheel out of gear with the driving-gear.

Tub'u-lar Float'ing-dock. One whose flotative power depends upon

air-tight chambers or cylinders. These are wooden cases or iron caissons. See also FLOATING-DOCK.

Clark and Standfield's tubular dock (Fig. 6753) is composed of a number of circular wrought-iron tubes with hemispherical

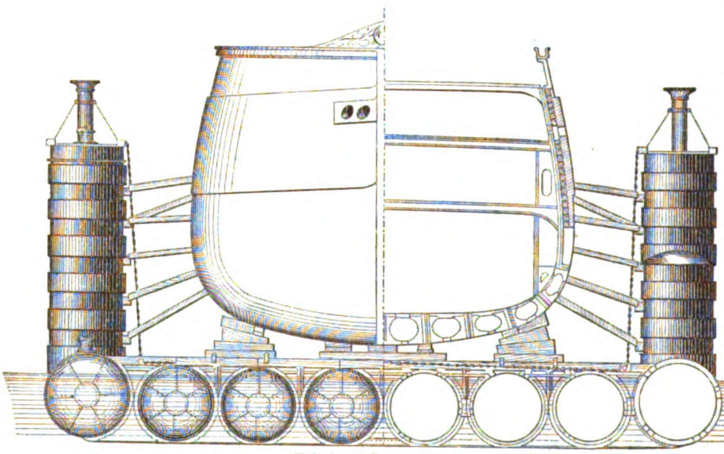
Fig. 6752.



Machine for Weaving a Covering for Cords.

ends, stiffened inside by angle-irons at intervals of two or three feet, and securely braced together by T and angle irons above and below, forming transverse girders of sufficient strength to support the weight of a vessel. These tubes are usually eight in number, and form a platform having sufficient buoyancy to float the superstructure and a ship. The two outer tubes are

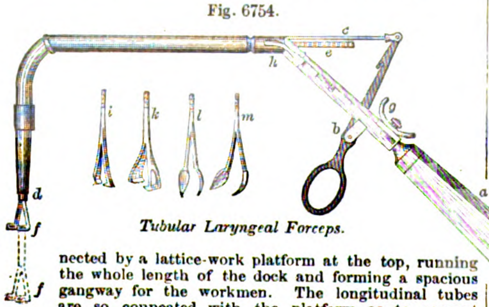
Fig. 6753.



Tubular Floating-Dock.

of larger diameter than the interior ones, and the central tubes are longer than those at the sides, so that the structure is somewhat pointed at the ends. The sides of the dock are each formed of from 12 to 24 similar vertical tubes, braced together and con-

Fig. 6754.



Tubular Laryngeal Forceps.

nected by a lattice-work platform at the top, running the whole length of the dock and forming a spacious gangway for the workmen. The longitudinal tubes are so connected with the platform as to convert the whole dock into a beam or girder of great depth and rigidity. The tubes are divided within into water-tight compartments connected by pipes. The base of the dock contains about sixty and the sides about forty of these compartments, those of the sides being hermetically closed, so that the dock cannot sink. A certain number of the bottom compartments are also hermetically closed, and the remainder are provided with valves at bottom, which can be opened and closed at pleasure, and with wrought-iron pipes which are grouped together, and all carried to a valve-house on the upper platform, where they are under the control of the valve-engineer. When it is desired to sink the dock, the bottom valves are opened and the air allowed to escape at the valve-house until the dock settles down to the required level. When it is desired to raise it, compressed air is forced into the tubes, expelling the water through the bottom valves, which are closed when the dock and the vessel upon it are raised to the proper hight.

The engines are in two pairs, placed within the vertical tubes near the center of the dock. The whole of the water-tight compartments in the bottom are divided into four equal groups corresponding to the four corners of the dock, and by means of four corresponding valves in the valve-house air is forced into or withdrawn from either or all of these four groups, so that the dock may be kept perfectly level in raising or lowering.

Tub′u-lar For′ceps. (*Surgical.*) The tubular laryngeal forceps (Fig. 6754) is designed for the extraction of tumors in the larynx.

It consists of a bent tube 7 inches long, and having a handle *a*, making with it an angle of 45°. On the handle is a lever *b* connected with a rod *c*, which passes through the tube and has attached at its lower extremity a smaller tube *d* within the larger one, by which the vertical portion of the instrument is lengthened and the forceps closed at will. Beneath *c* is another rod *e*, serrated at its upper extremity, which also passes through the tube and terminates in a socket, into which the forceps *f* is screwed. A slide on the handle, operated by the thumb-piece *g*, is so connected to two small retaining-levers *h*, that pressure on the thumb-piece causes the retainers to grasp the serrated rod *e* and retain it in any desired position. The outer side of each limb of the forceps is serrated, to enable the tube *d* to retain its hold, though there be no pressure on the lever *b*.

The vertical portion of the main tube is introduced into the larynx, and the lever *b* operated, projecting the smaller tube and the forceps into the position shown in dotted lines. When the proper position is attained, the serrated rod is arrested by pressure on the thumb-piece, causing the retainers to grasp the serrated lever, retaining it and the forceps in that position. The forceps are then closed by continuing the pressure on the lever, causing the rod *c* to push the smaller tube over the base of the forceps and close them. Various forms of forceps, as *i k l m*, may be used.

Tub′u-lar Gird′er. A hollow girder made of any shape of plates secured together. (See IRON BRIDGE.) The tubular bridge is but the largest kind of tubular girder.

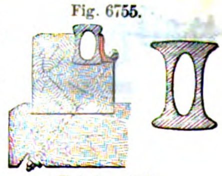
Tub′u-lar Goods Sew′ing-ma-chine′. The Akins and Felthousen patent of August 5, 1851, was the first machine to sew tubular goods, such as shirt-sleeves, boot-legs, etc.; and in 1865 it was estimated that 50,000 sewing-machines, embracing one or the other of the features of this improvement, were in use.

Tub′u-lar Rail. A railway-rail having a continuous longitudinal opening which serves as

A duct for water; Woodhouse English patent, 1803; or

A steam-pipe to prevent the accretion of ice or snow upon the track; Grimes's English patent, 1831.

Fig. 6755.



Tubular Rail.

Montgomery's tubular rail has its upper and lower faces alike, so that it may be reversed when injured by wear. It is held on one side by a rabbet in the longitudinal sill upon which it is laid, and on the other by locking plates secured by bolts pass-

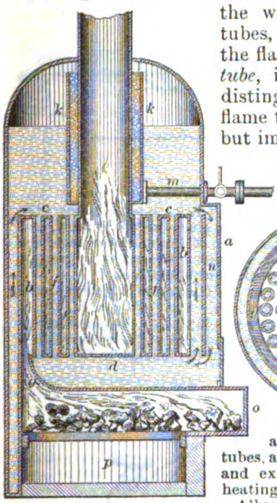
ing through the sills and ties. A number of other forms might be mentioned.

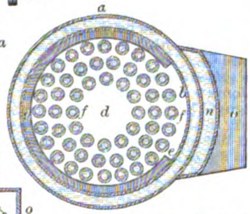
Tub′u-lar Rein. One in which an additional or safety rein slips through the other rein, which is hollow. See the following patents: —

13,306. Goddard, July 24, '55.	61,512. Donehoo, Jan. 29, '67.
59,596. Hartman, Nov. 13, '66.	65,721. Brook, June 11, '67.

Tub′u-lar Steam-boil′-er. A steam-boiler in which the water is contained in tubes, upon whose outside the flame plays. The term *tube*, in this connection, is distinguished from *flue*. The flame traverses *in* the latter, but impinges *on the outside* of a *tube*. See Plate LXI.

Fig. 6756.





Napier's Tubular Boiler.

Oliver Evans's boiler had a number of small water-tubes, able to bear a great pressure and exposing a relatively large heating surface.

Alban's boiler (Fig. 2685, *B*) was on the same principle, with the additional idea of dropping into the vertical tubes small charges of water which instantaneously flashed into steam. See also Fig. 5629, Plate LXI., and INSTANTANEOUS GENERATOR, page 1190.

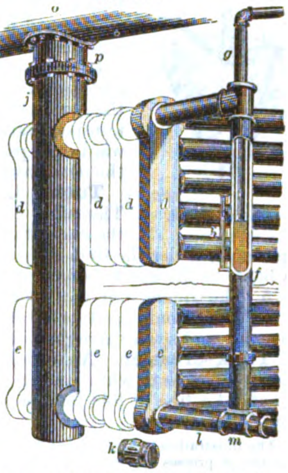
Booth and Stephenson's locomotive "Rocket" had 25 copper *flue*-tubes, 3 inches in diameter, open at one end to the chimney and to the fire-box at the other.

As many as 303 flue-tubes are employed in the "Great Western" engine, England. See also STEAM-BOILER, Plate LXI.

In tubular marine boilers, the flame and hot gases from the furnaces are led through a great number of small *flue-tubes* (of iron or brass), completely surrounded by water to the *uptake* at the bottom of the chimney.

Fig. 6756 shows Napier's tubular marine boiler. *a a* is a cylindrical chamber with a dome top, or outer casing of the boiler; and *b b* is a smaller cylinder with a flat top *c*, placed within the chamber *a*, and constituting the fire-box, while the space included between the two cylinders forms the water-chamber. Within the fire-box, and on a level with the upper part of the fire-door, is a flat circular vessel *d*, which is connected to the annular part of the water-chamber by a neck *e*, and to the upper part of the chamber by several concentric rows of tubes *f f*. This vessel *d* is somewhat less in diameter than the fire-box, so that there is an annular space *g* between its circumference and that of the fire-box, which forms a flue or passage for the smoke and heated gases from the furnace. The caloric current then traverses between the *flue-pipes f f*, and escapes by the chimney, which rises from the roof of the fire-box and passes out through the dome of the boiler. To protect the chimney from the effects of the fire, that portion within the boiler is surrounded by a water-casing *k*, which is open at top. The feed-water enters near the bottom of the casing by the feed-pipe *m*, and overflows at the top.

Fig. 6758.



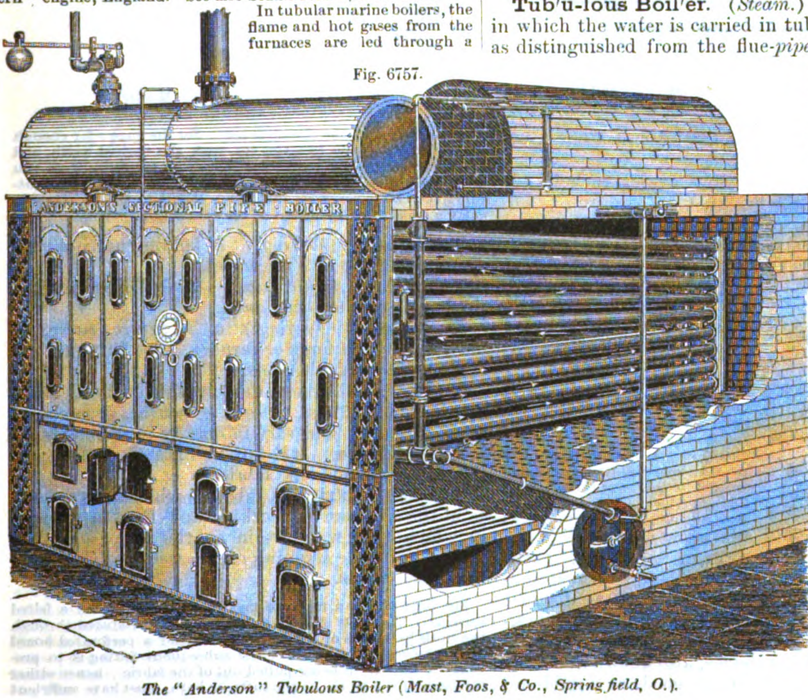
Section of "Anderson" Tubulous Boiler.

In order to establish a circulation of water in the boiler, a wide channel *n* is formed on the outside of the casing, which, being farther removed from the fire-box than any portion of the annular chamber, a descending current is maintained therein, while an ascending current is established in the annular water-chamber and pipes. *o* is the fire-door; *p*, the ash-pit.

Tub′u-lat′ed Re-tort′. One with an opening at top, closed by a stopper.

Tub′u-lous Boil′er. (*Steam.*) A form of boiler in which the water is carried in tubes or *water-pipes*, as distinguished from the flue-*pipes*, through which flame passes, as in the *flue-boilers* of locomotives and elsewhere. A *tubular* boiler.

Fig. 6757.



The "Anderson" Tubulous Boiler (Mast, Foos, & Co., Springfield, O.).

Fig. 6757 shows Mast's *tubulous* boiler, the name being a sort of protest against the confounding of *water-tubes* with *flue-pipes*.

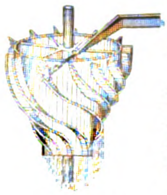
Each section is composed of two front manifolds *d e* (Fig. 6758) and one rear one, connected together by the upper and lower sets of tubes; these tubes being fitted to their places by right and left hand threads. These sections are united to each other by nipples *k* at the top and bottom of front manifolds, and the combination is completed by connecting the sets of sections to each side of a central column *j p*, to the top of which is attached the steam dome *o*. Extending outside of the masonry from

the upper and lower sections are two pipes *l* connecting to a vertical stand-pipe *f*, containing the automatic water-regulator. From the lower end of this stand-pipe extends another pipe to the mud-drum *m*, while from the top a pipe *g* connects to the feed-tank. The tubes are lap-welded, of wrought-iron. *b* is the gage-glass.

Tu′bu-lure. A tubular opening at the top of a retort.

Tub-wheel. A form of water-wheel which has a vertical axis and radial spiral floats, which are placed between two conical cases attached to the axis. The water is precipitated from a chute upon the wheel, and follows the spiral canals of the wheel until it is discharged at the bottom.

Fig. 6759.



Tub-Wheel.

It is a combination of the *horizontal* and common *recoil* wheel; the water, having exerted a certain percussive force, flows downward, and passes out like that in the *downward-discharge turbine.*

Tuck. 1. (*Shipbuilding.*) *a.* The after part of a ship, where the ends of the bottom planks are gathered, under the stem or counter. Its shape gives a name to the build, as *square*-tuck.

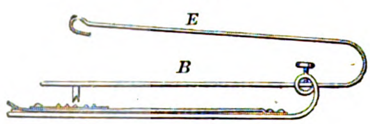
b. The square stem of a boat.

2. A horizontal fold or plait in a skirt, wide or narrow, and sewn throughout its length.

Tuck-creas′er. An instrument for making a crease upon cloth while passing through the machine, to afford a line of fold for the next tuck. Invented by Fuller.

The illustration is one of many kinds. As the needle-bar descends, it presses on the spring-bar *E*, which descends on *B*,

Fig. 6760.



Tuck-Creaser.

and presses the forked bar down upon the cloth and it upon the spurs beneath. See TUCK-MARKER. See also Fig. 4875, page 2121.

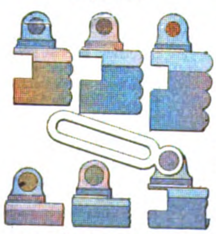
The early patents were Singer, 1856; Arnold, Wheeler, and Fuller, 1860.

Tuck-fold′er. For folding over a tuck in advance of sewing on the machine.

Goodrich's are made in sets; six in a set, adapted to various widths and spaces, and to various machines.

"They are confined to the machine by thumb-screws. After selecting the width of the folder required, fold the goods where you want the first tuck; then introduce the folded edge under the folder and up against the gage. Stitch the first tuck and press it flat, then make a fold in the goods just wide enough to fill the whole space in the folder when the tuck just made is placed in the front edge or hook portion, which serves the purpose of a guide to keep the tuck just made parallel to the next tuck. Keep the space between the two gage-lines full of cloth, and the tucks and spaces will be even."

Fig. 6761.



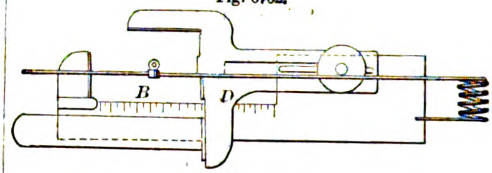
Goodrich's Tuck-Folders.

Tuck′ing-gage. (*Sewing-machine.*) An attachment for marking tucks at a determinate distance ready for the next line of sewing. See TUCK-MARKER; TUCK-CREASER.

Tuck-mark′er. A device, also known as a *tuck-creaser*, for making a crease on goods as a guide for width in making the next fold. The example has, besides the bar which is depressed by each descent of the needle, a gage for width of tuck. See also SEWING-MACHINE ATTACHMENTS, pages 2120, 2121.

In a later patent, the *creasing-plate B* has a scale marked from left to right, while the *gage-plate D* has a scale whose figures indicate spaces half as large as those of the *creasing-plate*, but

Fig. 6762.



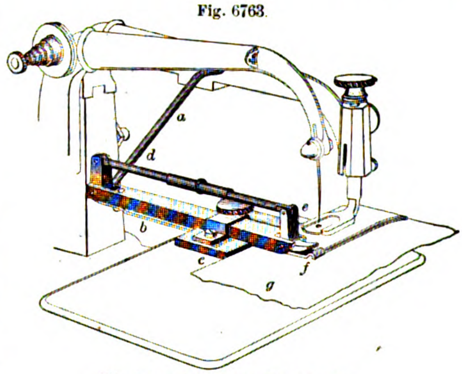
Tuck-Marker.

increasing in the reverse direction. The *gage-plate* is set with any figure at the point desired for a given width of tuck, and the *creasing-plate* is moved to a figure of double the value of the figure used on the gage, thus arranging the tucks in groups, the spaces between being twice the width of a tuck.

Jones's chart and scale for tuck-markers; patent dated August 11, 1874.

Fig. 6763 shows a tuck-marker as adapted to the old Wheeler and Wilson machine. Insert the loose end of the connection *d* into the tube of the same, and attach the marker to the cloth-

Fig. 6763.



Wheeler and Wilson's Tuck-Marker.

plate by means of the thumb-screw. Set the gage *e* far enough back from the needle to make the tuck the desired width, and fasten the thumb-screw and the creaser as far forward as you desire to fold the cloth for the next tuck, and fasten it by tightening the clamp-screw on the gage. Regulate the creaser *f* to make a good mark by means of the connection.

Tuck-net. (*Fishing.*) A landing net; one for dipping fish out of a larger net.

Tue′fall. (*Architecture.*) A building with a sloping roof on one side only.

Tue-ir′on. (*Forging.*) *a.* A *tuyere, tweer,* or blast nozzle of a forge or furnace. See TUYERE.

b. A blacksmith's tongs.

Tu′fa. A calcareous deposit which affords a hydraulic lime. *Trass, tarrass, travertine, pozzuolana,* are local names, and vary in quality to some extent.

Tuf-taf′fe-ta. (*Fabric.*) Tufted taffeta; a shaggy or *villous* silk fabric.

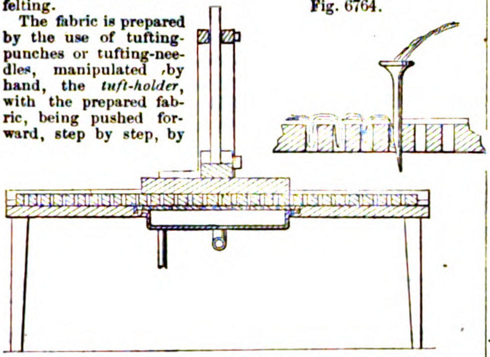
Tuft′ed Fab′ric. A fabric in which tufts are set, as in the old form of Turkish and Persian carpets, in which tufts were set in on the warp, and then locked in by the shooting of the weft and the crossing of the warps.

Fig. 6764 shows a mode of making tufted fabric on a felted backing. The tufts of yarn or rovings are introduced through the cloth by means of a suitable needle and a perforated board or *tuft-holder*. The object of the subsequent felting is to prevent the tufts from being pulled out of the fabric; hence either the back of the fabric, or the tufts, or both, must have sufficient

felting properties to unite with the bat or sliver, or with each other by the process of felting.

The fabric is prepared by the use of tufting-punches or tufting-needles, manipulated by hand, the *tuft-holder*, with the prepared fabric, being pushed forward, step by step, by hand, to the *jigger-board* and *steam-table* where the *hardening* is effected.

Fig. 6764.

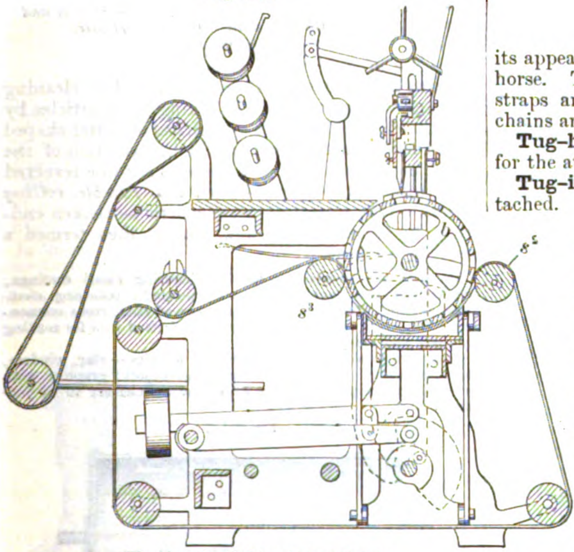


Felted Tufted Fabric.

Tuft'ed-fab'ric Ma-chine'.

Fig. 6765 is Eickemeyer's machine for setting in the tufts and felting them into and hardening the body in a continuous operation, in imitation of a *terry* fabric, as velvet; or a larger pile to imitate plush, shaggy goods, or fur. The machine is supplied with material for the tufts, whether bats, yarns, or rovings, and material for the body of the fabric, whether bats or cloth, and from them prepares a continuous tufted felted fabric. The *bat* is received from a carding-machine. The tuft-holder is a hollow cylinder *b*, with holes on its periphery which receive the tufts when the gang of tuft-punches descend. To give a diagonal position to the tufts, so that each may be opposite to the vacancies in the previous row, the gang of punches have, besides their up-and-down motion to punch the bats into

Fig. 6765.



Machine for Tufting Felted Fabrics.

the holes, a side motion across the machine alternately in opposite directions, to correspond with the positions of the tuft-holes. The tuft-punches move the tuft-holder on its axis, step by step, one row at a time, while within the tuft-holes, then withdraw from the tuft-holes, and move back over the next row of tuft-holes to be filled. A presser-plate covers the holes just filled, and a plaiter punches the bat forward over the next row of holes to make the next row of tufts. A *jigger* or rubbing-plate, perforated with fine holes for steam, is applied to the under side of the tuft-holder when in action for felting, which takes place periodically as the tuft-punches are withdrawn, and lasts till they are about to again descend. The bat which forms the back of the fabric is received from a carding-machine on the feeding-apron, which extends over the drums s^2, s^3, etc., passing between the concave jiggering-surface of the steam-box and the tuft-holder, from the rear to the front of the machine; thence downward, and underneath the machine, to the rear.

This feeding-band is also a hardening cloth, and is made of linen or canvas. The fabric as it comes from the machine is wound on a roller.

Tuft-mock'a-do. (*Fabric.*) A mixed stuff of silk and woolen, in imitation of tufted taffeta or velvet.

Tuft-taf'fe-ta. Formerly, a fabric with silk tufts.

Tug. 1. (*Harness.*) A trace by which the draft animal pulls the load.

At the end of the trace is a tug-hook, or cock-eye; the former for a *put-chain*, the latter for attachment to the *tug-pin* on the end of the *single-tree*.

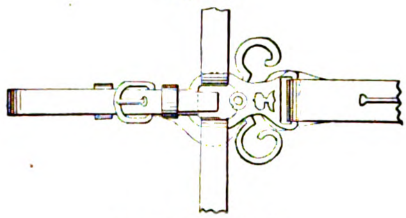
2. (*Nautical.*) A steam-vessel used for towing a sailing or disabled vessel, or a hull before receiving its rigging or steam equipment.

3. (*Mining.*) The iron hoop of a *corve* to which the tackle is attached.

4. (*Vehicle.*) A kind of timber carriage.

Tug-car'ri-er. (*Harness.*) An attachment to the back strap of wagon harness. The figure shows its appearance as viewed from above the back of the horse. The ring in the back strap to which the hip straps are attached has side hooks on which the chains are hung when unhitched.

Fig. 6766.



Tug and Chain Carrier.

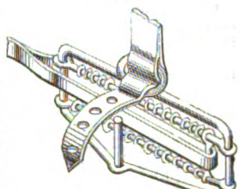
Tug-hook. (*Harness.*) A hook on the hame for the attachment of the trace.

Tug-ir'on. The hook to which a trace is attached.

Tug-slide. (*Harness.*) A metallic frame in which the tug is adjusted as to length. It is a substitute for a buckle.

Tug-spring. (*Harness.*) A frame with spring suspended from the back and having points of attachment for the tug and hold-back straps to prevent too great a jerk on the animal in starting and stopping.

Fig. 6767.



Tug-Spring.

Tu'la-met'al. An alloy of gold, silver, and lead.

Tulle. (*Fabric.*) A thin silk lace with open meshes, woven in narrow strips.

Tum'bler. 1. (*Founding.*) A vertically rotating case for cleaning castings placed within it.

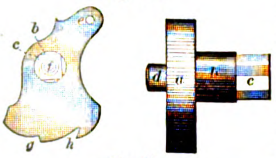
2. (*Locksmithing.*) A latch engaging within a notch in a lock bolt, or otherwise opposing its motion until it is lifted or arranged by the key, so as to remove the obstacle. See LOCK.

3. (*Fire-arms.*) The piece in the interior of a

gun-lock by which the main-spring acts on the hammer, causing it to fall and explode the cap.

It is connected with the main-spring by a *swivel*, which transmits the full pressure of the spring to the swivel arm. The tumbler has a partial revolution on pivots (the *arbor* being one), the extreme limits of its motion being from full cock to the striking of the hammer on the cap.

Fig. 6768.



Tumbler.
a, body; b, arbor; c, square; d, pivot; e, swivel-arm and pin-hole; f, tumbler-screw hole; g, cock-notch; h, half-cock notch.

The hammer is carried on the *square* of the tumbler; this is the outwardly projecting end of the arbor. It operates as follows: when the hammer is drawn back, the tumbler rotates in the direction *g h*; the *sear*, which is kept constantly pressed against the tumbler by the sear-spring, falls, first, into the notch *h*, and by a farther rotation into the cock-notch *g*; here it is held by the spring until a pressure on the trigger releases the nose of the sear from the notch and permits the tumbler to follow the movement of rotation impressed on it by the main-spring, which it does with great rapidity.

Fig. 6769.

Tumbler-Brush.

4. (*Nautical.*) One of the movable pins with which the *cathead-stopper* and *shank-painter* are respectively engaged. By the coincident movement of the pins, the ends of the anchor, which are suspended from the *cathead* and *fish-davit* respectively, are simultaneously freed.

5. (*Domestic.*) A drinking-glass with a flat base, no stem, and straight, somewhat flaring sides. It originally had a round or pointed base, so that it could not stand alone, and one must empty it before putting it down.

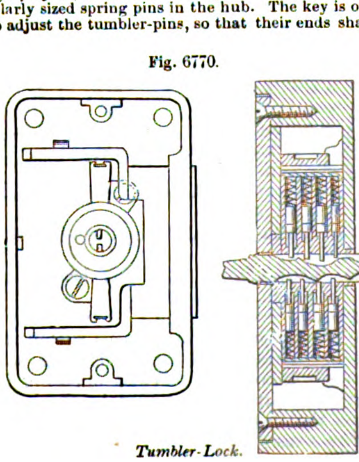
6. (*Vehicle.*) A kind of cart. A *tumbrel*.

Tum'bler-brush. The cylindrical block is axially perforated, and the holes for the bristles lead at an incline into the central bore. The handle and cap-piece are secured to the block by their cylindrical ends entering the bore of the block.

Tum'bler-lock. A lock which has latches or disks which require to be arranged in specific relation to enable the bolt to be shot. See LOCK; PERMUTATION-LOCK; and others cited in the list under LOCK, page 1342.

In the figure, the bolt is actuated by an eccentric which is connected to a cylinder having a keyhole into which the tumbler-keys project; these slide radially in the cylinder and abut on similarly sized spring pins in the hub. The key is of proper form to adjust the tumbler-pins, so that their ends shall coincide with the periphery of the cylinder and allow its rotation in the hub.

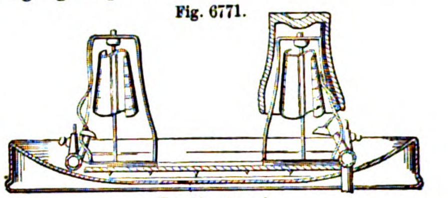
Fig. 6770.



Tumbler-Lock.

Tum'bler-punch. (*Fire-arms.*) A small two-bladed punch used for pushing the arbor of the tumbler, the band-springs, etc., from their seats, in taking a gun apart.

Fig. 6771.



Tumbler-Stand.

Tum'bler-stand. A tray with tripods, to hold tumblers reversed over a jet which washes them. The illustration shows one frame empty and one with the tumbler in position.

Fig. 6772.

Tumbler Washer and Holder.

Tum'bler-wash'er. A device (*a*) used in connection with soda-fountains or in barrooms, to wash tumblers. As shown, it has a jet for the inside of each tumbler and a sprinkler for the outsides.

b is a tumbler-holder, to avoid soiling the gloves in drinking soda-water or beer.

Tum'bling-bay. (*Hydraulics.*) A *weir* or overflow-dam.

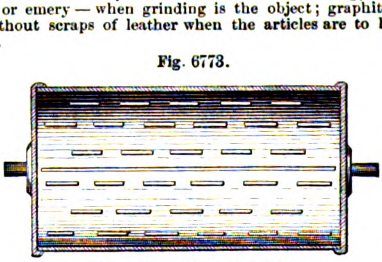
Tum'bling-bob. A counterpoise weight on an arm to cause it to react by gravity when the lifting lever is withdrawn.

Tum'bling-box. A contrivance for cleaning castings, and grinding or polishing small articles by attrition. It consists of a cylindrical or barrel-shaped vessel having a side door for the introduction of the work, and is mounted on an axis so as to be revolved by a winch or pulley. Called also *rumble*, *rolling barrel*. It is sometimes arranged to be shaken endways by means of a crank, and is then termed a *shaking*-machine.

Its uses are numerous: as, for cleansing small castings; brightening iron tacks previous to tinning; polishing steel-pens, needles, and pins, bone buttons, lead shot, rusty cannon-balls, etc.; and for dissolving gums in spirits of wine for making lacquers and varnishes.

Some material is put in with the articles — slag, cinders, sand, or emery — when grinding is the object; graphite with or without scraps of leather when the articles are to be polished.

Fig. 6773.



Founders' Cleansing-Mill.

The use of the tumbling-box is increasing; the tines of hay-forks, until late polished by an emery belt, are now finished in large cast-iron tumblers.

In Fig. 6773, the barrel is formed of perforated metallic staves secured between two flanged heads, and overlapping each other at the joints.

Tum'bling-home. (*Shipbuilding.*) Said of the sides of a vessel when they lean in. When vertical,

they are said to be *wall-sided;* when they lean out, *flaring.*

Tum'bling-shaft. (*Machinery.*) A cam-shaft; employed in stamping-mills, thrashing-machines, etc.

Tum'brel. A contrivance, formerly used for ducking scolding women, otherwise known as a ducking-stool for refractory shrews. *Tempora mutantur, et nos mutamur in illis.*

It was a chair attached to a long pole; the vixen was tied in the chair, swung over the pond, and immersed till she was supposed to be (temporarily) cured.

Tum'bril. 1. (*Ordnance.*) A covered cart for containing ammunition and tools for mining and sapping.

2. (*Vehicle.*) A manure-cart.

3. (*Husbandry.*) A large willow cage or rack for sheep feed.

Tum'mals. (*Mining.*) A great quantity. A heap.

Tum'pline. A head strap by which a porter steadies a pack carried on the shoulders and back.

Tun. The fermenting vat of a brewery.

Tun'bridge-ware. A kind of small cabinet work in which thin veneers of fancy woods are cut into small pieces, and glued upon a foundation, forming a mosaic, generally of geometrical figures.

Tung'sten. Equivalent, 94; symbol, W.; specific gravity, 17.6; fusible under the blow-pipe. A hard, brittle, white metal. Tungstate of lead is used as a pigment. See METALS.

Tun'ing-fork. (*Music.*) *a.* A pronged piece of steel adjusted to emit a particular tone when struck.

The pitch varies with the length, width, and thickness of the prongs, and may be made to correspond with any note of the gamut. In practice, that giving the sound of the middle or tenor C is employed: this is usually assumed to correspond to 512 single vibrations per second, but modern custom has adopted a higher pitch. In France 522, and in England and Germany 528, vibrations per second are taken as the standard for C. See PITCH; TELEPHONE; PIPE; etc.

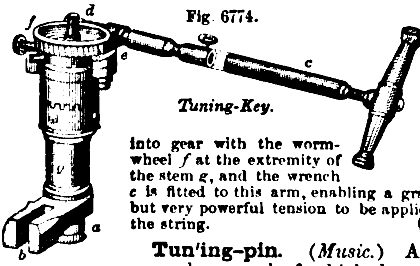
b. An instrument for turning the pins and tightening the wires of piano-fortes.

Tun'ing-ham'mer. A tuning instrument having two heads on the handle, and so resembling a hammer.

Tun'ing-key. A kind of wrench employed for imparting the proper tension to the strings of piano-fortes, etc.

In Sherwood's (Fig. 6774), the socket *a* is adapted for being placed over the pin of a string to be tuned while the fork *b* is placed over the adjacent pin. The wrench *c* is first applied to the stem *d*, and turned until the string is brought nearly to the proper pitch; the arm *e*, which carries a worm, is then thrown into gear with the worm-wheel *f* at the extremity of the stem *g*, and the wrench *c* is fitted to this arm, enabling a gradual but very powerful tension to be applied to the string.

Fig. 6774.



Tuning-Key.

Tun'ing-pin. (*Music.*) A pin around one end of which the string or wire is wound, and by turning which it is tuned.

Tun'nel. 1. (*Engineering.*) A horizontal or slightly inclined gallery beneath the surface of the ground; generally used for an aqueduct or for the passage of a roadway or canal.

Very extensive works of this kind were executed by the ancients; especially by the Romans, as a part of their magnificent structures for supplying cities with water.

One tunnel of antiquity is spoken of by Herodotus with great praise. He describes it as executed by Eupalinus, son of Naustrophus, a Megarian, for the city of Samos, on the island of the same name. "A tunnel under a hill 150 fathoms high, carried entirely through the base of the hill, with a mouth at either end. The length of the cutting is 7 furlongs; the hight and width are each 8 feet. Along the whole course there is a second cutting 20 cubits deep and 3 feet broad, whereby water is brought through pipes from an abundant source into the city." — Book III. chap. 60.

Strabo mentions a tunnel at Cumæ connecting that town with Avernus, made by Cocceius during the Augustan age. A more ancient and longer one had been made long previously between Dicæarchia (Puteoli) and Neapolis (Naples). It is yet open, and is known as the Grotta di Pausilipo. It is referred to by Seneca.

The lakes Trasimene, Albano, Nemi, and Fucino in Italy were all drained by tunnels (*emissaria*); the last mentioned was devised by Julius Cæsar and executed by Claudius A. D. 52. It is still nearly perfect. The circumference of the lake drained was 30 miles. The length of this tunnel is about 3 miles, discharging into the river Liris (Garigliano). 30,000 men were employed; time occupied, 11 years. A large number of shafts were sunk to allow a greater number of men to work and to facilitate the removal of detritus. It is from 20 to 30 feet high and 28 to 30 feet wide.

That which drained the waters of Lake Albano was cut through lava, about 6 feet high, 3½ feet broad, and 6,000 feet long. 50 shafts were sunk, and the work was prosecuted at many points, being completed in one year, 398 B. C. A water tower was erected at each end, and these, together with the arched conduit, are in good condition yet.

The stone mountain of Gibraltar is tunneled into galleries, from whose embrasures peep the grim cannon which defend the bay and the neutral ground. Quite a change since Gibraltar, *Gebel el Tarik*, Tarik's Mountain, was the scene of the landing of this lieutenant of the Emir Musa, April, A. D. 711. Musa the Saracen conquered Spain. The galleries in the rock are nearly 3 miles long, large enough to admit a carriage, and are pierced for cannon at every 12 yards. One thousand cannon are thus mounted.

A tunnel under the Thames, to connect Gravesend with the Essex side, was projected by Ralph Dodd, Esq., in 1798. In 1804, Mr. Chapman proposed to tunnel below the river from Rotherhithe to the north bank. In 1807 the work was actually commenced by sinking a shaft about 300 feet from the river, but was abandoned, on account of the influx of sand and water.

In 1807, the celebrated Cornish engineer Trevethick was placed in charge of the work, and, with great labor, succeeded in carrying a drift 5 feet 2 inches high, 2 feet 6 inches wide at top, and 3 feet wide at bottom, for a distance of 1,046 feet under the bed of the river, or within 33 yards of the distance required. Considering his skill or veracity impugned in respect of the direction followed, he made an opening in the top, to test the depth below the water, which dashed in and drove out the working part, nearly drowning Trevethick.

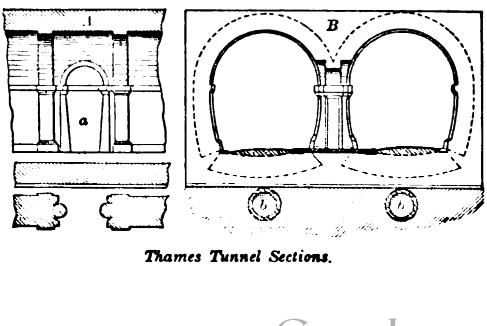
In 1824, the elder Brunel, Mark Isambert, devised plans for carrying out the work, and, a company having been formed for the purpose, it was commenced on the 1st of January, 1826, and by the 27th of April, 1827, 540 feet of the tunnel had been completed, when an irruption of water occurred. The leaks were stopped, the water pumped out, and the work advanced 50 feet farther, when a second irruption caused its total abandonment.

On this occasion, Brunel alone, of seven persons in the tunnel, escaped drowning.

In the progress of the work, Brunel made use of a sectional shield, designed by himself, to prevent the earth being crushed in by the pressure of the water above, and facilitate the excavation.

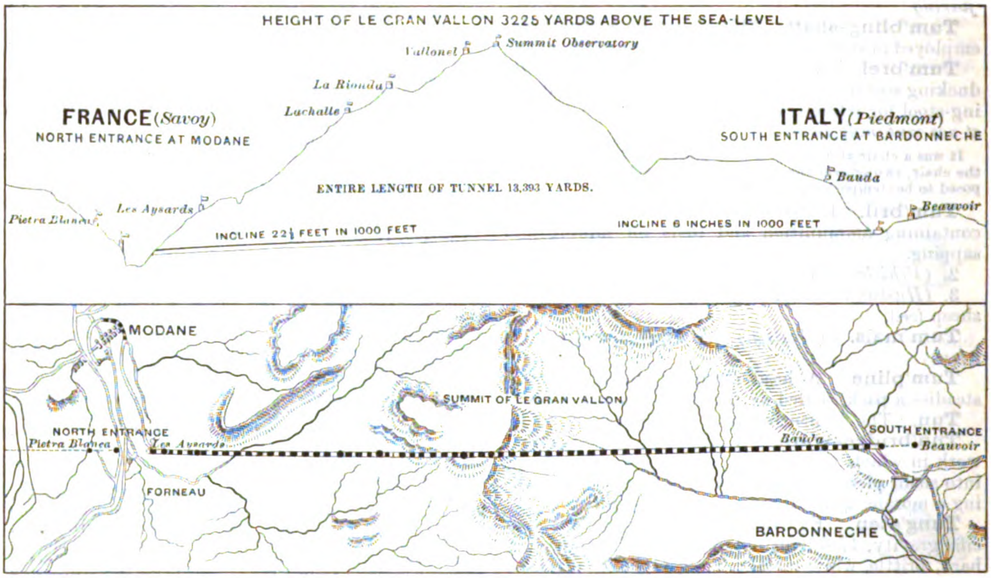
The tunnel was finally opened for foot-passengers, 1843. The length is 1,300 feet; width, 35 feet; hight, 20 feet; clear width

Fig. 6775.



Thames Tunnel Sections.

Fig. 6776.



Mont Cenis Tunnel (*Section and Plan*).

of each archway, 14 feet; thickness of earth between the crown of the tunnel and the bed of the river, about 15 feet.

A is a longitudinal, and *B* a transverse section of this tunnel; *a*, one of the transverse arches connecting the two roadways; *b b*, drains.

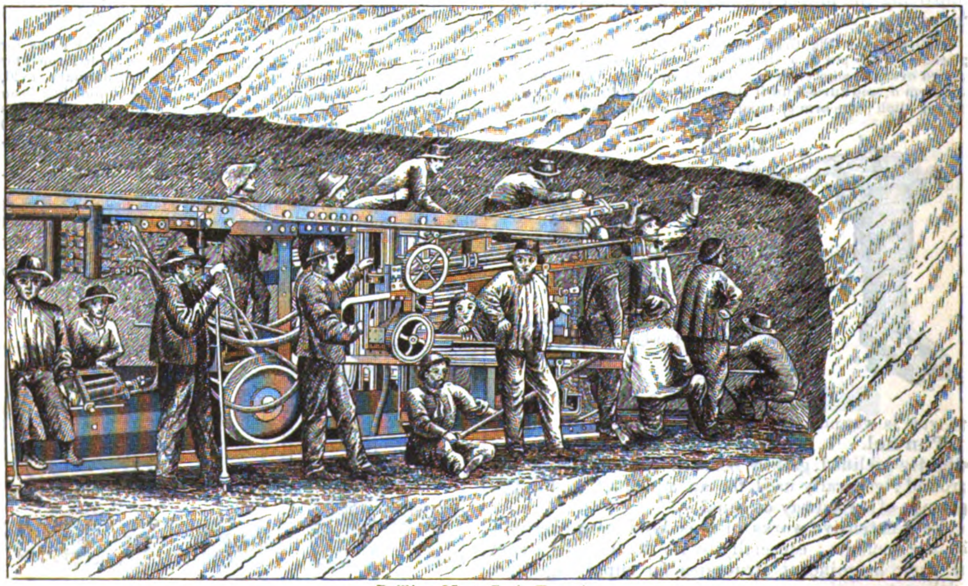
For submarine tunneling, see SUBMARINE EXCAVATION, etc.

The greatest completed tunnel of ancient or modern times is that generally known as the Mont Cenis, though it is, in fact, 15 miles southwest of that mountain.

This was first proposed by a Piedmontese road-contractor, Joseph Medail of Bardonneche. In 1842, a geological survey was made, resulting in the choice of the line at last actually taken. The work was actually begun in August, 1857, under the superintendence of Someiller, assisted by Grandis and Grattoni, the Piedmontese government having granted a subsidy of 20,000,000 of francs toward carrying it into effect. In 1855, Mr. Bartlett, an English engineer, had patented a rock-drilling apparatus to be operated by air compressed by means of a steam-engine. The idea of using water, instead of an engine, to compress the air, occurred to the Piedmontese engineers, and was adopted. In the use of a compressed air-drill, with water, consists the great novelty in the execution of the work.

Fig. 6776 is a section through Le Gran Vallon, and a plan, showing the course of the tunnel. The hight of the mountain is 9,600 feet, and the highest point of the mass perpendicularly over the tunnel is 5,307 feet. The geological composition of the mass, along the tunnel line, is, first, 2,350 yards of schist, then 396 yards of quartz, 2,954 yards of compact limestone, and the remainder, on the Italian side, is all schist. The dimensions of the excavation are: 25 feet 3½

Fig. 6777.



Drilling Mont Cenis Tunnel.

inches wide, at the base; 26 feet $2\frac{3}{4}$ inches wide, at the broadest part, with a semicircular top; 24 feet 7 inches high, at the Modane end, and $11\frac{3}{4}$ inches higher at the Bardonneche end. The roof and walls are cased with masonry.

From the north entrance, near Modane, the tunnel rises with an average grade of 1 in 45, or 117 feet 4 inches to the mile, to a point, just midway, 429 feet above the hight of the Savoy entrance. From this point to the Italian end, the inclination is but about 1 in 2,000, merely sufficient for drainage.

The exact length is $7\frac{1}{2}$ miles 242 yards, or $4\frac{1}{2}$ miles longer than the tunnel at Lanerthe, on the Paris, Lyons, and Mediterranean road, the longest ever previously constructed.

The excavation was effected simultaneously from both ends by boring and then blasting the face of the rock.

Air at the Italian end was compressed to six atmospheres, by means of hydraulic pressure obtained from the mountain streams. See PLATE X, opposite page 603.

The same apparatus supplied fresh air for ventilation, which was also assisted by exhaust apparatus at each end of the tunnel.

Fig. 6777 illustrates the operation of drilling. Seven drills pierced a series of holes in the rock about a yard in depth, and from 1 to 3 inches in diameter. Only the smaller holes were filled with nitro-glycerine, the larger being merely for decreasing the resistance of the rock. These took from five to seven hours to perforate, according to the hardness of the material. Previous to being charged, they were dried by blasts of air. The mines were successively exploded, beginning with the central ones, and the fragments removed by trucks. The progress in 24 hours was from 2 to 3 yards, depending on the nature of the rock.

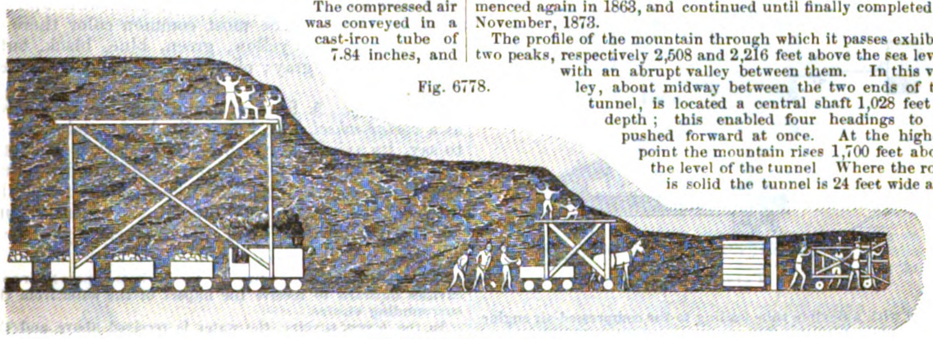
The compressed air was conveyed in a cast-iron tube of 7.84 inches, and made in sections of 6 to 8 feet long to the machine. The tube was provided with safety-valves, and whenever the pressure exceeded six atmospheres, the air escaped, and was conveyed by other tubes to the place of operation, for supplying the workmen with fresh air. The quantity of water consumed was 35.3 cubic feet per second, the fall being 144 feet. The ceremonial opening of the work took place September 17, 1871.

The length of the St. Gothard tunnel, now in progress, will be 48,651 feet, or 9 miles 377 yards. The altitude of the northern entrance, at Goeschenen, will be 3,703 feet above the level of the sea, and that of the southern entrance 3,850 feet. The summit in the tunnel will be 3,873 feet above the sea level, in order to give drainage in each direction; 7 in 1,000 to Goeschenen; and 1 in 1,000 to Airolo. 10 feet daily at each end is the usual rate of progress. The rock is solid at the northern portion, but requires lining and arching at the southern. That already traversed is for the most part mica gneiss and mica schist. The estimated cost is $ 10,000,000. The work is to be finished within eight years. The boring-machines used are those of Dubois and Francois, the general mode of working being similar to that at Mont Cenis, and the daily progress made appears to be rather more than double. It is feared now (1876) that this work will be abandoned.

The Hoosac tunnel, through the mountain of that name, on the railway between Troy, N. Y., and Greenfield, Mass., having a length of $4\frac{3}{4}$ miles, is the longest tunnel in the United States. It is cut through strata of mica slate of varying hardness, and was originally commenced about 1856. In 1859, when about 1,200 feet had been excavated, the work was suspended, recommenced in the following year, and again suspended, recommenced again in 1863, and continued until finally completed in November, 1873.

The profile of the mountain through which it passes exhibits two peaks, respectively 2,508 and 2,216 feet above the sea level, with an abrupt valley between them. In this valley, about midway between the two ends of the tunnel, is located a central shaft 1,028 feet in depth; this enabled four headings to be pushed forward at once. At the highest point the mountain rises 1,700 feet above the level of the tunnel Where the rock is solid the tunnel is 24 feet wide and 20 feet high, but where it is decomposed to such an extent as to render arching with masonry necessary, the dimensions are somewhat larger.

Fig. 6778.



Heading; Hoosac Tunnel.

Previous to 1866, the drilling was done by hand, but since that period compressed-air drills of the Burleigh pattern have been employed. The general method of operation was similar to that at the Mont Cenis tunnel, a number of the drills being carried upon a frame mounted on wheels. Gunpowder, nitro-glycerine, giant powder, and dynamite were at different times employed for blasting, and fired by a magneto-electric apparatus. The blasting was effected in front of a movable bulkhead which was advanced as the work progressed, and the subsequent enlargement and finishing of the walls was for a considerable period done by hand, gangs of men working on scaffolds of various hights. This method was subsequently superseded by the employment of a number of atmospheric drills arranged upon a large carrier of tubular iron. The air for ventilation was in part furnished by the drills, and in part by a special ventilating pipe 8 inches in diameter, and delivering 2,000 cubic feet per minute.

Though railway tunnels are quite numerous in the United States, few are of great length, being all far exceeded by the Hoosac.

The Sand Patch tunnel on the Pittsburgh and Connelsville railway is 4,750 feet long.

The "Sutro" tunnel, so called from its projector, M. Adolph Sutro, is intended to cut the Comstock Lode 2,000 feet below its highest point, for the purpose of draining and ventilating the mines, and transporting ores therefrom to a point upon the Carson River, where their concentration may be cheaply and conveniently accomplished.

The estimated cost, including a large margin for unforeseen contingencies, is $ 8,000,000, and its dimensions are as follows: —

Length of main tunnel	21,178 feet.
Aggregate length of branches	17,688 feet.
Aggregate depth of shafts	4,220 feet.
Total	43,086 feet.

The section of the tunnel is 12 feet square, and is intended to afford passages for two lines of cars, each car having a capacity of 5 tons. A drain beneath the roadway of the cars will carry off all the water from the different mines.

A tunnel under the river Indus at Attock is 7,300 feet long; and it has been proposed to construct a submarine tunnel 4,800 yards in length under the Mersey at Liverpool. This, however, does not compare in point of magnitude with the schemes for uniting Scotland and Ireland by tunneling St. George's Channel, or the venturous plan for uniting England and France by means of a tunnel. The soundings and borings for this work have already been made (1876).

Great accuracy has been attained in the alignment of tunnels so as to secure accurate meeting when working from both ends, or from several additional intermediate points. In making the Musconetcong tunnel, 5,000 feet long, the estimated length deduced from chaining and leveling over a mountain 450 above grade, varied from the actual length $6\,{}^{4}/_{10}''$; the center lines of the headings varied ${}^{1}/_{300}''$.

The Hoosac tunnel, 25,031 feet long, with an ascending grade of $26\,{}^{4}/_{10}'$ to the mile, had an error of alignment when the headings met of ${}^{9}/_{16}''$, and of level $1\,{}^{1}/_{2}''$.

The Mont Cenis tunnel, 30,326 feet long, level on Italian side 435 feet above the French entrance, and the level in the middle 10 feet above the Italian entrance, the error in alignment was 18″, and in level 24″; the French heading above the Italian.

The cost of single-track tunnels in Pennsylvania was given as follows to the writer: —

Driving and timbering; soft rock, $ 3 to $ $4\frac{1}{2}$ per cubic yard. Usual estimate, 14 cubic yards per lineal foot; the cutting out being wide enough to timber in. Price up to $ 6 for hard rock.

The estimated cost for the proposed Jones's-fall tunnel, Baltimore, is $ 2 per cubic yard, $ 145 per lineal foot.

The cost of the Mont Cenis tunnel was $ 300 per lineal foot.

The Kilsby double track in England, through difficult quicksands, was $ 262 per lineal foot.

Terre Noire, on the Paris, Lyons, and Mediterranean Railway, cost $ 50 per foot.

The Haeunstein tunnel, between Basle and Berne, Switzerland, cost $ 133 per lineal foot.

The Hoosac, through mica slate and quartz, with a working shaft 1,000 feet in depth, $ 300 per lineal foot.

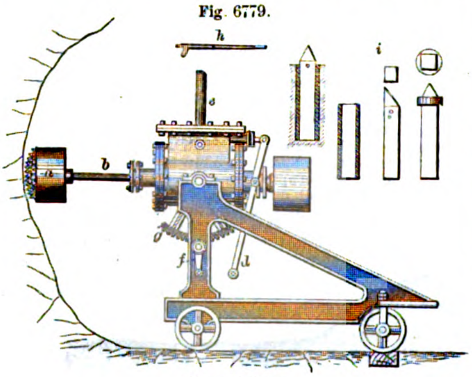
The entire cost of the Fourth Avenue underground railway of New York, $ 6,395,070, $4\frac{1}{2}$ miles, $ 205 per lineal foot.

2. A level, adit, or drift in a mine.
3. A funnel.
4. A chimney or flue.

Tun'nel-bor'er. (*Civil Engineering.*) A ram, operated by compressed air, for making excavations through rock. It is said that the battering-ram was used by the ancient Romans in making tunnels where their aqueducts had to pass through rocky strata.

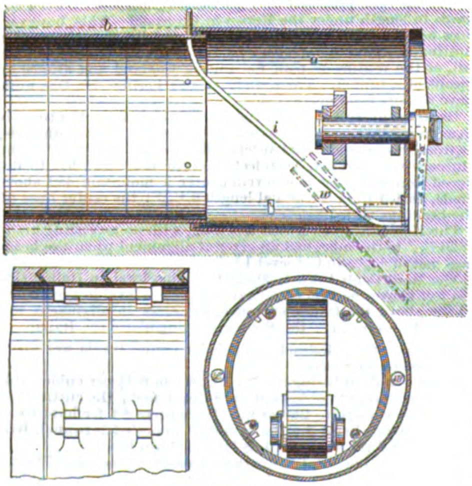
The present device was invented by Captain Penrice, an English engineer, and is reported to have been worked with satisfactory results in the quarries of Vaugirard, near Paris. *a* is the ram-head; its face is studded with removable cutters; it is fixed on the piston-rod *b*, which is provided with a heavy counterweight *c*, and is reciprocated by the admission of air alternately to either side of the piston through valves operated by the hand-lever *d*. The air is received through the pipe *e*, connected with a flexible tube leading to the compressed-air engine outside of the tunnel. The apparatus is mounted on trunnions upon a carriage, and the vertical angle of presentation of the ram is varied by means of the lever *f*, which carries a pinion gearing with the toothed sector *g*. *h* is a handspike, which is inserted in holes in the rims of the truck-wheels for the purpose of maneuvering the carriage. *i* shows the cutting devices.

Fig. 6779.



Tunnel-Borer.

Fig. 6780.



Dowd's Tunneling-Machine.

Fig. 6780 is Dowd's tunneling-machine for river-beds and treacherous ground. It has a cylindrical or elliptical shield *a* which is pushed against the heading of soil or silt, and iron sections are built up behind it as it advances, forming a tunnel *b*; a packing is introduced at the junction of the two. A scraper in advance of the tube is revolved by gearing and any suitable motor inside. Water is introduced through a tube in the axis of the scraper-arm. The mud is withdrawn from the face of the shield and ejected by pipe *i* above the tunnel casing. The tube *w* is applied when an obstructing stone or old anchor may be met with, to excavate a hole and sink the obstruction out of the way. One of the lower figures shows the mode of locking the tubes together, and the other the mode of running in a section.

Tun'nel-head. (*Mining.*) The top of a furnace, at which the materials are put in.

Tun'nel-kiln. (*Lime-burning.*) One in which lime is burnt by coal; as contradistinguished from a *flame*-kiln, in which wood is used.

Tun'nel-net. (*Fishing.*) One with a wide mouth and narrowing in its length.

Tun'nel-shaft. (*Engineering.*) One dug from the surface to meet a tunnel at a point between its ends.

Tur'ban. An Oriental head-dress made of a cloth wound around the head. The shapes, materials, size, and mode of wearing vary much in different countries. In India it is a strip of cloth usually from 9 to 12 inches wide and from 5 to 25 yards long, but has been known to be a yard wide and 60 yards in length. The most common color there is white; next red, yellow, green, blue, black, buff, shot colors, and gray; of cotton, silk, and of printed colors.

Tur'bine. A form of water-wheel; also known as a *vortex-wheel*. It is usually horizontal; that is to say, its axis is vertical. It has curved buckets. It was invented by Fourneyron in 1823, and the first one was made in 1827. In the original form, the discharge is *outward*, the water in the central chamber being directed upon the buckets by curved chutes.

In the *central-discharge* turbine, the buckets expose their concavities outward to receive the impact of the water from the surrounding chutes.

In the *Jonval* turbine, the water is received above and the discharge is downward, that is, parallel to the axis of rotation.

Some variations may be noticed.

The water is introduced at the outside and takes a curved course, discharging downward; or, being introduced from the center, is curved downward.

A turbine above delivers the water into a turbine below, rotating in a different direction.

Several turbines on one shaft receive water from a series of chutes, the number of the latter being proportioned to the quantity of water available, so that one or more wheels may be used, as expedient.

The axis may be horizontal, or, the axis being vertical, the water may be received from below. See WATER-WHEEL.

Turbines are divided into *high* and *low pressure*, the former being relatively small, revolving at a high rate and driven by elevated heads of water. The *low pressure* are relatively larger, contain a larger volume, and run at a slower rate. In the Black Forest of Baden, turbines are running with heads of 72 and 354 feet, and having diameters of 20 and 13 inches respectively. Low-pressure turbines are doing good duty with large volumes of water having only 9 inches head.

The theory of the turbine was investigated by Euler, whose theory was to construct a horizontal wheel to turn on a vertical axis, and be driven by water directed from a reservoir immediately above it upon floats of curved form fixed to its circumference. The curvature to be given to the floats was such, that at the top, where the impulse of the water was to be first received, they should be nearly vertical, while at the bottom they should approach the horizontal. Within the reservoir he proposed to place a set of curved plates to give direction to the issuing water, in which the construction above described should be reversed, the summits of the *directrices* being nearly vertical, and their lower edges nearly horizontal. By this arrangement it would happen that the water at its first discharge would strike the faces of the floats or pallets nearly in the plane of rotation; and before its final escape, it would transfer to the wheel nearly all its living force. No water from the reservoir was to be admitted to the wheel except that which was directed on the pallets.

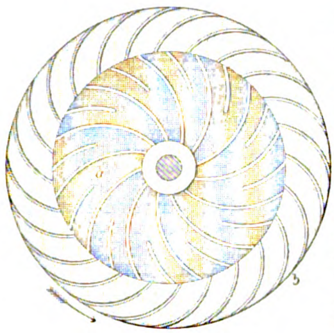
The turbine is also known as the *reaction-wheel* (see page 1887). The first exemplification of the force developed was in the Barker mill (see page 231).

Fig. 6781 represents the Fourneyron *outward*-flow wheel *b*, with the interior directrices *a*, which pro-

ject the water upon the floats of the wheel. The escape of the water is outward.

The illustration shows none of the surroundings, but is a simple plan view. The direction of motion is shown by the arrow; the water acts with a pressure in proportion to the hight of the fall. The efflux of the water is regulated by a hollow cylindrical sluice, to which a number of stops, acting simultaneously between the guide-curves, are fixed. With this short cylinder, or hoop, they are all raised or lowered together by means of screws communicating with a regulator or governor, so that the opening of the sluice and stops may be increased or diminished in proportion as the velocity of the wheel may require to be accelerated or retarded.

Fig. 6781.



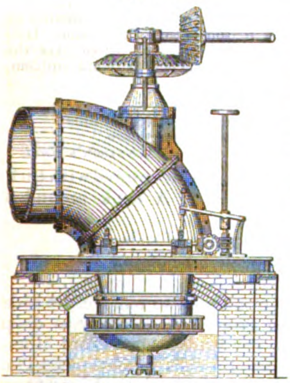
Fourneyron's Turbine.

Fig. 6782 is the Boyden outward-flow turbine on the Fourneyron principle.

Fig. 6783 has the reverse movement, or *inward* flow; the water entering at all points around the circumference of the wheel and escaping at the center and downward.

In the illustration, the parts are represented as detachable, so as to reach any stones or brush which may become jammed. The sections occupy grooves in the faces of the top and bottom plates, so as to be removable when the upper plate is lifted.

Fig. 6782.



Boyden's Outward-Flow Turbine.

Kindleberger's turbine is also of the *inward*-flow and center-vent variety. Its peculiarity is in the mode of applying water and graduating the area of the gated openings.

Each of the twelve gates has a strong brass spiral spring inclosed in a box, so that if foreign matters, such as sticks, should become jammed in the water-way, the gate closing that particular opening may be allowed to gape when the other buckets are closed by the rotation of the annular sleeve and set of levers, one of which latter rotates each bucket on its pintle. The sleeve is rotated by a segment rack and pinion, the latter being rotated by a shaft which passes upward to the floor above.

The obliquity of the bucket edges relatively to the gated openings is such that the water impinges constantly upon an equal area of bucket surface, the forward edge of each coming first into action.

The Jonval turbine has *downward* flow, the guides for the water being above.

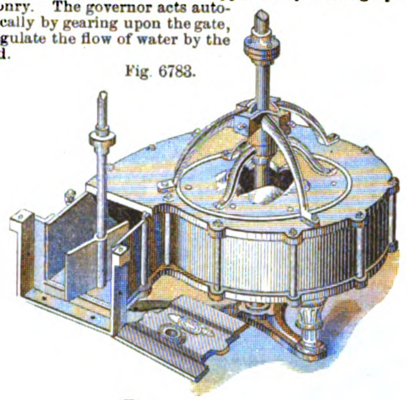
Fig. 6784 is the Watson turbine, on the Jonval principle, with its guides above and downwardly discharging wheel beneath. The draft-box is a flume or tube extending downward from the wheel-case, so as to obtain the benefit of a considerable fall, with the wheel at or near the top instead of at the foot of the fall.

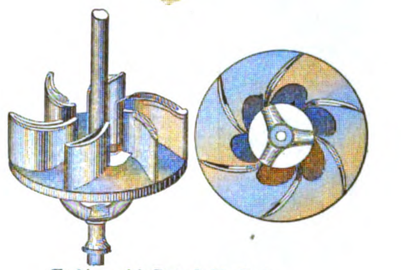
The draft-box is the invention of the Parkers.

The Swain wheel is a combination of the *inward* and *downward* flows.

Fig. 6785 is a sectional elevation of a 60-inch Swain turbine; an eighth-turn casing, connecting by means of a feed-pipe with the gate-hoisting apparatus, is supported by framing upon the masonry. The governor acts automatically by gearing upon the gate, to regulate the flow of water by the speed.

Fig. 6783.



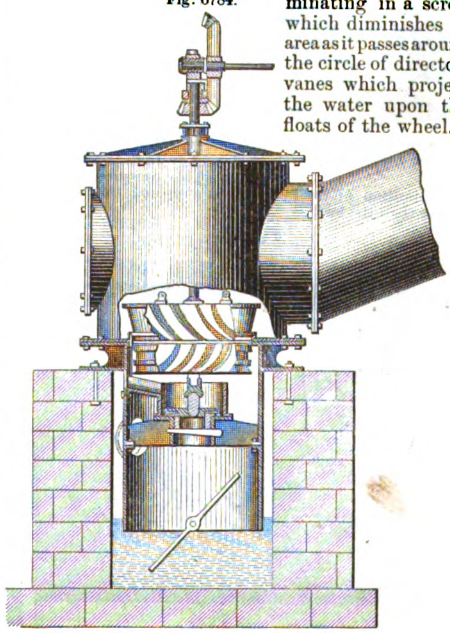


Turbine with Detachable Parts.

Fig. 6786 is the Chase turbine, receiving the water on its exterior, and discharging it downward. The wheel is shown with the case removed, and a small part of the lower rim, to show the lower ends of the buckets.

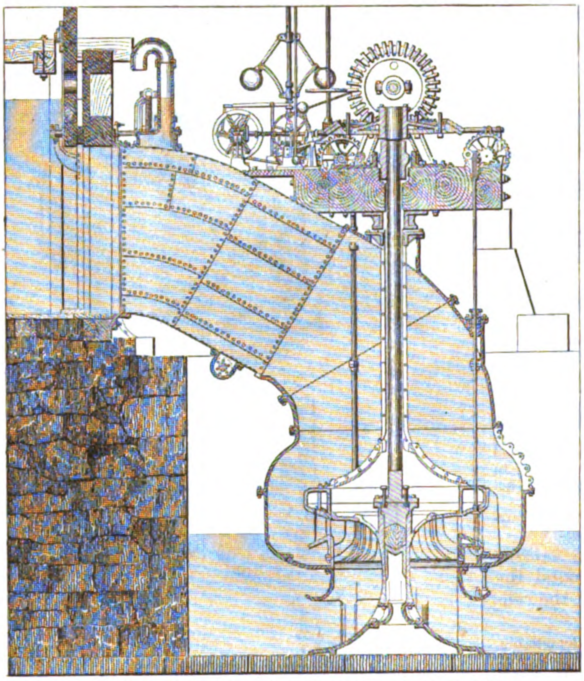
Figs. 6787, 6788, show another modification. The water surrounds the wheel, and is projected inward upon the double-winged floats, which discharge the water upward and downward, not centrally; the tube of supply terminating in a scroll which diminishes in area as it passes around the circle of director-vanes which project the water upon the floats of the wheel.

Fig. 6784.



Watson Wheel with Draft-Box.

Fig. 6785.



60-*Inch Swain Inward and Downward Flow Turbine.*

The wheel is inclosed in a cylindrical box, which is open beneath and above; the water enters upon the point — as it may be termed — of the double-winged float, and passes equally downward and upward, escaping in directions parallel to the axis.

Fig. 6786.

Chase Inward and Downward Flow Turbine.

The Leffel double turbine has two independent sets of buckets, one a vertical and the other a central discharge, each receiving its water from the same set of guides at the same time, and the water leaving each wheel independently. The two sets are cast together and to the same shaft (Fig. 6789).

The Girard *free turbine* is so called from its having a pressure of air in the casing into which the wheel discharges, to allow the wheel to run in air and avoid the friction of tail-water. This pressure is, of course, in diminution of head, but it is supposed that the gain is greater than the loss.

The reversal of the action of the turbine driving it by steam-power in the direction contrary to its natural motion as a water-wheel forms the centrifugal or centripetal pump, according to whether the turbine be on the *inward* or the *outward* flow principle. See CENTRIFUGAL PUMP; CENTRIPETAL PUMP; PROPELLER PUMP, Fig. 3977.

Ruthven's English patent of 1849, for a hydraulic ship propeller, acting by a steam-driven turbine-wheel, ejecting the water aft, was tried in 1866 on the "Water-Witch." It was termed the NAUTILUS PROPELLER (see page 1515). See also HYDRAULIC PROPELLER, pages 1149, 1150.

Several tables have been constructed to indicate the powers and rates of wheels of varying diameters under different heads.

They contain the sizes of the wheels in inches of diameter: the head in feet; the cubic feet of water per minute; the number of revolutions per minute; the horse-power.

Tur'bine-dyn'a-mom'e-ter. See TESTING-MACHINE, Fig. 6331.

Tur'bine-pump. A form of pump,— the turbine reversed. It is driven by power, and the floats, catching the water, force it up the chute.

a (Fig. 6791) is a turbine-case; *b* an air-cock for escape of water when the starting-pump is filling the case.

Tu-reen'. (Fr. *terrine.*) (*Domestic.*) A large deep table-dish for soup, etc.

Turf-cut'ter. A *paring-plow.*

Horses excavated in the turf, exposing the colored soil or subsoil, are found on steep hills in England, — as the *red horse* of Warwickshire, a memorial of Richard Neville, Earl of Warwick, whose castle of Fullbrook, 8 miles off, faced the hill. On this hill the earl killed his horse just before the battle of Towton. The white horse of Marlborough Downs, near Calne, shows the chalky subsoil, and is visible 12 miles distant. The dark mark forming the pupil of the eye is a mound of turf 5 feet across, measured by the author's umbrella. It is believed to be a memorial of the victory of Alfred over the Danes, A. D. 871. The horse is an ancient national emblem, being shown on British coins.

"And as now
Men weed the white horse on the Berkshire hills
To keep him bright and clean as heretofore."

TENNYSON'S *Enid.*

Turf-drain. (*Husbandry.*) One covered with turf.

Turf-hedge. (*Husbandry.*) A bank around a field, made of turfs or sods.

Turf-house. A hovel made of sods.

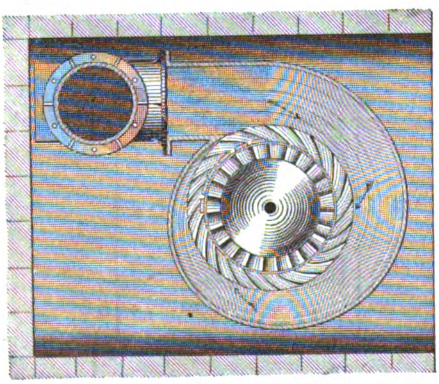
Turf'ing-ir'on. A spade for cutting sods.

Turf'ing-spade. A *turf-spade.*

Turf-plow. A plow adapted to remove the sods from the surface of the ground preparatory to deep plowing, or for destroying grubs, etc. That illustrated (Fig. 6792) is an English invention. The vertical cutter which precedes the share has an eccentric movement by which the depth of cut may be regulated.

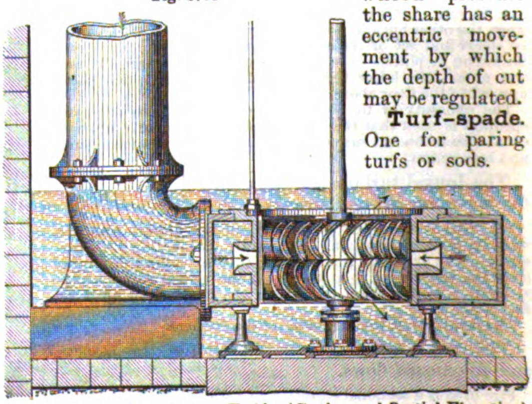
Turf-spade. One for paring turfs or sods.

Fig. 6787.



Schiele's Inward-Flow Turbine (Plan, showing Scroll).

Fig. 6788.

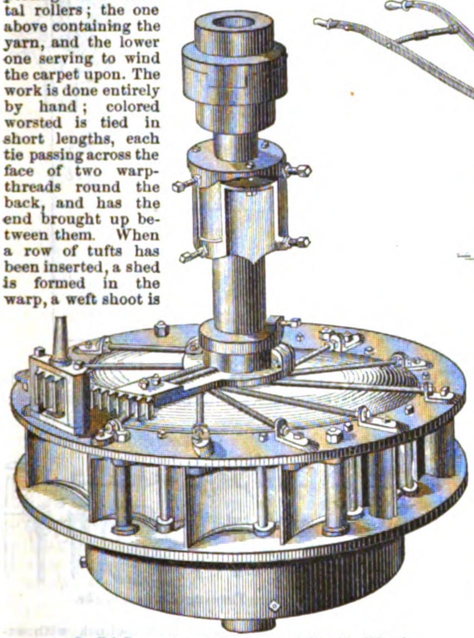


Schiele's Inward-Flow Turbine (Section and Partial Elevation).

Tur'key-car'pet. Turkey-carpet is formed of a chain and weft of strong linen yarn and tufts of worsted tied into the fabric in the course of manufacture.

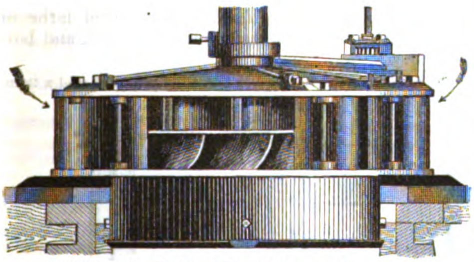
The loom of Eastern countries consists of two upright pieces fixed at a certain distance apart and supporting two horizontal rollers; the one above containing the yarn, and the lower one serving to wind the carpet upon. The work is done entirely by hand; colored worsted is tied in short lengths, each tie passing across the face of two warp-threads round the back, and has the end brought up between them. When a row of tufts has been inserted, a shed is formed in the warp, a weft shoot is passed across from right to left and returned, and is beaten down by hand beaters. This binds the whole together, and thickens the web.

Fig. 6789.



Leffel Inward and Downward Double Wheel.

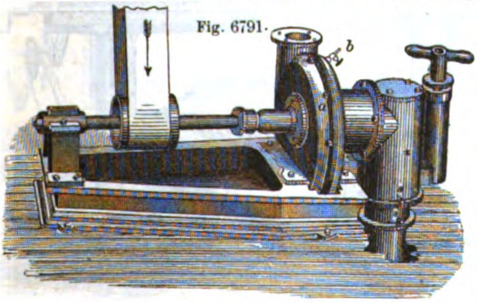
Fig. 6790.



Leffel Double Turbine Wheel (Case partly removed).

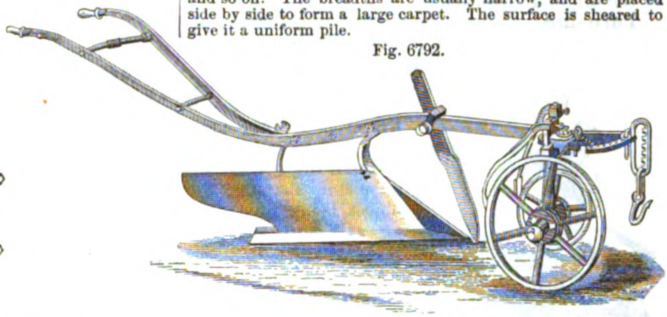
The Turkey-carpet loom of Europe is similar; the posts and beams are similarly arranged, the upper roller carrying strong linen yarn which passes down through heddles to the lower beam. The weaver is seated, as at the common loom, and having thrown a weft thread once or twice across, he fastens to every thread of the warp, by a peculiar twist, a small bunch of yarn, colored according to the pattern of the design before him. One row of tufts being inserted, he passes a linen weft through the shed, and drives it well against the web, locking the tufts in position. He then twists in another row of tufts, and so on. The breadths are usually narrow, and are placed side by side to form a large carpet. The surface is sheared to give it a uniform pile.

Fig. 6791.



Turbine-Pump.

Fig. 6792.



Turf-Plow.

Tur'key-red. The brilliant color known by this name is produced by a series of processes differing slightly at different places, but not essentially varying from the following French method: —

The cloth is steeped in an oily liquid; then allowed to ferment or sweat for several hours, and exposed to the heat in a hot closet for several hours longer; these processes are three times repeated, after which the cloth is steeped in an alkaline liquid, and then in a solution of alum and galls, next in lime-water, then boiled in a solution of madder, washed and dried, again steeped in alum and galls, and boiled with madder; after three successive boilings with soap, pearlash, and other ingredients, it is exposed to the air for some time, and finally boiled with water and bran and then dried.

Tur'key-stone. A fine quality of oil-stone from Turkey, — *novaculite.* Sir Thomas Gresham paved the old Royal Exchange, London, with Turkey-stone.

Turk's-head. (*Nautical.*) *a.* An ornamental knot, like a turban, worked on to the end of a rope.

b. A knot formed on a man-rope or other standing rope. It is formed by taking a round turn around the rope with a piece of log-line, crossing the bights on each side of the round turn, sticking one end under one, and the other under the other cross, as shown at *b*, and following the lead until it shows three parts all around, as at *c*.

Fig. 6793.

Turk's-Head.

Turn. (*Mining.*) A pit sunk in a drift.

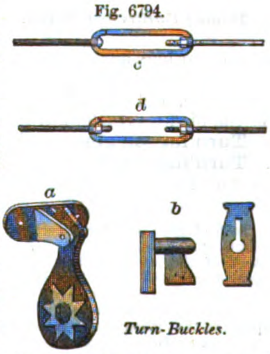
Turn-bench. A small portable lathe used upon a bench or desk by watch, model, and instrument makers.

Turn-bridge. A *swivel* or *swing* bridge. See SWING-BRIDGE; PIVOT-BRIDGE.

Turn-buck'le. 1. (*Hardware.*) A form of shutter-fastening having a gravitating catch *a* (Fig. 6794).

2. (*Ordnance.*) An analogous device used for securing the free ends of the implement-chains in a gun-carriage and the cover of the ammunition-chest (*b*).

Fig. 6794.



Turn-Buckles.

3. (*Nautical.*) A link used for setting up and

tightening the iron rods employed as stays for the smoke-stack of a steamer or for similar objects (*c d*).

Turn-cap. A turning chimney-top or cowl, presenting its mouth to leeward.

Turned House. (*Mining.*) A term used when a level, in following branches of ore, is turned out of the original direction.

Turn-file. A burnisher used in throwing up slight burs on the edges of the comb-maker's files, the teeth of which are originally made by the file and not by the chisel. Used by workers in horn, tortoise-shell, iron, and bone.

Fig. 6795.

Turning Pottery.

Turn'ing. 1. Wood or metal shaping, the object being rotated on an axis and the tool presented to it. See LATHE.

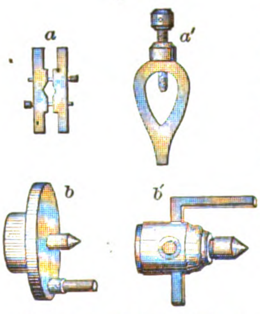
2. (*Pottery.*) A process for smoothing thrown pottery, consisting in turning off the exterior surface of the partially dried vessels, which are in what is called the *green* state. The moistened surface of the vessel adheres to the top of the rotating disk, while the turner removes a long ribbon of clay by means of a cutting tool. This being completed, and the green handle cemented on by *slip*, the vessel is cut loose by a wire and sent to be fired.

Some articles of small ware are *chucked* and turned in a manner closely analogous to that employed in the ordinary wood-lathe.

Turn'ing-bridge. A SWING-BRIDGE. See also PIVOT-BRIDGE.

Turn'ing-car'ri-er. (*Lathe.*) A device for holding metallic work while being turned in the foot-lathe. The work is clasped by the carriers *a a'*, which are caused to rotate by means of the drivers *b b'* fixed to the lathe-mandrel. See also DOG; DRIVER.

Fig. 6796.



Turning Carriers and Drivers.

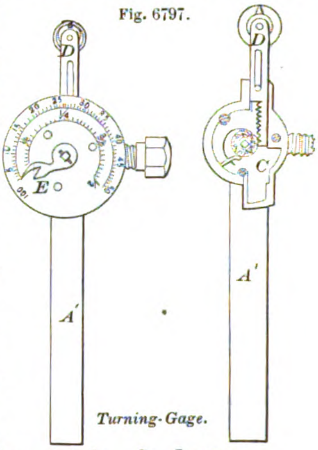
Turn'ing-chis'el. A chisel used by turners for finishing work after being roughed out by the gouge. There are several kinds. Some are rectangular, with an oblique whet, like a graver; others have a chisel edge, with two peculiarities: the chamfer for the edge is on both sides of the blade, and the edge is obliquely across the end of the blade. See TURNING-TOOLS.

Turn'ing-en'gine. A lathe.

Turn'ing-gage. An instrument to assist in setting over the tail-stock of the lathe, so that a given taper in a given length of work may be obtained.

To find the taper for a certain number of inches in length, the shank *A'* of the gage is inserted in the tool-stock of the lathe; a straight shaft-arbor with a uniform diameter is then adjusted upon the center points of the lathe; the tail-stock carrying the dead center is then set over either to or from the tool, as the case may require, so that when the tool is traversed back and forth upon the surface of the shaft the distance through which the taper is to be turned, by moving the slide-rest of the lathe, it shall force in the self-adjusting bar *D*, thereby rotating the shaft *C*, carrying the head with the pointers *E* sufficiently to indicate the exact taper required; this is done by approximation, the motion of the pointer through an inch, its multiple, or its fractions, on the dial through the given traverse of the slide-rest, giving the required position of the back center.

Fig. 6797.



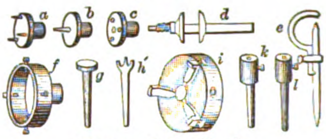
Turning-Gage.

Turn'ing-in. The process of *strapping* a *dead-eye;* that is, bending a rope tightly around it in the *score.*

Turn'ing-lathe. A machine for turning wood or other materials to symmetrical forms. A common form for wood is called a *pole-lathe.* See LATHE.

Turn'ing-lathe Chuck. Fig. 6798 shows various forms of lathe-chucks and other machine appliances.

Fig. 6798.



Turning-Lathe Chucks.

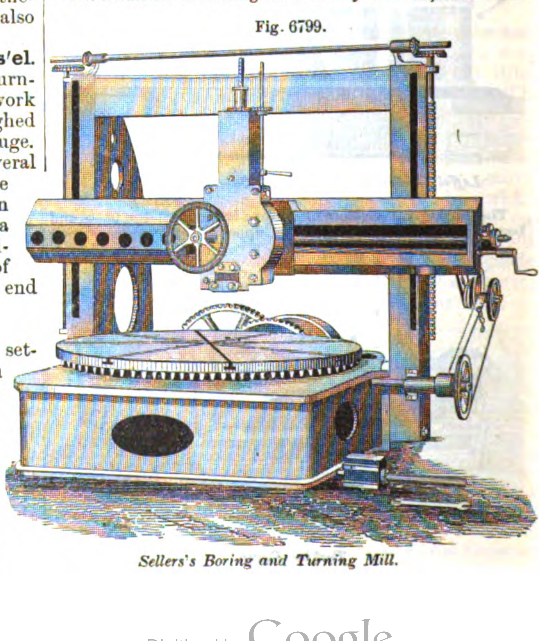
a, three-pronged chuck.
b, screw-chuck.
c, steel arbor, for holding circular saws, emery-wheels, grindstones, etc.
d, face-plate, for holding wooden chucks, polishing-wheels, etc.
e, Turner's sizer, or caliper.
f, shell-chuck.
g, drill-rest.
h, spur-chuck.
k, plain drill-chuck, with set-screw.
l, drill-chuck, with square hole for bits.

Turn'ing-ma-chine'. (*Boot-machine.*) One for turning boot-legs after the seams have been sewn and rolled.

Turn'ing-mill. A form of horizontal lathe or boring-mill. It has a compound slide-rest and boring-bar.

The holder for the boring-bar is readily removed, and a turn-

Fig. 6799.



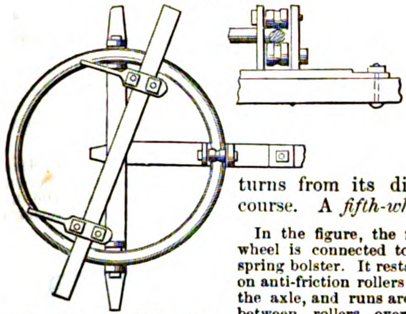
Sellers's Boring and Turning Mill.

ing-tool substituted; the feed is self-acting in all directions and at all angles; the boring-bar has a quick return motion; the face-plate rests in an angular bearing similar in shape to the slide of a planing-machine; an adjustable center step takes such amount of the vertical strain as may be desired. See also HORIZONTAL LATHE, Fig. 2562; also BORING-MACHINE.

Turn'ing-piece. A camber top-board used as a centering for a discharging arch.

Turn'ing-plate. A circular plate above the front axle, where the bed moves upon it as the carriage turns from its direct course. A *fifth-wheel.*

Fig. 6800



Turning-Plate, or Fifth-Wheel.

In the figure, the fifth-wheel is connected to the spring bolster. It rests upon anti-friction rollers over the axle, and runs around between rollers over the central reach.

Turn'ing-saw. A saw having a thin blade stretched in a frame, and capable of making a curved kerf. Used in sawing scroll-work, chair backs, etc. Otherwise known as a SWEEP-SAW, BOW-SAW, FRAME-SAW, or SCROLL-SAW (which see).

Turn'ing-tools. The cutting implements used by turners vary considerably according to the nature of the material to be operated on and the character of the work, whether it is to be plain or beaded, or employed on the exterior or interior of the work.

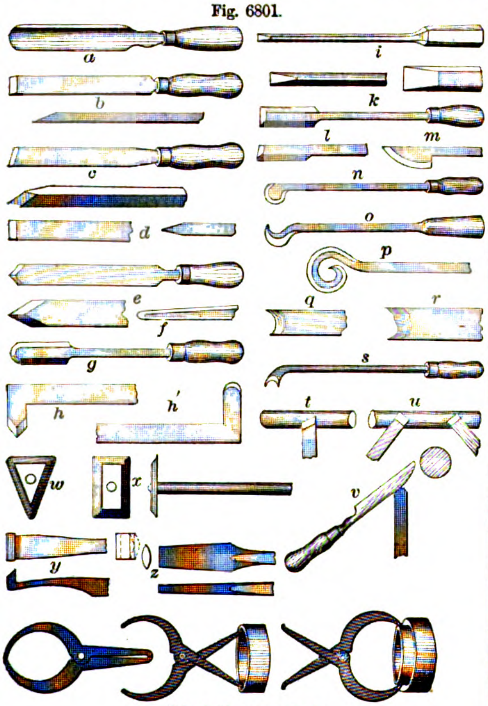
For turning the softer woods, chisels and gouges having cutting angles of 25° to 30° are employed; for harder woods this angle is made as much as 40°. The edge of the gouge is ground elliptical, and its central portion is that principally used: it is employed for getting the first rough cylindrical surface on the work, the convex side being turned downward, and also for turning out hollows. Hook tools *o p* are also used for surfacing. For finishing, chisels generally having an oblique edge, doubly beveled, are employed.

Square-edged chisels, with rather thicker edges than those ordinarily employed in carpentry, are in frequent use for smoothing. The *broad y* is used for this purpose. It is held underhand. Other forms of *broad*, as *w x*, are also used, principally upon large work, the plank way of the grain.

The side tool *z* is used upon insides of cylinders.

The tools for hard wood and ivory are beveled on one edge only, which has consequently nearly double the thickness of that used for soft wood.

Fig. 6801.



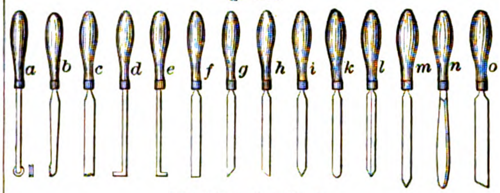
Wood-Turning Tools.

a (Fig. 6801), gouge; used for roughing-out work.
b, chisel; plan and section.
c, sharp-pointed chisel.
d, doubly beveled chisel.
e, obtuse-pointed chisel.
f g, round-pointed chisel.
h h', inside chisels.
i, ripping-chisel, for starting an opening.
k l m n, wood-turners' chisels.
o p, inside tools.
q r s, chisels for turning beads, etc.
t u illustrate modes of applying the chisel.
v, gouge in position on the rest.
w x y, broads.
z, side-tool, for insides of cylinders.
a', calipers.
b', calipers applied for measuring inside diameters.
c', calipers applied for measuring exterior diameters.

Fig. 6802.

Inside Tools.

Fig. 6803.



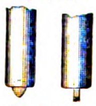
Metal-Turning Tools.

a (Fig. 6803), milling-tool, with wheel.
b c, chasers, for cutting screws.
d e, bent inside tools, } for brass, ivory, hard wood, etc.
f, flat tool,
g h, right and left side tools,
i, point tool,
k, round-point tool,
l, square graver, for metal.
m, cutting-off tool, } for wood.
n, turning-gouge,
o, turning-chisel,

Fig. 6802 shows *inside* tools.

For turning the concave and convex surfaces of rubies or sapphires, used for the jewels of watches and chronometers, a diamond-drill such as is shown in Fig. 6804 is used; *a* represents the flat surface and *b* the edge of such a tool. It may also be used for engraving extremely fine lines. The diamond was first used for turning by Ramsden in cutting the hardened steel screw for his dividing-engine.

Fig. 6804.



Diamond-Turning Tools.

See under the following heads: —

Astragal tool.	Gouge.
Bead-tool.	Hanging-tool.
Bevel-tool.	Heel-tool.
Bottom-tool.	Hook-tool.
Broad tool.	Inside tool.
Chisel.	Nail-head tool.
Comb.	Parting-tool.
Cranked tool.	Screw-cutting tool.
Flat tool.	Skew-chisel.

Turn'ing-up. (*Bookbinding.*) Taking the round out of the back, while the fore edge is cut.

Tur'nip-cut'ter. A machine for slicing roots for animal feed. See ROOT-CUTTER, etc., pages 1975, 1976.

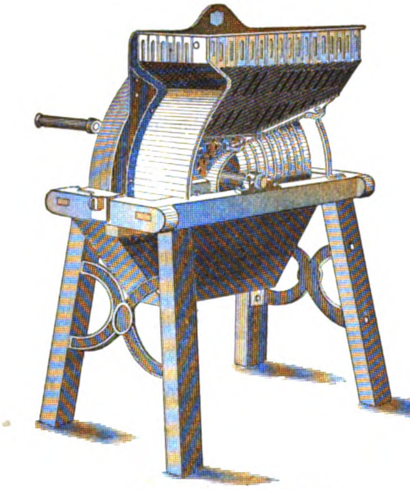
Tur'nip-pull'er. (*Husbandry.*) An implement, but little used in this country, for pulling turnips out of the ground.

Tur'nip-pulp'er. (*Agriculture.*) A machine

for pulping turnips, etc., to be used as food for cattle.

Hornsby's (Fig. 6805) has a rotary disk containing a number of cutters and corresponding apertures through which the pulp falls. The roots are placed in a hopper, and fed by their own

Fig. 6805.



Hornsby's Turnip-Pulper.

weight to the cutters, and the disk has parallel projections at right angles to its face, which prevent the pulp from escaping except through the apertures arranged for that purpose, and from which it falls into the trough.

Turn'key. An instrument to extract teeth; not much used now. It was known to the ancients, who had instruments called *pelican*, on account of resembling the bill of said bird. The stump-extracting machine used in this country by farmers is patterned after the *turnkey*.

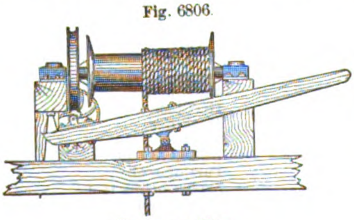
Turn'out. (*Railway.*) A railway siding.

Turn-o'ver Boil'er. A form of boiler in which the flues were *turned over* the fire-box or furnace. It was one form which the boiler improvement assumed in the gradual conversion of the old Cornish boiler into a more compact form.

Turn-o'ver Gear. (*Saw-mill.*) An application of machinery for hauling up logs from the saw-mill to the log-carriage, or turning the log on the carriage after slabbing one side.

A simple and compact form is shown in Fig. 6806, in which a lever brings a gear into contact with a worm-wheel on the axis of the rope-drum, and so hauls upon the rope which leads to

Fig. 6806.



Turn-over Gear.

the pond or over a pulley to a cant-hook, by which the log is turned.

Turn'pike. 1. A toll-gate across a road.

2. A proprietary road, where toll is collected. The name has come to signify one which is graded and either *macadamized* or graveled, so as not to be mere mud. The first American turnpike act was in 1796, — the National Road from Baltimore to Illinois. See PAVING; ROAD.

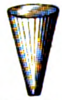
3. A TURNSTILE (which see).

4. A winding stairs.

5. (*Fortification.*) A beam filled with spikes. A *cheval de frise.*

Turn'pike-stair'case. A winding stair, constructed around a central newel or post.

Fig. 6807.



Turn-Pin.

Turn-pin. A plug for stopping the flow from the open end of a pipe. A *tube-stopper.*

Turn'plate. A TURN-TABLE (which see).

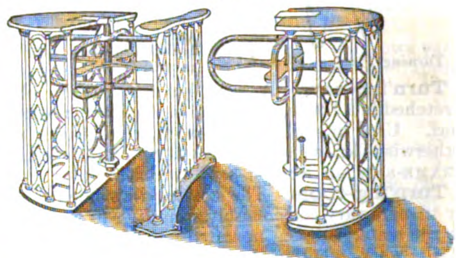
Turn-screw. 1. A screw-driver.

2. A screw-wrench.

Turn'stile. A post with four horizontal arms, which revolve as a person pushes by them.

Fig. 6808 is a self-registering turnstile, for toll-bridges or other places where fares are to be collected from foot passengers, or it is desired to ascertain their number. The upright shaft on which the stile turns actuates a train of gearing mov-

Fig. 6808.



Turnstile.

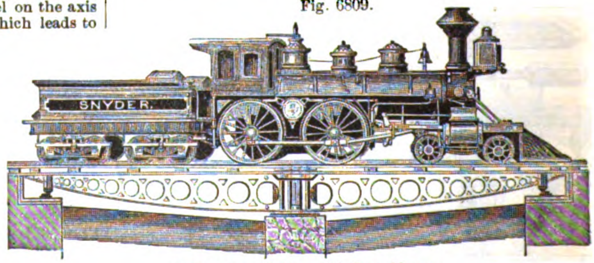
ing a series of indexes wnich point out the number of revolutions or partial revolutions made by the stile.

The *groma* of the Romans was the board on a turnstile to show the direction of the ways in a camp.

Turn'stile-count'er. A turnstile-counter for omnibuses and cars is described in English patent No. 2189, of 1854. See previous and succeeding articles.

Turn'stile-reg'is-ter. A device for registering the number of persons who pass through a turnstile serving as the entrance to a toll-bridge or building, and serving as a check on the collector. The axis on which the stile turns is caused to rotate a series of gear-wheels which operate the indicator. The stile can only rotate in one direction, and has a lock-

Fig. 6809.

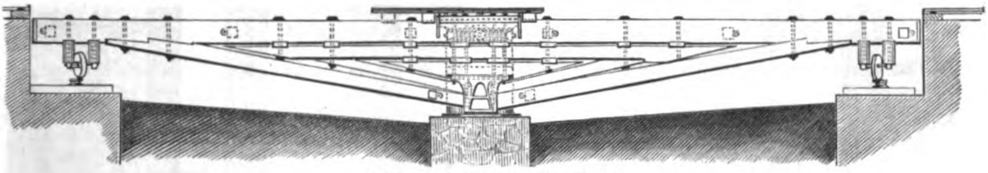


Kelly Turn-Table, with Iron Frame.

ing device controlled by a foot-lever, so that the collector may prevent the passage of more than one person at a time.

Turn-ta'ble. 1. (*Railway Engineering.*) A platform which rotates in a horizontal plane, and is used for shifting rolling stock from one line of rails to another. Devices common to all are the plat-

Fig. 6810.

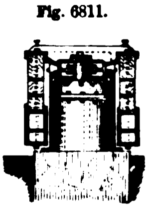


Turn-Table, with Wooden Frame.

form, which has one or more tracks of rails on its upper surface ; rollers on which it turns, gearing for rotating it, a central pivot on which it rotates, a circular track on which the rollers move, and solid foundations for this track and for the central pivot.

Kelly's turn-table (Fig. 6809) is centrally supported on a series of frusto-conical rollers turning on arms radially projecting from a collar, which revolves around the axis of the table. The apexes of the cones would, if they were complete, meet at a point in their axis. They are interposed between two annular castings correspondingly beveled, the lower of which is fixed, and serves as a track, and the upper is attached to and turns with the table. Flanges on the inner ends of the rollers prevent their being pushed outwardly by the pressure. In a modified arrangement small conical rollers turning between the large rollers and plates on the ends of the arms which carry them are substituted for the flanges. See also Figs. 6810, 6811.

Fig. 6811.

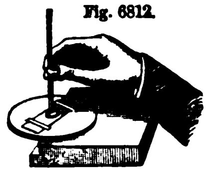


Turn-Table.

Adams's turn-table (English) floats in a water-tank.

2. A device upon which a microscope slide is held for tracing the circular cement cells in which objects are placed for examination.

Fig. 6812.



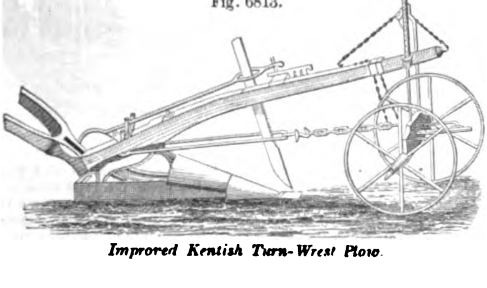
Turn-Table.

Turn-tree. (*Mining.*) A part of the drawing-*stowce* or windlass.

Turn-wrest Plow. (*Husbandry.*) *a.* An English plow of large size, and without a mold-board, adapted to be drawn by four horses and as many more as the farmer can spare. It burrows in the soil of the county (Kent), where it still maintains its hold upon the affections of the people, and is apparently prized on account of its lifting and tearing action in a soil which would be too much compacted by the pressure of a sole, landside, and mold-board.

We should esteem it a regular horse-killer, and could use it nowhere but in grubbing, and then it should be drawn by three or four yokes of oxen.

Fig. 6813.



Improved Kentish Turn-Wrest Plow.

The name *turn-wrest* has clung to it for two and a half centuries, through all the scoffing and affected admiration it has excited, and means that the *wrest* or direction in which the soil is wrenched or pushed can be *turned* or changed. This is accomplished by shifting the colter to one side or the other, so as to divide the slice from the land ; the *share*, burrowing beneath, then lifts the slice, which is farther displaced by the *breast* of the timber to whose end the share is attached.

This extraordinary and clumsy implement has a share which resembles, except in size, some of the ancient plows, and those still in use in countries where the schoolmaster, the steam-engine, and the printing-press have not effectually penetrated. See Plow.

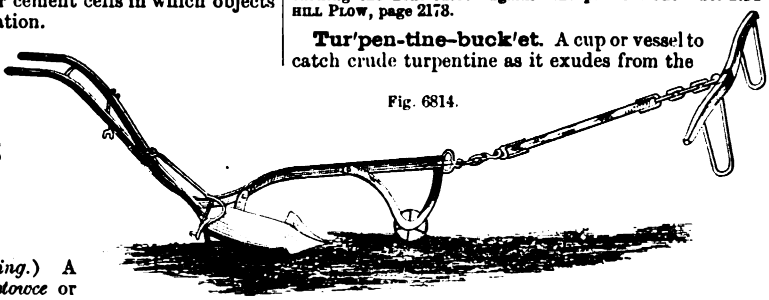
English agricultural authorities admit that "it is the ugliest, heaviest, and most cumbersome-looking machine to be found in all England."

Boys, in his "Survey of Kent," gives a description of the implement.

b. A plow having a reversible share and colter so as to work both backward and forward and lay the furrows in the same direction.

The illustration shows a simple form adapted for light plowing on easy soils. A wing on the share acts as a colter, and at the end of the furrow the mold-board and share are turned under the frame of the plow, and at once fall into place for turning the next furrow against the previous one. See Side-hill Plow, page 2178.

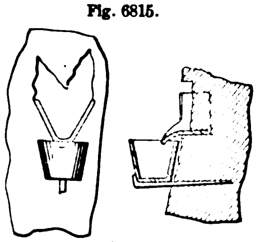
Fig. 6814.



English Turn-Wrest Plow, made for India.

Tur'pen-tine-buck'et. A cup or vessel to catch crude turpentine as it exudes from the tree. In the example (Fig. 6815), the spout is made in a V-form, and is driven into the tree to form the bottom of the *boxing* chopped out to collect turpentine.

Fig. 6815.



Turpentine-Bucket.

Tur'pen-tine-hack. A tool for barking and cutting pine-trees, to allow the crude turpentine to exude.

Fig. 6816 is a tool for either cutting or scraping, by upward or downward motion.

Ten thousand trees or *boxes* constitute a plantation. Each tree is cut at the bottom so as to form a box or receptacle, holding about a quart of crude turpentine. Each tree is partially stripped of bark, and every two weeks is cut higher up, always in the shape of a V, by a heavy long-handled implement, termed the *hack*. The V-cut prevents the edges from becoming hard and the turpentine from oozing out, the turpentine being guided to the lowest point of the V. The hands become very proficient in cutting and keeping open these V's. One man is able to cut 10,000 of the boxes in a week, some trees having three and four boxes. There are three crops and a scraping raised in a season, — say, 450 barrels. — the scrapings generally paying all the expenses attending the cutting and gathering. When the cutting

Fig. 6816.

Turpentine-Hack.

reaches an inconveniently high point, the tree is felled and used for timber or firewood.

The *hacking* operation, and the mode of hauling the filled barrels of tar to market, which is often effected in a manner similar to that formerly employed with tobacco hogsheads in Virginia, are shown in Figs. 6817, 6818. Both tar and turpentine are frequently rafted to the seaboard.

The *dipping* (Fig. 6819) is effected with a spoon-shaped instrument, the gum being collected in buckets, which are afterward emptied into barrels. The first year's produce is *virgin-dip*, the second *yellow-dip*, the third yellow-dip and *scrape*; after the third year, the product is all scrape. The virgin-dip is, when carefully gathered, a honey-like gum, of whitish appearance. From it are produced *No.* 1, *pale*, *extra*, and *window-glass* rosins. It yields about 7 gallons of spirits and somewhat less than ¾ of a barrel of rosin to the barrel of 280 lbs. *Yellow-dip* and *scrape* yield about 6 gallons of spirits and ¾ barrel of rosin to the barrel.

Fig. 6817.

Hacking.

Scrape is the gum which collects on the face of the box or barked portion of the tree, when it has been worked up 3 or 4 feet or more. It is a whitish, cheese-like substance. Fig. 6820 represents the operation of chipping the face; this is done with an implement termed the *round-share*. For removing the *scrape*, a somewhat similar tool, the *scraper*, is employed.

Fig. 6818.

Hauling.

The gum is distilled in copper stills, containing from 10 to 60 barrels; from 30 to 40 barrels is a usual size. They are bricked up at the sides, and the fire strikes directly upon their bottoms. The top has a large hole for the cap, which connects with the worm for condensing the spirits, and a small hole for enabling the stiller to watch the process and let in water, if required. The residual rosin is drawn off into vats and barreled. Fig. 6821 is a rear view of a distillery, showing the stills and rosin-vats.

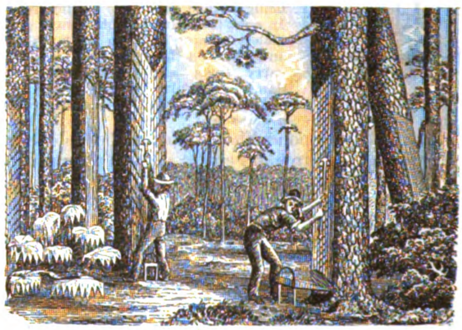
In trees deadened by fire, old boxed trees left standing, and in stumps of trees cut while the sap is up, the pores become saturated with the gum. These are largely employed for making tar.

Fig. 6819.

Dipping.

For this purpose the wood is split into billets 3 or 4 feet long, and about 3 inches thick. These are laid radially around a central aperture, each tier projecting slightly beyond that below, the whole kiln forming a frustum of an inverted cone, as shown in Fig. 6822. The fire is kindled at the top of the kiln, and

Fig. 6820.



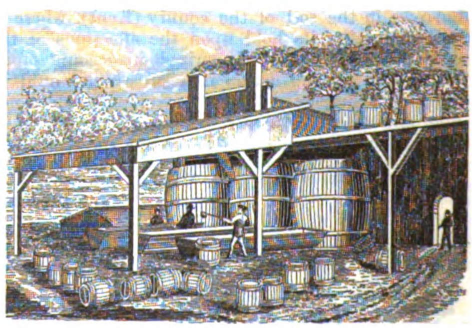
Chipping the Face.

the tar trickling downward into the opening is conducted by a spout to a suitable reservoir. See also CHARCOAL-FURNACE.

Tur'pen-tine–still. An apparatus for the distillation of turpentine from pine wood.

The blocks of wood are placed in retort *G* (Fig. 6823), the door on the right closed, the valve at the conical end closed, and the valve above opened. Water being introduced into the

Fig. 6821.



Distilling.

chambers to the level of the grate-bars, fire is applied, and the clear white spirit passes in vapor by the neck *V* to the worm in tub *C*. As soon as it begins to show color, the valve above is closed, and the valve at the conical end opened, when the vapor passes through the purifier *L* into the chamber, which is surrounded by water in tub *D*.

Tur'rel. A cooper's tool.

Tur'ret. 1. (*Architecture.*) A tower attached to a building, and extending above and beyond its general outline.

2. (*Fortification.*) The revolving tower for offensive purposes, on land or water, was invented by Theodore R. Timby, of Saratoga, N. Y. The idea was conceived and a model made in 1841, caveated in 1843, patented in 1862.

The tower of that time consisted of a cylindrical iron structure, having several tiers of casemates, and one barbette platform, all revolving together around a central tower which

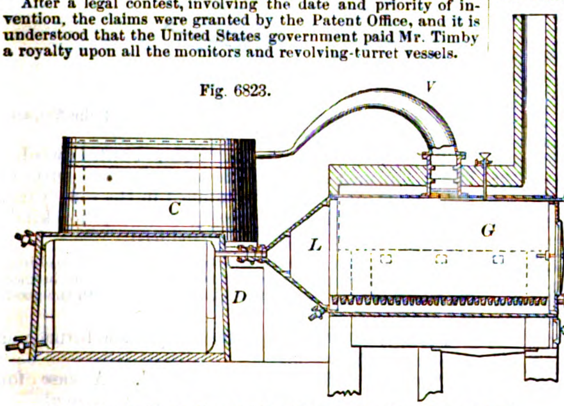
Fig. 6822.

Tar-Kiln.

forms the axis, the motor being a steam-engine. At the summit of the central tower is the lookout, which is capable of independent revolution when desired, and has a telescope mounted to sweep the horizon, and with altitude adjustments. Electric apparatus, under the control of the observer at the telescope, fires the guns, as, in their revolution, they come into range corresponding to that of the telescope above. The revolving tower is partially imbedded in a base, whose crowning story forms a stationary casemate-tower.

After a legal contest, involving the date and priority of invention, the claims were granted by the Patent Office, and it is understood that the United States government paid Mr. Timby a royalty upon all the monitors and revolving-turret vessels.

Fig. 6823.



Apparatus for Extracting Spirits of Turpentine from Pine-Wood.

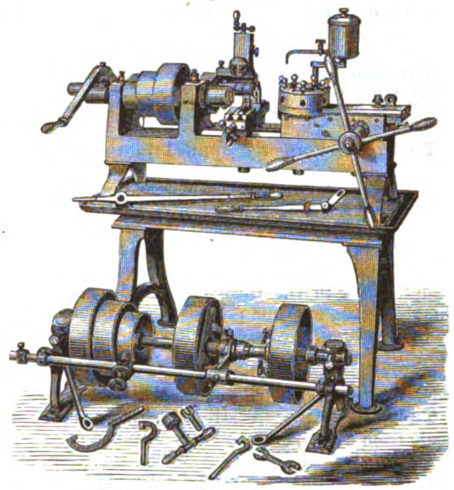
The turret adopted by Captain Ericsson in his monitors is constructed on the same general principle as that of Mr. Timby.

Between 1855 and 1860, Captain Cowper Coles, R. N., invented a form of turret for war-vessels, differing from the above in having but little elevation above the deck, resting upon rollers beneath the deck, and being turned by a hand-winch. See ARMOR-PLATING; IRON-CLAD.

It has been proposed to construct circular floating turrets, inclosed in tanks or wells; these may be either located on land or be buoyant structures in which the turret floats.

Two circular-turreted ships have been built by the Russian government. These are of iron, planked with wood, and sheathed with copper, 99.2 feet in diameter, and drawing 12.1 feet of water. The bottom is perfectly flat, and the sides are vertical, having an overhanging projection aft to protect the rudder. In order to insure stability, twelve keels, each about three inches in depth, are affixed to the bottom. The turret is fixed, is 29 feet 6 inches in diameter, and 7 feet high,

Fig. 6824.



Brown and Sharpe's Turret-Lathe.

and the gun platforms turn on a hollow axis, which serves as an ammunition scuttle, at the center of the ship, and contains two 11-ton guns, mounted *en barbette*, so as to fire over the top of the turret walls and admit of being trained to an angle of 30° or 35° on either side of a fore and aft line; the upper part of the hull and the turret are plated with 9-inch armor. These vessels are driven by six screws, operated by as many as 80 horse-power engines, and one of them has attained a speed of six knots an hour, and has been turned in 1 minute and 19 seconds.

3. (*Railway.*) The elevated central portion of a passenger-car, whose top forms an upper story of the roof, and whose sides are glazed for light and pierced for ventilation.

Tur'ret-clock. One adapted for an elevated position in a church or other tower.

Tur'ret-gun. One specially adapted for use in revolving turrets of vessels.

Tur'ret-lathe. (*Metal-working.*) A screw-cutting lathe having a slide provided with a polygonal block or *turret*, having apertures in each face for receiving dies which are secured therein by set-screws.

The rod of metal to be threaded is inserted in the hollow mandrel of the spindle, and the threads are cut successively deeper by the dies on the different sides of the turret, which is partially rotated for this purpose after each cut. The slide has automatic feeding arrangements, but may be advanced by hand. A cutter on a hand side-rest serves to sever bolts to the required lengths after the thread is cut, and they are dropped into a receptacle below. Nuts can be drilled, tapped, and one side faced up, and many parts of sewing-machines, cotton machinery, gas and steam fittings, made on this machine, with a great saving of time and labor. Size of hole through spindle, 1¼ inches. Size of holes in revolving head, 1 1/16 inch. Length that can be milled, 6 inches. Friction-pulleys on counter-shaft are 14 inches diameter and 3½ inches wide. Counter-shaft should run 170 turns per minute. Weight of machine prepared for shipment, about 1,450 pounds.

Tur'ret-ship. A ship whose armament is placed in a tower or turret which is capable of revolution, so as to bring the embrasure opposite to the gun, which is pointed in any direction and temporarily unmasked while firing.

Sometimes the revolving turret projects through the deck of an iron-plated war-vessel. Invented by Timby, of New York. Captain Coles, of England, made some changes in the adaptation of the turret to the hull. See TURRET.

Turs'kil. The Scotch paring-spade. *Tuskar.*

Tur'tle. (*Printing.*) The segmental plate in which a *form* is *locked* up, in a cylinder press.

The column-rules are wider at top than at bottom, to hold the type firmly, and are secured by screws. The edge of the side-stick has a series of beveled projections, and is pressed against the form by a piece having similarly beveled projections and operated by a screw.

Tusk. 1. Formerly applied to the share of a plow.

> "That shortly plow or harrow
> Shall pass o'er what was Ismail, and its *tusk*
> Be unimpeded by the proudest mosque." — *Don Juan.*

2. (*Locksmithing.*) A sharp projecting point or claw which forms a means of engagement or attachment. Used in the parts of locks in which bolts, tumblers, etc., are thus provided so as to be touched, dropped, raised, etc., by the key, directly or by intermediate devices.

3. (*Carpentry.*) The beveled shoulder on the back of a tenon of a binding joist, to strengthen it.

Tus'sah-silk. A strong, coarse, dark silk, made from a native Bengal silk-worm.

Tu-ta'ni-a. (*Alloy.*) A white alloy for tableware, etc. German: copper, 1; tin, 48; antimony, 4. Spanish: steel, 1; tin, 24; antimony, 2. See ALLOY.

Tu'te-nag. 1. (*Alloy.*) A white alloy of copper, 50; nickel, 19; and zinc, 31, used for tableware, etc. It resembles Packfong, Chinese white copper, albata, German silver. The alloy has various names and proportions of the ingredients; a small quantity of lead or iron is added in some formulas. See WHITE-METAL ALLOYS, table, page 63.

2. Zinc or spelter.

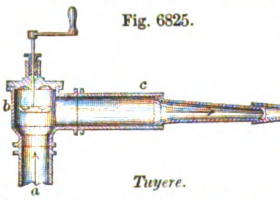
Tut'ty. An impure protoxide of zinc, used as a polishing powder.

Tut-work. (*Mining.*) Work done in the non-metalliferous rock for the purpose of discovery, in the excavation of shafts, drifts, adits, etc. Also called *dead-work.*

Tuy-ere'. 1. (*Metallurgy.*) A tube having a conical end, with its appurtenances for regulating and directing a current of air upon the metal in a smelting furnace or forge.

In Fig. 6825, *a* is the pipe through which air is received from the wind-chest of the blowing-apparatus; a valve *b*, operated by a handle, governs the amount admitted to the tube *c*, the conical end of which enters a corresponding aperture in the lower part of the furnace. Usually two or three tuyeres are so arranged that their blasts are converged toward the center of the furnace. When but two are employed, they are placed at opposite sides, but the *nose-pipe* of each is so directed as to give a little inclination to the air-jet, that the currents may not interfere with each other.

Fig. 6825.



Tuyere.

In blast and cupola furnaces, but especially the latter, a number of tuyeres have been employed, arranged in vertical series, as shown in Fig. 6826. See also CUPOLA-FURNACE.

In Fig. 6826, the area of the blast openings of the tuyeres decreases toward the upper portion of the series, and their mouths are protected by pillars of fire-brick.

Pevy's cupola-furnace has a wind-chest around the furnace, from whence the tuyeres are supplied.

Truesdale's cupola-furnace has circular rows of tuyeres around the chamber, arranged in several tiers. The blast-openings decrease in area in the several tiers from the upper to the lower.

The tuyeres of the Bessemer convertor are perforated blocks of fire-brick set in the floor of the retort, and affording passage for the air into the mass of liquid metal above. See BESSEMER; CONVERTOR; STEEL.

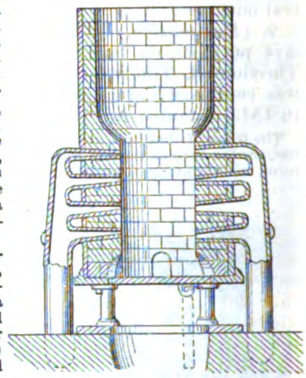
The blast-pipe of the forge or furnace is sometimes cooled by passing through a casing around which a current of water is caused to pass. Such an arrangement is called a *water-tuyere.*

Wm. Barker's United States patent, November 10, 1818, for a water tew-iron, is the first instance of a *water-tuyere* known to the writer.

"An external covering or case of metal passing round the common tew-iron and forming a chamber into which a continual supply of water is introduced; whereby water keeps the tew-iron cool, and prevents it from burning." One pipe conveys in the water, and another carries away the steam. Where water is abundant, a stream is run continually through it.

In Mackenzie and Isbell's cupola-furnace, separate blast-chambers are arranged in a vertical series around the cupola, receive air by valved branch-pipes from the main, and communicate by distinct rows of tuyeres with the interior.

Fig. 6826.

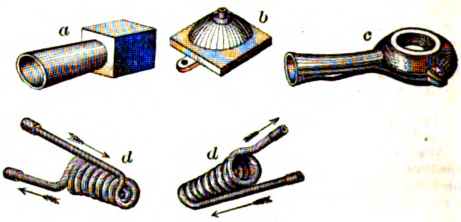


Cupola-Furnace.

Tuyeres in different positions around the furnace, and at different elevations, are described in Howell's United States patent for making malleable iron direct from the ore.

a, negro-head tuyere.
b, bull's-eye tuyere.
c, duck's-nest tuyere.
d are the air-supply pipes for the tuyeres of a hot-blast furnace. They are convoluted, so that the air in its passage through them is longer exposed to the action of the fire, and becomes more thoroughly heated.

Fig. 6827.



Forge-Tuyeres.

Tweed. (*Fabric.*) A light, twilled woolen fabric for men's wear, with an unfinished surface. Two colors are generally combined in the same yarn. The best is made all of wool, but in inferior kinds shoddy and cotton are also introduced.

The name is said to have originated in a mistake in spelling; the word *tweed* having been substituted for *tweel* in an invoice, the consignee took advantage of the fact to put forth the goods as a new kind of fabric.

Tweer. A *tuyere*, or blast-pipe of a furnace or forge. See TUYERE.

Tweeze. (From Fr., *Etuis*, pl. A case for small articles.) A surgeon's case of instruments.

Twee'zers. 1. A delicate kind of pinchers with two fingers, adapted for grasping hairs. Used among almost all nations, especially among those who eradicate the beard.

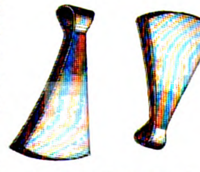
The Roman *volsellæ;* used in eradicating hair. A small pair made of ivory has been found in a British barrow.

The cut shows Peruvian tweezers, of copper.

Tweezers of copper have also been disinterred at Pompeii, and are now in the museum at Portici.

"And there bought me a pair of tweezers, cost me 14 *s.*" — PEPYS, 1662.

Fig. 6828.



Peruvian Tweezers of Copper.

2. A surgeon's case of instruments. See TWEEZE.

Twelfth. (*Music.*) A stop of an organ tuned one twelfth above *open diapason*. See STOP.

Twelve'mo. (*Printing.*) A sheet which folds into 12 leaves or 24 pages. Otherwise called duodecimo, and written 12mo.

Twen'ty-fours. (*Printing.*) A sheet adapted to be folded into 24 leaves, 48 pages. Otherwise written 24mo.

Twi'bill. 1. A mattock. The blade has one end like an axe, the other like an adze.

2. A mortising-tool.

3. A reaping-hook.

Twill. 1. Or *tweel*. A diagonal appearance given to a fabric by causing the weft-threads to pass over one warp thread, and then under two, and so on; instead of taking the warp-threads in regular succession, one down and one up. The next weft-thread takes a set oblique to the former, throwing up one of the two deposed by the preceding. The diagram will make the plan understood. In some twills it is one and three, or one and four.

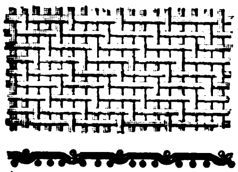
The Latin *trilix*, a certain pattern in weaving, became *drillich* in German, and hence our word *drill*.

Twill is derived from *zwillich*, which answers to the Latin *bilix*, and Greek *dimitos*. The latter survives in *dimity*. See also SAMITE, derived from ἑξάμιτος, six-leaved.

The French *touaille* has also been suggested as the etymological source of the word.

The fabrics thus woven are very numerous, — *satin*, *blanket*, *merino*, *bombazeen*, *kerseymere*, etc. When the threads cross each alternately, in regular order, it is called *plain weaving*; but in *twill*, the same thread of weft is *flushed*, or separated from the warp, while passing over a number of warp-threads, and then passes under a warp-thread. The points where the threads of the warp cross form diagonal lines, parallel to each other, across the face of the cloth. In *blanket twill* every third thread is crossed. In some fabrics 4, 5, 6, 7, or 8 threads are crossed. In *full satin twill* there is an interval of 15 threads, the warp (*organzine* silk) being floated over 15 threads of the woof (*tram*), giving the glossy appearance.

Fig. 6829.



Four-Leaved Twilled Weaving.

Twills require heddles equal in number to the threads that are included in the intervals between the intersections. This disposition of the warps in the heddles is termed *mounting the loom*; and the heddles are termed *leaves*. A twill takes its name from the number of *leaves* employed, as a *three-leaf twill*, a *five-leaf twill*, etc.

Twills are used for the display of color, for strength, variety, thickness, or durability.

"The generic difference of twilling, when compared with common cloth, consists in the intersections, although uniform and equidistant, being, at determinate intervals, greater than between the alternate threads. Hence we have specimens of twilled cloths where the intersections take place at the 3d, 4th, 5th, 6th, 7th, 8th, and 16th intervals only. The threads, thus deflecting only at intervals from a straight line, preserve more of their original direction, and a much greater quantity of materials can be combined in an equal space than in the alternate intersection, where the tortuous deflection, at every interval, keeps them more asunder. On this principle, twilled cloths, of 3 and 4 leaves, are woven for facility of combination alone. The coarser species of ornamental cloths, known by the names of *dornock* or *diaper*, usually intersect at the 5th or half-satin interval. The 6th and 7th are rarely used, and the 8th is distinguished by the name of *satin*, in common, and of *damask*, in ornamental, twilling." — URE. These are varieties known as *broken*, *biassed*, *regular*.

2. The fabric so made.

Twilled cloth has several advantages: —

1. The materials may be put more closely together.
2. Its susceptibility for receiving ornament, being capable of being inverted at pleasure.

For a statement more at length, see "Ure's Dictionary," II. pp. 821-826.

3. A quill or spool for winding thread.

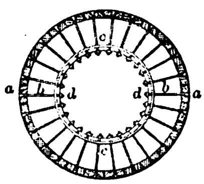
Twil'ly. A willowing-machine. A form of cotton-cleaner. In the coarse Lancashire style a *twilly-devil*.

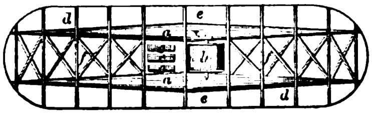
Twin-boat. A boat or deck supported on two parallel floating bodies, which are placed some distance asunder. The floats are usually long, pointed at each end, and circular in cross section. They are called *spindle* or *cigar shaped*.

The object of the construction is stability and speed, the former being secured by the lateral extension, and the latter by diminished submerged section. The wheel is usually in the space between the spindles.

The idea may be founded upon the outrigger boats of the Indies, or upon some form of raft.

Fig. 6830.





Twin-Boat.

Twin-boats have found their principal employment in ferries, the central portion being used for the wheel and the machinery, and the platform on each side for the vehicles and passengers.

The largest boat of this construction, of which we have seen any mention, was a vessel constructed to run on the Hudson River. The spindles were 300 feet long, and in the center, or thickest part, were 8 feet in diameter, tapering in a regular parabolic curve to a point at each end. The paddle-wheel, which was 30 feet in diameter, worked in the space between the spindles.

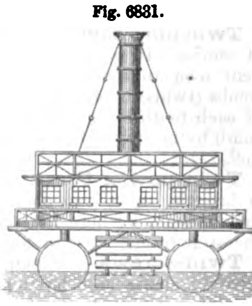
In the sectional view, *a a* are the staves, 26 in number and $8\frac{1}{2}$ inches thick, to each of which is attached an iron bolt, *b b*, 26 inches long, passing through the staves, and countersunk on the outside of them. These bolts pass through an iron ring *c*, on the inside of which they are screwed up by nuts *d d*: sufficient room is left in the center for a man to enter and pass fore and aft, to examine the bolts.

In the plan, *a a* are the spindles; *b*, the paddle-wheel; *c c c*, the boilers; *d d*, the cross-beams, which cross the spindles, and reach to the outside yards; *e e*, *f f*, the diagonal bracing.

This vessel was built at New York for a Hudson River passenger-boat. She was said to have run 21 miles in 61 minutes, to have averaged on the river 20 miles per hour, and 14 miles per hour at sea. Her draft of water was 24 inches. She was wrecked after making a few trips.

Snodgrass twin-boat, English patent, 1837. The spindles are of sheet-iron, and are cylindrical for the middle one-third portion of their length. They are divided into apartments, by bulkheads, which divide each spindle into air and water tight sections. Longitudinal beams and transverse braces supported the platform, or deck, upon which the boilers, engines, and cabin accommodations were placed. The single wheel rotated in the interval between the spindles.

Fig. 6831.



Snodgrass Twin-Boat.

Gemmell's patent, about the same time, had exterior side-wheels.

Symington's steam-boats, 1789-1802, were twin-boats, in which the single paddle-wheel was revolved in the central space.

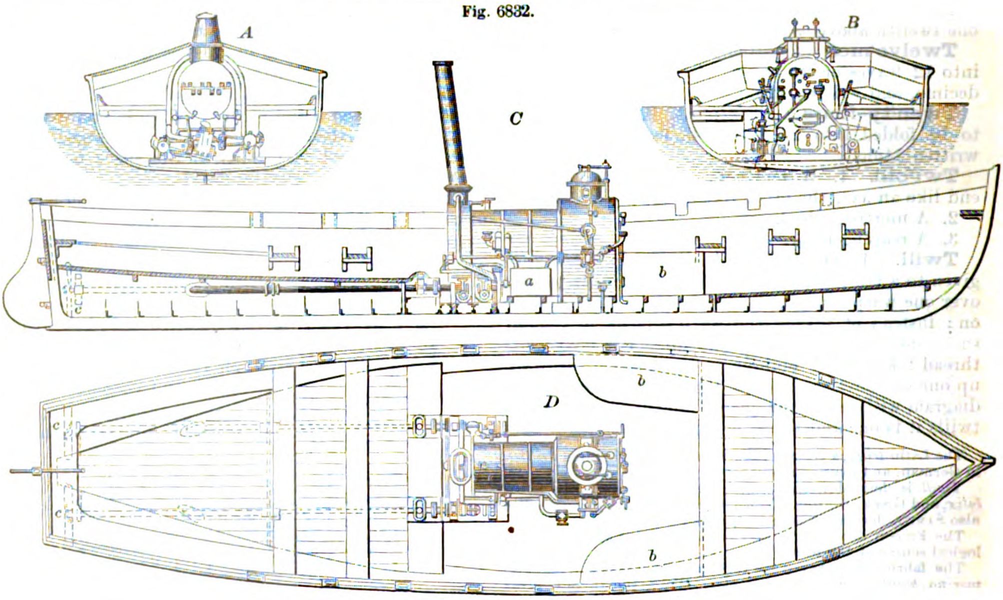
A large twin channel steamer, the "Castalia," has lately been put upon the Dover and Calais ferry, Europe. Each hull is 234 feet long, 16.4 beam, 12.6 hold; distance between hulls, 25.2. She has paddle-wheels between the hulls, each driven by its own engine.

Twine. A strong hempen thread used in sewing sails.

Sewing-twine for sails weighs at the rate of 360 to 430 fathoms to the pound.

One pound of twine will sew 160 yards of seam, on an average.

Fig. 6832.



Twin-Screw Launch.

Fig. 6833.

Twine-Holder.

Twine-cut'ter. A blade or knife on a table, stand, or counter, to cut twine when tying packages.

Twine-hold'er. A box or case to hold a ball of twine on a counter.

Twine-ma-chine'. A spinning-machine for small hempen or cotton string. A *thread-machine.*

Twine-reel'er. A *mule-doubler.*

Twin'ning-ma-chine'. A machine for cutting two combs (twins) from the single piece. It is said to have been invented by Mr. Thomas of Philadelphia. The cutter consists of two chisels which act perpendicularly and alternately upon the plate which passes beneath them. Each chisel cuts one side of two teeth, and severs one from the opposite back at each stroke. See COMB.

Twin'ning-saw. A saw for cutting the teeth of combs. It is so called because the material is bent over to render the cut surface convex, two combs (twins) being cut from one piece. The point of each tooth is cut from the back of the opposite comb by means of an instrument called a *plugging-awl.*

Twin-pow'er Press. One in which the power is brought upon two objects in alternation, as in some machines where the punch and shears are in the same frame. See under those heads.

Twin-screws. A pair of screw-propellers on separate shaft, and having *right-handed* and *left-handed* twists respectively. Being turned in contrary directions in driving ahead, they counteract each other's tendencies to produce lateral vibration.

The shafts of the twin screws are sometimes made to pass through the ship's skin at suitable points in the after part of the bottom, and supported at their after ends by iron buckets; and sometimes they are contained in a pair of twin stern-posts and twin runs, the ship being so designed as to have a single fore-body and a double after-body.

Twin-screws were used upon the earliest practical propeller steamboat, that of Colonel John Stevens of Hoboken, 1804. See SCREW-PROPELLER, page 2071, Fig. 4747.

Twin-screws are used also upon some of the Winan's cigar-steamers, the third and the fourth of the series. See page 553.

Fig. 6832 illustrates a steam-launch with twin-screw propellers.

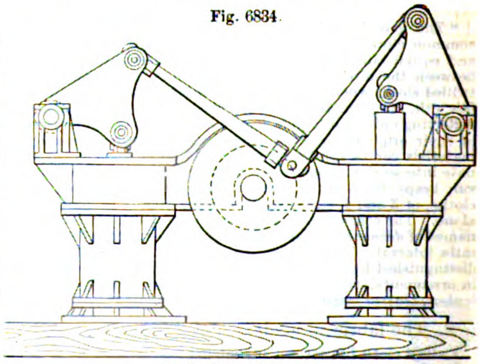
A, transverse section looking forward.
B, transverse section looking aft.
C, longitudinal sectional elevation.
D, plan.
a, feed-water tank.
b, coal-boxes.
c, twin-screws.

Twin Steam-en'gine. Another name for a duplex engine; one in which two engines, complete in their parts, are associated in a single effort.

Numerous instances occur in practice where the name might be correctly applied.

Fig. 6834 is one form in which two vertical cylinders with an entablature resting upon them as upon columns, by which means the cylinders and entablature constitute the principal frame of the engine, and give access to the cylinder-heads through apertures in the entablature. The main crank is located in the center of the entablature, and both pistons are connected to the same crank.

Fig. 6834.

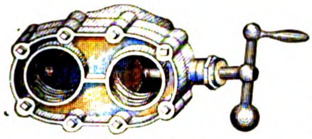


Twin Steam-Engine.

Twin-valve. A form of valve attached to the discharge outlet of a pump. It is used for making a double connection, one with the steam-boiler, for supplying it with water, and the other with a line of hose, for use in case of fire, or for conducting water wherever desired.

Twist. 1. (*Small-arms.*) A mode of construction of gun-barrels in which the iron, in the form of a ribbon, is heated and coiled spirally around a mandrel. The spiral is then raised to a welding heat and dropped upon an iron rod, which is *jumped;* that is, struck forcibly and vertically upon an anvil, which causes the edges of the spiral to adhere. The welding is finished on an anvil, the mandrel retaining its position inside.

Fig. 6835.



Twin-Valve.

The ribbon of iron is several yards long and about half an inch wide, varying in thickness from the thick or breech end of the barrel to the thin or muzzle end.

Fig. 6836.

Twisted Barrel.

Various kinds of ribbons are made. Those from horseshoe nails and steel are called *stub-twist.* A certain laminated iron and steel is known as *wire-twist.* A laminated iron and mild steel, laid parallel in ribbons, welded, then twisted at one end while the other is held in a vise, combined in a fagot with another or others twisted in a diverse direction, rolled, and drawn into ribbons, is a *Damascus-twist.* See GUN-BARREL.

2. (*Guns and Ordnance.*) The spiral in the bore of a rifled gun. It is spoken of as a $\frac{3}{4}$ twist, etc., as it completes that much, more or less, of a revolution in the length of the barrel.

An *increase* or *gaining* twist is one in which the spiral inclination of the grooves becomes more rapid toward the muzzle. Invented by Tamisier.

Another mode of designating the twist is in the length required to complete a revolution, which is usually considerably in excess of the length of the barrel.

3. (*Architecture.*) The wind of the bed-joint of each course of voussoirs in a skew arch.

4. (*Weaving.*) The *warp*-thread of the *web.* Also known as the *filling,* or *chain.*

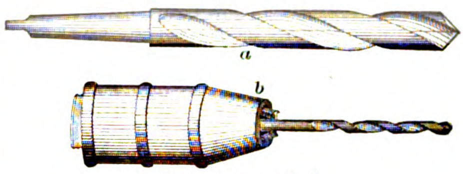
5. A kind of cotton yarn.

6. A closely twisted strong sewing-silk. Saddler's silk.

Twist-drill. (*Metal-working.*) A drill having a twisted body like that of an auger. The advantages claimed for such drills are that they serve as guides to keep the hole true, that they work at the proper cutting angle, and are tempered throughout their working length, and that they do not require re-dressing to maintain a uniform size.

In making them, a bar of steel is rolled to a special shape, cut into length, and again rolled in cam rolls, which form a

Fig. 6837.



Twist Drills and Chuck.

straight groove, after which the shank is formed. The blank is then twisted by means of a machine, where one end is received in a hollow nut at the end of a perforated spindle, which has a rotary and longitudinal movement, the other end being held by vise-clamps. After twisting, the drill is centered and rough ground, hardened by heating in a lead bath and cooling in water, tempered in an oil bath, and finally finished by grinding to a standard gage.

Twist-drill Grind'er. One specifically adapted for giving an accurate chisel-point to a twist-drill, the cutting edges being inclined at similar angles.

Twist'ed Bit. 1. (*Manege.*) One having a mouthpiece made with square sides and afterward twisted.

2. (*Carpentry.*) A wood-boring tool adapted to be used in a brace. It is a form of flat bar twisted into a spiral form and provided at the ends with a cutter and a routing-table. See BIT.

Twist'ed Mouth. (*Manege.*) A bit whose mouthpiece has been twisted, to make it more severe than it otherwise would be.

Twist'er. 1. A reel used in twisting yarns or threads.

2. A girder.

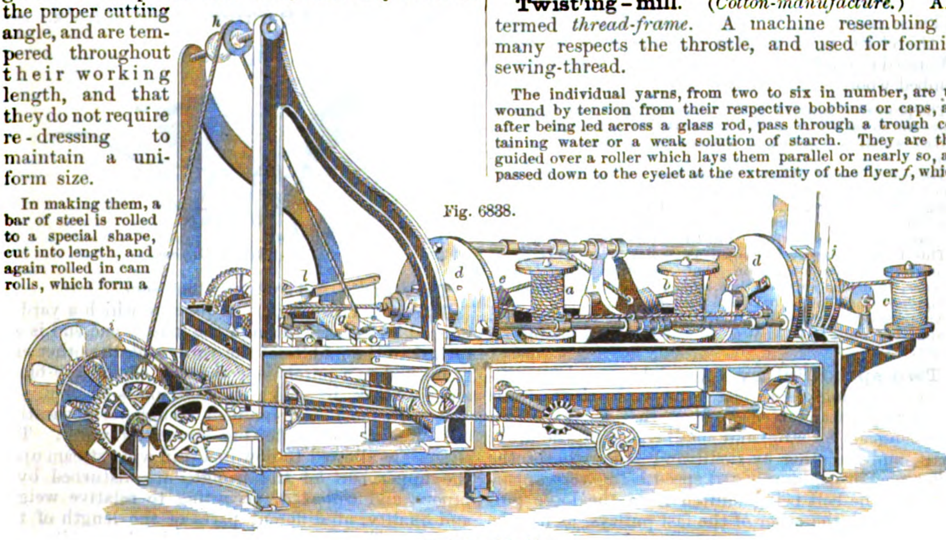
Twist'ing-ma-chine'. A machine for twisting and laying rope and cordage (Fig. 6838).

The strands are wound upon spools *a b c*, and are led through eyes along the revolving frame *d d*, and, meeting at the top *e*, are conducted through the hollow axis *f* of the frame, and after passing several times around the tension-rollers *g g*, the twisted rope is finally carried over an elevated roller *h* and wound upon the reel *i*. The rotary motion of the twisting-frame *d d* is derived from a belt and pulley *j* independent of the device by which the motion of translation is imparted. The velocity with which the rope is advanced and wound upon the reel *i* is governed by cone-pulleys *k k*, and is varied to impart a greater or less twist with a uniform rotary movement of the frame *d d*. *l* is a brake for checking and equalizing the motion of the tension-rollers. See ROPE-MACHINE.

Twist'ing-mill. (*Cotton-manufacture.*) Also termed *thread-frame.* A machine resembling in many respects the throstle, and used for forming sewing-thread.

The individual yarns, from two to six in number, are unwound by tension from their respective bobbins or caps, and after being led across a glass rod, pass through a trough containing water or a weak solution of starch. They are then guided over a roller which lays them parallel or nearly so, and passed down to the eyelet at the extremity of the flyer *f*, which,

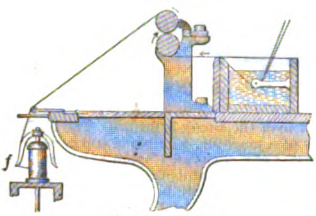
Fig. 6838.



Twisting-Machine.

by its rapid rotation, twists them into a solid cord or thread, which is wound upon the bobbin. The twist of the thread is usually in a reverse direction to that of the separate yarns. The copping rail on which the bobbins are placed has an up-and-down motion to cause an equal distribution of the thread on the bobbins.

Fig. 6839.



Twisting-Mill.

Twist-ma-chine'. One form of lace-making machine.

Twitch. A noose attached to a stock or handle and twisted around the upper lip of a horse, so as to bring him under command when shoeing. See BARNACLES.

Twit'ter-bit. The bottom of the countersink which receives the head of the screw, uniting the halves of a pair of scissors.

Two-box Loom. (*Weaving.*) One having two boxes for as many shuttles carrying differently colored yarns.

Two-deck'er. (*Nautical.*) A vessel of war carrying guns on two decks.

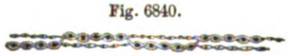
Two-hand'ed Saw. A whip-saw used in getting out ship-timbers. It has a handle at each end, one for each man.

Two-line Let'ters. (*Printing.*) Capitals which are equal to two bodies of any specific size of type, as *two-line pearl, two-line brevier,* etc. Used for lines in title-pages, the large letters at the beginning of advertisements, etc.

Two-ply. Woven double. See TWO-PLY CARPET.

Two-ply Car'pet. A carpet having a double web. Each web has its warp and its weft; but as these are interchangeable, a great variety of colors may be produced on either surface. One of the warps is alternately raised above the other while the shuttle is thrown. A section of this fabric is shown in Fig. 6840.

Fig. 6840.



Double Cloth.

These carpets are wholly of worsted or of woolen; or the chain is of worsted and the weft of wool. (Worsted is a well-twisted yarn, made of long-stapled, combed wool.)

The process of weaving both webs is carried on at the same time, and in each part of the cloth that part is brought to the surface which is required to produce that portion of the pattern.

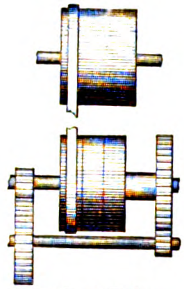
The warps are of different colors, and the threads are governed by treadles or by the Jacquard arrangement. The latter has generally superseded the less perfect contrivances, such as the *treadle, barrel,* or *draw looms.* The back of the carpet has the same pattern as the front, but the colors are reversed.

This form of carpet is known as *Scotch,* from its being so extensively manufactured in that country; also *kidderminster,* from the town of that name; also *ingrain,* from its being *dyed in the grain,* or before manufacture.

An extension of the same idea, in which three webs are interchangeably united, is known as *three-ply* or *triple-ingrain* carpet.

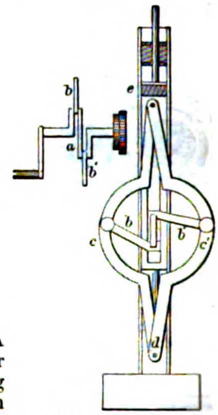
Two-speed Pul'ley. A variable speed arrangement consisting of two fast pulleys, the shaft of one being tubular and sleeved upon that of the other. One connects by large and small wheels to the lower shaft, and the other by small and large wheels, the difference in communicated speed being very apparent, and the belt being shifted from the loose pulley to one or the other of the fast pulleys, as may be required.

Fig. 6841.



Two-Speed Pulley.

Fig. 6842.



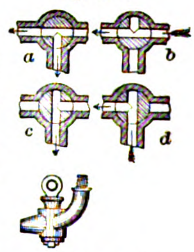
Two-Throw Crank.

Two-throw Crank. A device for converting circular into rectilinear reciprocating motion, or *vice versa.* In Fig. 6842, the crank *a*, rotated in any suitable way, has two levers *b b'*, one connected to each wrist, their other extremities being jointed to the curved rods *c c'*, which have a common fixed pivot *d* and are connected to the plunger *e*. The rotation of the crank causes an alternate approach and recession of the rods, imparting a reciprocating motion to the plunger and its connecting rod.

Two-top'sail Schoon'er. One carrying a square foresail and square foretopsail.

Two-way Cock. By the two-way cock the water may be distributed to each of two branches, to either of them separately, or be entirely shut off.

Fig. 6843.

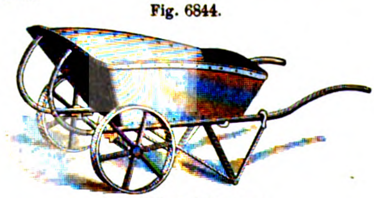


Two-Way Cock.

a shows the water passing to each branch pipe.
b, the water passing to the direct branch only.
c, the water passing to the lateral branch only.
d, the water shut off.
For large stop-cocks for water-mains, see STOP-VALVE. For small ones, see STEAM-VALVE; STOP-VALVE; GLOBE-VALVE; etc.

Two-wheeled Bar'row. A sort of truck. See Fig. 6844.

Fig. 6844.



Two-Wheeled Barrow.

Twy-ere'. A TUYERE (which see).

Tye. 1. (*Nautical.*) A rope by which a yard is hoisted. It passes through the mast; one end is attached to the middle of the yard, and the other end is hooked to a purchase composed of the tye-block and fly-block, by which the hoisting is effected.

2. (*Mining.*) An inclined trough for separating ore by means of a flowing stream of water. The slimes are allowed to flow in a thin wide stream upon the upper part of the trough, are disturbed by a broom, and collected, according to relative weight and quality, at different parts of the length of the trough. The sorts are known as ***heads, middles,*** and

tails; the first going to *pile,* the second is *re-tyed,* the third is refuse.

Tye-block. (*Nautical.*) An iron-bound swiveled block, bolted into an eye in the hoop round the yard; through it the tye for hoisting the yard is rove.

Ty'ing. An operation on tin or copper ores resembling *buddling,* in which the ore is spread on an inclined bed and subjected to the action of running water. The ore is agitated with a broom or shovel, and the operation depends upon the superior weight of the particles which are richest in metal. The lighter portions travel farthest on the plane and are rejected, while the heavier are collected and smelted.

Buddling, tying, trunking, chimming, and *tossing* depend upon the agitation of the ore in the vessel. In *rocking, dilluing, jigging, framing,* or *racking,* the vessel itself is agitated. In all of them agitation in water is the effective action.

Tym'bal. (*Music.*) A kind of kettle-drum.

Tymp. (*Metallurgy.*) A space in the bottom of a blast-furnace, adjoining the crucible. See TYMP-PLATE; BLAST-FURNACE.

Tym'pan. 1. (*Printing.*) A rectangular frame hinged by one edge to the carriage of a printing-press, and having stretched across it a piece of cloth or parchment. The blank sheets are laid upon the tympan, in order to be brought down upon the form to receive the impression.

The blank sheet is fitted upon the *tympan-sheet,* which is of the same size as the paper to be printed, and forms a guide for placing it.

The blank sheet is held by the *frisk t.* See PRINTING-PRESS.

The *inner tympan* is a smaller canvassed frame, and the two *tympans* hold the blanket between them.

2. (*Architecture.*) A triangular space or table in the corners or sides of an arch, usually hollowed, and enriched with branches of laurel, olive, oak, etc., and sometimes with emblematical figures.

3. (*Music.*) The kettle-drum.

Tym'pa-no. (*Music.*) A kettle-drum. See TYMPAN.

Tym'pan-sheet. (*Printing.*) A sheet of paper like that to be printed, laid on the tympan as a guide for position in placing the sheets to be printed.

Tym'pa-num. 1. (*Hydraulic Engineering.*) An ancient form of wheel for elevating water. Its original form was like that of a drum, whence its name. It was a cylinder with radial partitions and small openings in the periphery, which admitted a certain quantity of water into the chambers thus formed as those portions of the periphery came in turn to be submerged. As the wheel revolved, such portions of water were carried up and flowed along the partition toward the axis around which the water was discharged, being elevated to a hight nearly equal to the radius of the wheel. The wheel was driven by floats on the periphery or side of the wheel, or by means of animal or manual power, and had several modifications.

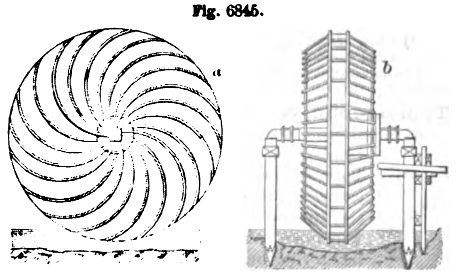
The Roman form of the *tympanum* is described by Vitruvius, 50 B. C., and was derived from Egypt. The partitions were 8 in number, and were radial; the holes, 6 inches in diameter, were made in the drum-like, cylindrical surface, which was otherwise closely boarded up; the wheel was mounted so as to rotate over the side of a vessel which was moored, and was driven by a *tread-wheel* on board the vessel; the water lifted by the buckets was discharged at the axis of the wheel. What is known as De la Faye's pump is constructed on this plan.

This wheel is often called the *Persian,* and this may be correct, geographically speaking; but for perspicuity, the term *Persian* should be applied to a wheel with boxes, pots, or buckets which are attached to the wheel, on or near its periphery. The *Noria* wheel of Palestine is, perhaps, a true example of the *Persian* wheel. See NORIA.

In process of time this highly useful wheel, so much used in Oriental countries in raising water for irrigation, was improved by removing the exterior surface from which it derived its name, the buckets being made scoop-shaped.

Such was the form used by Perronet, at Orleans Bridge, about 1750. In Fig. 6845, *a* is a section, and *b* an end elevation of this wheel. It had curved buckets, and raised the water 8 feet. Its effectiveness varied with the depth to which its circumference dipped into the water. At 1 foot submergence, 12 men, relieved every 2 hours, gave 2 turns per minute; at each turn, 24 cells were emptied, each containing 1¼ cubic feet, giving, for the hour, 4,320 cubic feet of water raised 8 feet high; this was conveyed by the spiral buckets to an annular discharge-chamber around the axis of the wheel.

Fig. 6845.



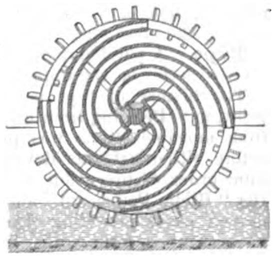
Perronet's Tympanum.

The comparison of effectiveness was as follows: —

Submergence.	Revolution per hour.	Cubic feet raised.
12 inches.	120	4,320
9 inches.	150	3,600
6 inches.	180	2,880
3 inches.	180	2,160

A modification of the tympanum has spiral ducts leading to a discharge-chamber around the axis. It is, or may be, propelled by the current.

Fig. 6846.



Tympanum.

This form of wheel has its advocates in all civilized countries, and is employed in draining some of the fluviatile districts in our Western country; for instance, at Cairo, where a wheel of this character is, or was, driven by steam-power, for removing the drainage of that rather low site, discharging it over the levee, which keeps back the waters of the river.

The *tympanum,* under the name of the *scoop-wheel,* is much used in the drainage of the fens in the East of England. The name is somewhat confusedly applied to wheels of the tympanum character, and to those with radial buckets which traverse in a chute. These wheels, driven by steam-engines, have, to a great extent, superseded the Dutch windmills and pumps which have been used there for several centuries. In one place, a steam-engine has superseded 44 windmills. In another place, two steam-engines, of 110 horse-power, drain 28,000 acres, and have superseded 75 windmills.

These very efficient wheels have a diameter a little more than double that of the elevation to which the water is required to be raised. Some wheels deliver the water at the axis, and others have floats like an ordinary water-wheel, and merely traverse in a curved, inclined trough of masonry, which connects the lower with the upper level. See SCOOP-WHEEL.

2. (*Architecture.*) The triangular panel of the fastigium or pediment of any building, comprehended between its corona and that of the entablature. The panels of a framed door were called *tympana* by the Romans.

3. (*Music.*) Another name for the tambourine. See Plates LXXVI., LXXVII., Bonanni's "Istromenti Armonici," Roma, 1776.

The tympanum (Gr. *tympanon*) was a hand-drum or tambourine, but covered with parchment, back and front. It was used in company with various kinds of harps, lyres, and pipes, cymbals (*kymbala*) of metal, the straight brass trumpet (*salpinx*) and curved brass horn (*keras*), the castanets (*crotala*) of wood and metal.

The drum is common among all uncultivated nations, and was a prominent feature in the ancient practice. The Egyptian musical instruments were harps, guitars, single and double pipes, two kinds of trumpets, three of tambourines, three of drums, gongs, bells, cymbals, and castanets, the sistrum, maces, and bells.

The largest Assyrian band shown at Khorsabad has a leader with a harp, followed by two with a dulcimer and double pipe; these by two men with harps; then four women with harps;

one beating a drum and another with a double pipe. Then comes a chorus of singers, clapping their hands.

The Hebrew drum (*toph*) was a small hand-drum or *tambourine*, called *timbrel* or *tabret* in the English version; *vide* Miriam and Jephtha's daughter. The hand-drum of some parts of the East is still called *doff*, *diff*, or *adufe*.

Tym'pa-num, Ar-ti-fi'cial. (*Surgical.*) An elastic membrane designed to replace the natural tympanum where this has been ruptured.

Fig. 6847.

Clarke's Artificial Tympanum.

Toynbee's consists of a thin plate of vulcanized rubber about $\frac{1}{16}$ inch in diameter, in the center of which a fine silver wire about an inch long is fastened. This has a ring on its outer end, by which it can be easily removed. Clarke's is elliptical in shape, and on being worn becomes concave outwardly; the wire is curved downwardly to suit the shape of the auditory canal, but does not touch its sides. The ring is dispensed with.

Hyde's ear-trumpet has an artificial tympanum to transmit the pulsation of the air to the natural organ. See ACOUSTIC INSTRUMENTS; TELEPHONE.

Tymp-plate. A plate in front of the hearth of a blast-furnace, sustaining and protected by the *tymp-stone*, which is immediately exposed to the heat. The *tymp-plate* is imbedded at its ends in the side of the hearth, and itself sustains the front. See BOSHES.

Tymp-stone. The stone which forms the front of the hearth in a blast-furnace, resting upon and against the *tymp-plate*. See BOSHES.

Type. A parallelopipedon or square prism with a raised letter on the upper end, used in printing.

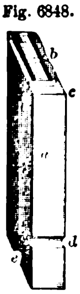
The history of type is a part of the history of printing. Printing from engraved blocks and then from movable letters was practiced in China long before either art was developed in Europe. The same order of invention occurred again in Europe, the "Biblia Pauperum" and other books with engraved pages preceding the movable blocks, which were set up to form words, lines, and pages.

The movable type of China, A. D. 1041, is described in Ringwalt's "Encyclopædia of Printing," page 104, and in this work *supra*, page 1790.

The movable type of Europe is referred to, *supra*, pages 1790, 1791. First made by Guttenberg or Koster (Laurentius Zanssen); first cast by Schoeffer.

The first book executed with cast-metal type is said to have been the "Durandi Rationale Divinorum Officiorum," published in 1459. See PRINTING.

Fig. 6848.



Type.

For the making of type, see TYPE-FOUNDING.

Fig. 6848 shows a type. The parts have the following names: —

a, body.	*d*, nick.
b, face.	*e*, groove.
c, shoulder.	

Nicholson (English), 1790, gave type a taper toward the lower end, so as to make them fit upon the circumference of a cylindrical type-holder.

Donkin and Bacon (English), 1813, effected the object by placing the forms on the plane sides of a revolving prism.

Cowper (English), 1815, curved the stereotype-plates.

Type is improved by facing with copper or with nickel. The nickel has the advantage of allowing the use of some colors, some of which are changed by the copper, while some others act upon the copper.

Type are distinguished by names indicating *size* of the *body* and the consequent number which will go in a given space; by the different sizes or styles of *face* on a given body; by the *case*, as *upper* or *lower*, caps or small letter; by peculiar style or ornamental characteristic.

As to *size*, —

Brilliant.	Agate or ruby.
Diamond.	Nonpareil.
Pearl.	Minion.
Brevier.	Pica.
Bourgeoise.	English.
Long primer.	Great primer.
Small pica.	etc., etc.

As to *face*, —

Full.	Medium.
Heavy or fat.	Light.
Displayed.	Condensed.

As to *case*, —

Caps, or upper case.	Small letters, or *lower case*.

As to *style*, —

Roman.	Antique.
Italic.	Black letter.
Script.	San Ceriph.
Old English.	Old style.
German text.	Hair line.
Gothic.	etc., etc.

See also FONT, pages 900, 901.

See specimens on pages 2672-2674, kindly furnished by George Bruce's Son & Co., New York.

SIZES; ROMAN AND ITALIC.

ROMAN.

DIAMOND, 201.88 lines to a foot. ABCDEFGHIJKLM abcdefghijklmnopqrstuvwxyz.

PEARL, 179.59 lines to a foot. ABCDEFGHIJKL abcdefghijklmnopqr.

AGATE, 160 lines to a foot. ABCDEGHIJKL abcdefghijklmn.

NONPAREIL, 142.54 lines to a foot. ABCDE abcdefg.

MINION, 126.99 lines to a foot. ABCDE abcdefg.

BREVIER, 113.13 lines to a foot. ABCD abcd.

BOURGEOIS, 100.79 lines to a foot. ABC DEFGHIJKLMN abcdefghijklmnopqrstu.

LONG-PRIMER, 89.79 lines to a foot. ABCDEFGHIJKL abcdefghijklmno.

SMALL-PICA, 80 lines to a foot. ABCDEFGHIJK abcdefghijklm.

PICA, 71.27 lines to a foot. A BCDEFGHIJ abcdefghijklm.

ITALIC.

DIAMOND, half Bourgeois. ABCDEFGHIJKLMNO abcdefghijklmnopqrstuvwxyz

PEARL, half Long-Primer. ABCDEFGHIJKLMN abcdefghijklmnopqr.

AGATE, half Small-Pica. ABCDEFGHIJK abcdefghijklmnop.

NONPAREIL, half Pica. ABCDEFGHI abcdefghijklm.

MINION, half English. ABCDEFG abcdefghijkl.

BREVIER, half Columbian. ABCDEF abcdefg.

BOURGEOIS, half Great-Primer. ABCD EFGHIJKLMN abcdefghijklmnopqrstu.

LONG-PRIMER, half Paragon. ABC DEFGHIJKLM abcdefghijklmnopqrst.

SMALL-PICA. ABCDEFGHIJK LMNOPQRS abcdefghijklmnopqrs.

PICA. ABCDEFGHIJKLM abcdefghijklmnopqrstuvwxyz.

VARIETIES OF FACES.

Brevier, Roman, Large-faced.

Brevier, Roman, Heavy-faced.

Brevier, Roman, Compressed-faced.

Brevier, Roman, Joined-Seriff.

Brevier, Roman, Medium-faced.

Brevier Italic, Large-faced.

Brevier Italic, Compressed-faced.

Brevier Italic, Medium-faced.

STYLES.

Brevier Roman Condensed.
Brevier Roman Extra Condensed.
Brevier, Roman, Modern Old-style.
Brevier Title Roman.
Brevier Title Roman Condensed.
BREV. EXT.
Brevier Expanded.
Brevier Title Expanded.
Brevier Aldine.
Brevier Italic.
Brevier Italic, Modern Old-style.
Brevier Title Italic.
Brevier Title Italic.
Brevier Engravers' Italic.
Brevier Law Italic.
Brevier Gothic Condensed Italic.
Brevier Antique.
Brevier Antique.
Brevier Antique.
Brevier Antique.
Brevier Antique Condensed.
Brevier Antique Condensed.
Brevier Antique Extra Condensed.
Nonp. Antique Ext.
PEARL ANTIQUE EXTENDED.
PEARL ANTIQUE EXTENDED.
Brevier Clarendon.
BREVIER GOTHIC.
Brevier Gothic.
Brevier Gothic.
Brevier Gothic.
BREVIER GOTHIC CONDENSED.
Brevier Gothic Condensed.
Brevier Gothic Condensed.
BREVIER GOTHIC CONDENSED.
BREVIER GOTHIC CONDENSED.
Brevier Gothic Extended.
Brevier Round Gothic Shaded.
Brevier Celtic.
Brevier Runic.
BREVIER RUNIC.
Brevier Extended Runic.
Brevier Doric.
BREVIER ORNAMENTED.
Brevier Ornamented.
BREVIER SHADED.
BREVIER SHADED.
BREVIER SHADED.
BREVIER SHADED.
Brev. Ext. Shaded.
Brevier Extended Black.
Long-Primer Arabesque.
LONG-PRIMER ORNAMENTED.
Long-Primer Ornamented.
Long-Pr. Ornamented.
Pica Ext. Rimmed.
Great-Primer Tendril.
Brevier Italian Condensed.
Brevier Italian Antique.
LONG PRIMER Engravers' Hair-line.
Long-Primer Italic Hair-line.
Pica Hair-line Shaded.
Pica Condensed Hair-line.
BREVIER GOTHIC CONDENSED HAIR-LINE.
BREVIER OUTLINE.
BREVIER SKELETON.
Long-Primer Engravers' **Open.**
Pica Old-Style Ornamented.
Brevier German.
Brevier German Title.
Brevier Victoria.
Brevier Black.
Brevier Black.
Brevier Augustan Black.
Long-Primer Black Outline.
Long-Primer Condensed Black.
Long-Primer Black Open.
Great-Primer Italian Text.
English Church Text.
Double S.P. Medieval
Pica Anglo-Black.
Pica Borussian.
Pica Script.
D. S.P. Running-hand.
Great-Pr. Copperplate Script.
Double S.P. Italian Script.

Double English Notarial.

D. S. P. Italian Secretary

Double Pica Graphotype.

Pica Title Script.

D. Pica Penman.

D. Pica Penman.

Double Small-Pica Caligraph.

Double Small-Pica Ronde.

Pica Madisonian.

Pica Secretary.

Pica Venetian.

Pica Paint Brush.

See also under the following heads: —

Albertype.	Lithotype.
Ambrotype.	Logotype.
Amphitype.	Melanotype.
Authotype.	Melotype.
Autotype.	Music-type.
Calotype.	Phototype.
Chemitype.	Stereotype.
Chromatype.	Talbotype.
Chrysotype.	Telotype.
Crochet-type.	Thermotype.
Crystalotype.	Type.
Cyanotype.	Type-founding.
Daguerreotype.	Type-metal.
Electrotype.	Type-setting machine.
Embossing-type.	Type-setting telegraph.
Heliotype.	Voltatype.
Hyalotype.	Wood-type.

Type-block. One having upon it raised figures representing letters or numbers. It is used in impressing or printing words or figures. In the former case, the result is a sunken or intaglio legend, name, or what not; in the latter, the impression is given in printer's ink, or by a hot block upon gold-leaf, to cause it to adhere to the size or *glaire* spread upon the object beneath the leaf. See GILDING. See also TYPE-WHEEL.

Type-cast'ing. See TYPE-FOUNDING.

Type Cast'ing and Set'ting Ma-chine'. One which makes its type from matrixes, and sets them in a row, or in galley, as the letter-keys of the machine are manipulated in the order of the copy.

Westcott's machine, No. 115,796, June 6, 1871, is constructed to cast, dress, and set up type in a continuous line for solid matter, or book or newspaper work, the line being afterward divided off, justified, and set up into column, as usual. See also his patents 169,215, 169,216, October 26, 1875.

The machine contains keys appropriated to each letter, character, and number that the machine is adapted to cast. When one key is moved it brings into action levers, slides, and other parts, that place a matrix-stock, carrying the matrix corresponding to the letter or mark on the key, in position to be taken by a carrier to the place where the casting is effected. The molds forming the body of the type are opened to the proper extent for making the sized body adapted to the letter. The type is cast, the matrix is withdrawn, carried back, and replaced in its receptacle. The type is taken out of the mold and brought forward to dressing-tools, that remove from the body of the type any burs, fins, or inequalities, and the type is then set up in line. By this machine the types are cast and composed in the order in which the finger-keys are moved; and when the types are no longer required they are either melted up, instead of being distributed, or else they may be distributed and used in the ordinary way, if desired.

Type-dis-trib'ut-ing Ma-chine'. A companion machine to the type-setter. See TYPE-SETTING MACHINE.

Type-dress'ing Ma-chine'. One forming a substitute for the usual mode, which is to rub the type by hand upon the plane surface of a stone, using as an auxiliary a scraper or file. Welch's machine passes the type set up in rows between a pair of knife-blades set in exact parallelism.

Type-found'ing. The early history of type is that of printing; for though the art of engraving blocks and seals in cameo and intaglio for stamping and sealing had been known for 2,000 years, they only became *type* when adapted for association together for printing and for subsequent distribution.

As stated under PRINTING, the earliest form of printing was from a block engraved with the device or matter; this was common among the Chinese, and in some other quarters. The "Biblia Pauperum," or "Poor Man's Bible," of the 14th century, was thus produced. *Stamping*, or making impressions in ink or color from engraved blocks, is old. The essence of the invention of printing consisted in the idea of movable types, capable of composition and distribution. These were originally cut in wood, and were subsequently cast in metal. The trio, Guttenberg, Faust, and Schoeffer, were so intimately connected in the invention that it is difficult, and perhaps not important, to determine the part each had in the discovery. The world can well afford to canonize them as the benefactors of their race. It should appear that Guttenberg invented cut, movable types, and Schoeffer invented casting them in matrixes, before which time they had been produced by great and tedious labor. The claims of Koster of Haarlem must not be overlooked, but there is no room here to state or balance testimony. (See PRINTING.) For more than 100 years after the invention of printing, the printers cut their own matrixes, cast their own type, made their presses, composed the type, printed, folded, and bound their own books. In 1686, the branches of the trade were divided as follows: *master-printer*, *letter-cutter*, *letter-caster*, *letter-dresser*, *compositor*, *corrector*, *pressman*, *ink-maker*, *binder*. Caxton seems to have regarded himself as well supplied, having five fonts.

In 1706, William Caslon brought the art of type-making to great perfection, and rendered England independent of the Continental type-founders. Caslon was an engraver of gun-locks and gun-barrels, and, having a reputation for ingenuity, was employed by "The Society for Promoting Christian Knowledge" to cut the punches for a font of Arabic. That foundry is still known by his name.

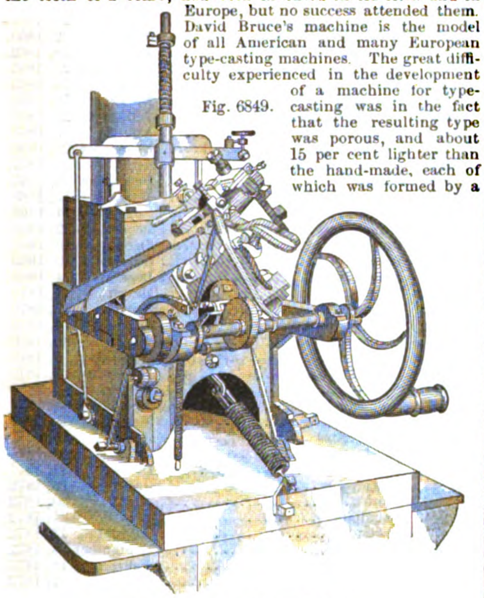
The first type-founder in America was Christopher Saur of Germantown, Pennsylvania, and the first font cast was of German type, about 1735. In 1768, a foundry was established in Boston, but did not succeed. Abel Buell of Killingworth, Connecticut, succeeded, so far as good work was concerned, but was prevented by a turbulent disposition, and by the War of Independence, which supervened, and in which he took an active part, from pursuing the business to a successful issue. Just before the war of the Revolution, he was one of a party who destroyed the leaden statue of George III., in the Bowling Green, New York, and was discovered at his house melting up the head into type-metal, so as to put his Majesty to work disseminating information. A piece of the head, with some punches and matrices, were found many years afterward in the ammunition-chest of an old field-piece to which Buell had been attached during the war.

In 1796, Archibald Binny (as he wrote it then), of Edinburgh, Scotland, came to Philadelphia, bringing with him his own tools; these were seized on his landing in New York, but were afterward released. He established a type-foundry in Philadelphia, and some years afterward took into partnership James Ronaldson. The type-founding tools and materials imported by Dr. Benjamin Franklin, from France, for his own use, it is understood were purchased by Mr. Binny and partner. The foundry was successful from the first. It is likely that Mr. Fürstf, a die-sinker at the Philadelphia Mint, may have engraved the punches for A. Binny, as his name occurs as engraver under a likeness of Binny on the obverse of a medal, which has also the inscription, "A. Binny, Letter-founder, Philadelphia"; the inscription on the reverse, under an appropriate group of figures and tools, is, "Letter-foundry of Philadelphia, established A: 1796."

The old hand-mold and spoon reigned supreme till 1838, when the first successful type-casting machine was invented by David Bruce of New York. Machines for casting a number of

types, simultaneously projecting from a common sprue, like the teeth of a comb, had been invented in America and in Europe, but no success attended them. David Bruce's machine is the model of all American and many European type-casting machines. The great difficulty experienced in the development of a machine for type-casting was in the fact that the resulting type was porous, and about 15 per cent lighter than the hand-made, each of which was formed by a

Fig. 6849.



Bruce's Type-Casting Machine.

peculiar spasmodic jerk given by the workman to the mold, as he poured in the metal. The effect of this was to condense the metal and expel air. In the Bruce machine, the metal is kept fluid by a gas-jet beneath, and is projected into the mold by a pump, the spout of which is in front of the metal-pot. Each revolution of the crank brings the mold up to the spout, where it receives a charge of metal; it flies back with it, the top of the mold opens, and the type falls out. The matrix containing the letter is held by a spring against the mold opposite to the opening at which the metal is injected, and the rate of making is about 100 per minute, for average-sized type. The saving effected by the machine, patented in 1843, is estimated at 25 per cent. The quality is, if anything, superior, and the machine enables steam power to be used for the production of some varieties of type.

After casting, the *jet*, or surplus metal, at the foot of the type and which filled the ingate of the mold, is broken off; the sides of the type are rubbed on a grit-stone; they are set up regularly in sticks: corrected for inequalities; a groove planed in the middle of the base, forming what are known as *feet*. The proportion of each letter, for a font of a given weight, is arranged in a galley 6 × 4½ inches, and forms what is known as a type-founder's page. This is papered, and marked with the kind of letter contained.

Printing types were first electrofaced with copper in 1850.

A French invention, by M. Didot, was designed to cast about 200 types at once, the operation taking about 20 seconds. The matrixes were arranged in the parts, or jaws, of the machine, and the spaces for the types were connected by grooves, with a reservoir filled with metal. Pressure brought upon the molten metal forced it into all the recesses of the molds.

The apparatus was patented in England by Pouchée, and was long in successful use in London; whether it is yet in use, the writer does not know.

Westcott's machine (United States patents, 115,796, June 6, 1871; and 169,215, 169,216, October 26, 1875) casts and sets the types. The matrices of the letters, figures, and spaces are operated by separate keys, and the cast types are carried to the stick and set up in order. See TYPE-COMPOSING MACHINE.

Type-mak'ing Ma-chine'. See TYPE-FOUNDING.

Type-meas'ur-er. A stick having upon its sides or edges the measure of the various sizes of type, so as to readily indicate the number of lines by laying it alongside a column of matter or proof, or the *ems* in a line by placing it along the line.

Type-met'al. A white alloy for casting type, composed of lead, 3 to 7; antimony, 1.

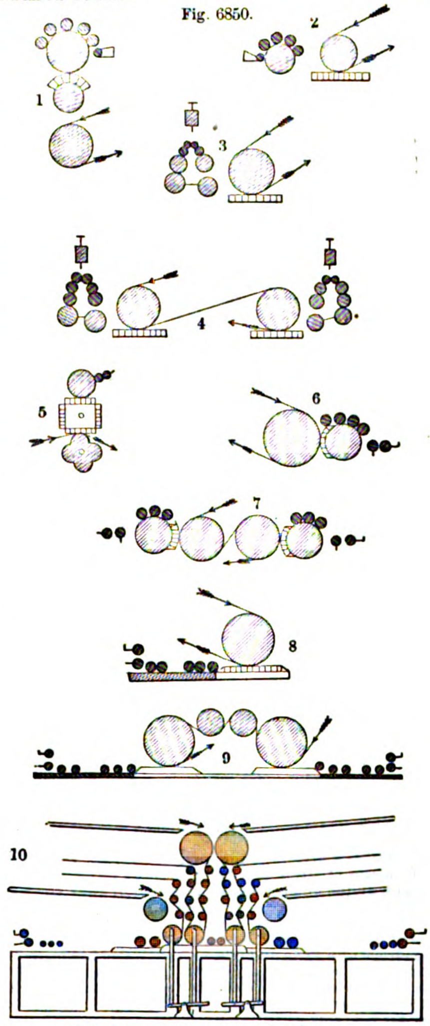
The larger type have the largest proportion of lead. The small type have more antimony, to render them harder and enable them to resist wear.

Besley's patent: lead, 100; antimony, 30; tin, 20; nickel, 8; cobalt, 5; copper, 8; bismuth, 2. See ALLOY.

Type-re-volv'ing Press. (*Printing.*) That form of press in which the type is secured on a cylinder, which revolves and presents the form successively to the inking-roller and to the paper. See CYLINDER-PRESS.

Fig. 6850 shows the principles of the type-revolving presses. See PRINTING-PRESS.

Fig. 6850.



Principles of Type-Revolving Presses.

1. Nicholson, 1790.	6. Cowper, 1815.
2. Nicholson, 1790.	7. Cowper, 1815.
3. König, 1814.	8. Applegath and Cowper.
4. König, 1818.	9. Applegath and Cowper.
5. Donkin and Bacon, 1813.	10. Applegath, 1827.

Hoe's ten-cylinder machine is described and represented under CYLINDER-PRESS, Plate XI. See also WEB-PRESS; PERFECTING-PRESS.

Type-set'ting Ma-chine'. A composing-machine for type. There are several varieties of machines for this purpose. Ordinarily, they have separate pockets or galleys for each *sort*, and the mechanical arrangement is such that on touching the key, arranged with others like the keyboard of a piano, the end type of the row is displaced, and is conducted in

a channel or by a tape to a composing-stick, where the types are arranged in regular order in a line of indefinite length, and from whence they are removed in successive portions to a justifying-stick, in which they are spaced out to the proper length of line required.

Type-distributing machines have frequently been invented as companion machines to those for composing, and are patented with them in some cases. The *distributing*-machine reverses the method of the setter. The *dead matter* is placed on a bed, each line is cut off and the types raised *seriatim*, so that they can be read by the observer. The corresponding key on the keyboard being depressed, the type is pushed into its appropriate tube, ready for supplying the composing-machine. In another machine each sort has its peculiar nick, and the process of selection is automatic.

A machine for this purpose was patented in England, by William Church, in 1822. No. 4,664. It is for an apparatus "for casting the printing types, and also of arranging them in boxes of letters, so that the types of the same denomination are placed side by side, in ranges, ready to be transferred to the composing machinery." In another portion of the apparatus, "the individual types are composed into words and sentences."

Type-setting machines form three groups: —

I. The type, when set free by the keys, fall into inclined grooves, or channels, in which, by their own weight, they descend, one after another, to the receptacle, or composing-stick, provided to receive them. They here form a line of indefinite length, from which they are removed, in successive portions, to a *justifying-stick*, in which they are spaced out to the proper length of lines required. A machine of this kind was exhibited at the Paris Exposition of 1855, by Mr. Sörensen of Denmark; another by Mr. Young of London; and a third by Mr. Delcambre of France. Delcambre's was the only machine of any kind for setting up movable types in the Exposition of 1867.

In all these machines the types are arranged in compact rows, side by side, and in separate but parallel channels, each row occupying a channel by itself, and all these channels standing (except in the machine of Sörensen) somewhat inclined, in one plane just behind the key-board. In Sörensen's machine these channels occupy the circumference of a cylinder. Generally, the action of the key displaces the lowest type of the column and delivers it over to the contrivance for transmission to the composing-stick. In Delcambre's, however, the types in each channel are pressed upward from below, and the column has a curvature at the top which brings the upper end to a horizontal position. It is the most advanced type at this extremity of the column which is dropped under the action of the key.

II. This group is illustrated by Mitchell's machine, in which each type, as it is delivered from its receptacle, falls upon an endless band which carries it horizontally for a certain distance directly from the operator, or at right angles to the key-board; when it encounters another endless band at a little lower level, which moves obliquely, or in the direction of the hypothenuse of a right-angled triangle, of which the first band is the base. To this second band it slides gently down a brass shoot, and is carried forward to a point beyond the last of the parallel bands, where it is acted on by a notched wheel called the setting-wheel, which sets it upright and advances it to make room for the next type.

III. Mackee's machine (English patents, 1865, 1866) is operated by means of strips of paper previously perforated so as to represent, by the number and arrangement of holes, the respective letters of a sentence. As the paper passes, by consecutive steps, $\frac{1}{10}$ of an inch across a perforated drum, the pegs of the levers of certain letters enter such perforations as come in correspondence with them and release types which are carried by a traveling-ring to a delivery-channel, where a pusher drives them on to a belt which delivers them in line. See "Ringwalt's Dictionary of Printing," page 291.

See the following patents: —

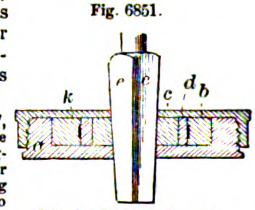
Type Setting and Distributing Machines.

No.	Name.	Date.	
2,139.	Young and Delcambre	June	22, 1841.
3,257.	Rosenborg	September	9, 1843.
4,313.	Henning	December	16, 1845.
7,738.	Beniowski	October	29, 1850.
9,413.	Harmon	November	23, 1852.
9,974.	Mitchell	August	30, 1853.
10,656.	Beaumont	March	21, 1854.
10,929	Mitchell	May	16, 1854.
13,710.	Longborough	October	23, 1855.
339.	Longborough (reissued)	January	8, 1856.
15,340.	Koenig	July	15, 1856.
16,743.	Mitchell	March	3, 1857.
16,947.	Houston	March	31, 1857.
18,175.	Alden	September	15, 1857.
3,572.	Alden (reissued)	July	27, 1869.
18,264.	Mitchell	September	22, 1857.
26,149.	Gilmer	November	15, 1859.
28,463.	Felt	May	29, 1860.
28,857.	Harger	June	26, 1860.
30,211.	Dorsey and Mathers	October	2, 1860.
34,265.	Ray	January	28, 1862.
36,991.	Brown	November	25, 1862.
38,955	Felt	June	23, 1863.
52,073.	Paulding	January	16, 1866.
52,254.	Allen and Mackay	January	23, 1866.
57,034.	Baer	August	7, 1866.
59,786.	Van Gieson	November	20, 1866.
64,200.	Coney and Harper	April	30, 1867.
71,610.	Harper	December	3, 1867.
75,681.	Houston	March	17, 1868.
84,273.	Foster	November	24, 1868.
85,251.	Slingerland	December	22, 1868.
91,988.	Umstadter	June	29, 1869.
95,853.	Thome	October	12, 1869.
97,801.	Delcambre	December	14, 1869.
100,366.	Brown	March	1, 1870.
102,183.	Thompson	April	19, 1870.
104,236.	Westcott and Rider	June	14, 1870.
105,855.	Slingerland	July	26, 1870.
108,813.	Morgan	November	1, 1870.
108,980.	De la Pena	November	8, 1870.
110,077.	Shipley	December	13, 1870.
113,912.	Neff and Scruggs	April	18, 1871.
114,850.	Plunkett	May	16, 1871.
115,777.	Slingerland	June	6, 1871.
115,796.	Westcott	June	6, 1871.
120,398.	Ray	October	31, 1871.
122,744.	Thompson	January	16, 1872.
126,262.	Brown	April	30, 1872.
126,944.	Farnham	May	21, 1872.
130,485.	Corey	August	13, 1872.
130,982.	Corey	September	3, 1872.
136,018.	Baldwin	February	18, 1873.
137,466.	Moore	April	1, 1873.
138,241.	Gally	April	29, 1873.
138,922.	Oring	May	13, 1873.
140,278.	Kastenbein	June	24, 1873.
140,279.	Kastenbein	June	24, 1873.
142,652.	Ray	September	9, 1873.
149,647.	Foster	April	14, 1874.
150,234	Farnham	April	28, 1874.
152,869.	Reynolds	July	7, 1874.
152,868.	Reynolds	July	7, 1874.
157,694.	Paige	December	15, 1874.
164,037.	Richards	June	1, 1875.
166,549.	Pattyson	August	10, 1875.
167,726.	Allen	September	14, 1875.
168,044.	Millar	September	21, 1875.
168,591.	Thompson	October	11, 1875.
169,215.	Westcott	October	26, 1875.
169,216.	Westcott	October	26, 1875.
170,372.	Hooker	November	23, 1875.
170,593.	Richards	November	30, 1875.

Type-set'ting Tel'e-graph. One in which the message at the receiving end is set up in type. The title is also held to mean, but does not correctly define, the instrument in which certain letters are made to deliver an impression in consecution, and so spell out the message. See PRINTING-TELEGRAPH.

Type-wheel. A disk having raised letters on its periphery, employed for printing or stamping, and in some forms of telegraph, as the Hughes. Various plans have been tried for cleanly and sharply producing the raised letters on the face of the disk.

Fig. 6851.



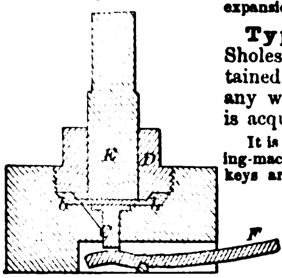
Die for Raising Letters.

In Fig. 6851, the annulus *d*, which is to form the tire of the wheel, is placed between segmental plain dies *c* and exterior segmental matrixes *b*, having the letters engraved in intaglio on their inner peripheries; the whole are inclosed in a box *a*, and the inner segmental dies expanded by a tapering plunger *e e*, forcing the metal into the matrixes; or the inner segments *c* may be dispensed with, and the metal expanded directly by the plunger.

In Fig. 6852, the metal is forced into the countersunk letters in the interior of the sectional dies *b b* by a plunger *E* working within the screw-nut *D*, and is afterward lifted by the follower *C*, operated by a lever *F*.

In another plan, the type-wheel is tightly compressed between two circular plates, which completely cover and compress the two lateral surfaces of said wheel, leaving only a

Fig. 6852.



Die for Forming Letters.

narrow rim allowed for lateral expansion.

Type-writ'er. The Sholes type-writer has attained more popularity than any with which the writer is acquainted.

It is about the size of the sewing-machine, and is worked with keys arranged in four *banks* or rows, each type being thrown up as its key is struck.

The types are engraved on the ends of a series of steel bars which are pivoted in a circle, so that they may vibrate on the pivots, and all strike at the same point in the center of, and a little above, the horizontal plane of that circle. Directly over the point where the types all strike, an inking-ribbon, similar to the inking-ribbons used in the common hand-stamps, is drawn, so that every type strikes it in delivering an impression; it is made to move a slight distance every time a key is struck, so that every type will strike it in a fresh place. Directly over the inking-ribbon, the paper carriage moves horizontally from right to left, and the paper is arranged to go under a cylinder or roller, which acts as a platen, and over the inking-ribbon, so that every time a key is struck a type is thrown up against the inking-ribbon, carrying the ribbon with it against the cylindrical platen, and there it leaves its impression. A weight pulls constantly against the paper-carriage, which is held by a ratchet or trip, which lets go every time a key is struck and catches again, and in the interval the weight pulls the carriage and paper along the space of one letter. By means of a treadle attached to the paper-carriage, a movement of the foot will draw the carriage back to the place of beginning; and as the carriage is drawn back, a ratchet and ratchet-wheel attached to and connected with the cylindrical platen are made to revolve the platen and move the paper the distance desired for a line-space.

This machine has 44 characters in it, as follows: A B C D E F G H I J K L M N O P Q R S T U V W X Y Z & - . , ; : ? ! 1 2 3 4 5 6 7 8 9. The parenthesis and apostrophe) ' are straight marks. By holding the space-key down while an "I" and "S" are struck, one over the other, a dollar-mark is obtained, thus: $. By striking, in the same way, the period and apostrophe together, an exclamation is obtained, thus: ! ! !

Johnston's apparatus for the blind is to enable them to write by pressure upon letters in the required order, the finger-letters corresponding to those which print upon the sheet of paper beneath. The disk has a circular series of vertical plungers with raised letters on their lower ends to imprint the paper, which is properly fed beneath. Corresponding with the series of vertical plungers are horizontally moving plungers whose raised letters are exposed on the periphery to the touch of the operator. The letter, being selected, is pressed inward, and the rotation of the disk brings it to the stopping-place, at which an impulse is given to the vertical corresponding plunger. Each selected letter is brought to the same spot, being arrested by engagement with a depression in the stationary ring.

The following patents on type-writers may be consulted: —

No.	Name.	Date.
3,228.	Thurber	August 26, 1843.
4,271.	Thurber	November 18, 1845.
7,652.	Fairbank	September 17, 1850.
7,771.	Eddy	November 12, 1850.
8,980.	Jones	June 1, 1852.
10,935.	Thomas	May 30, 1854.
14,907.	Cooper	May 20, 1856.
14,919.	Jones	May 20, 1856.
15,164.	Beach	June 24, 1856.
18,504.	Francis	October 27, 1857.
22,423.	Harger	December 28, 1858.
38,815.	De Mey	June 9, 1863.
39,296.	Livermore	July 21, 1863.
57,182.	Peeler	August 14, 1866.
59,522.	Flamm	November 6, 1866.
62,206.	Johnston	February 19, 1867.
65,807.	Hall	June 18, 1867.
79,265.	Sholes *et al*	June 23, 1868.
79,868.	Sholes *et al*	July 14, 1868.
81,000.	Pratt	August 11, 1868.
87,941.	Johnson	March 16, 1869.
94,329.	Moore	August 31, 1869.
109,161.	Washburn	November 8, 1870.
115,287.	Draper	May 30, 1871.
118,491.	Sholes	August 29, 1871.
124,437.	Halstead	March 12, 1872.
125,952.	Hansen	April 23, 1872.
127,739.	Cadmus	June 11, 1872.
133,841.	Edison	December 10, 1872.
139,914.	Pember	June 17, 1873.
140,921.	Hill	July 15, 1873.
144,450.	Galloway	November 11, 1873.
148,946.	Gally	March 24, 1874.
158,071.	Hansen	December 22, 1874.
168,898.	Hansen	October 19, 1875.
169,757.	Alissoff	November 9, 1875.
170,233.	Case	November 23, 1875.
170,239.	Crandall	November 23, 1875.
170,621.	Deming	November 31, 1875.
171,139.	Johnson	December 14, 1875.
171,335.	Allen	December 21, 1875.
171,408.	Morgan	December 21, 1875.

See also the following English patents: —

No.	Date.	No.	Date.
395, of	1714.	306, of	1869.
9,204, of	1841.	997, of	1869.
9,745, of	1843.	3,699, of	1869.
10,939, of	1845.	3,234, of	1870.
868, of	1854.	918, of	1871.
1,110, of	1854.	3,177, of	1871.
674, of	1856.	823, of	1872.
1,060, of	1856.	990, of	1872.
1,969, of	1857.	1,912, of	1872.
101, of	1863.	2,161, of	1872.
2,031, of	1863.	2,289, of	1872.
295, of	1864.	2,481, of	1872.
893, of	1864.	3,548, of	1872.
1,983, of	1864.	668, of	1873.
2,260, of	1864.	3 852, of	1873.
3,257, of	1864.	927, of	1874.
1,412, of	1864.	1,786, of	1874.
2,687, of	1864.	2,131, of	1874.
1,186, of	1866	3,528, of	1874.
1,448, of	1866.	2,119, of	1875.
3,163, of	1866.		

French patent, 7,028, of 1840.

Ty-po-graph'ic Ma-chine'. One in which the depression of keys operates type in the proper succession to impress a matrix, from which a stereotype plate may be cast.

Sweets's machine is described and figured in Dr. Barnard's "Report of the French Exposition of 1867," pages 443–448. It resembles a parlor-organ in appearance, having in front one or more banks of keys, the number corresponding to the number of sorts to be employed in the work.

Flamm's typographic compositor is shown and described in the same work, page 449.

See also TYPE-WRITER.

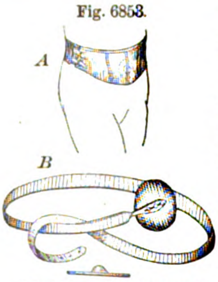
U.

U-dom'e-ter. An instrument to determine the quantity of rain-fall. A *rain-gage* (see pages 1871 – 1874). An *ombrometer* or *pluviameter.*

Ul'tra-ma-rine'. A blue color, originally prepared from lapis lazuli, but now usually produced by chemical means. The credit of first artificially producing this beautiful pigment at a price enabling it to be extensively employed in the arts appears to be due to Guimet.

Um-bil'i-cal Band'age. (*Surgical.*) A broad band of fabric which is buckled around the umbilical region of the body to serve as an abdominal supporter and for palliating umbilical hernia.

Fig. 6853.



Umbilical Bandage and Truss.

Some have hard pads of wood, cork, or metal, and others are provided with pads of sponge, horsehair, or other soft material, or of india-rubber inflated with air (*A*, Fig. 6853).

B is an umbilical truss, designed for the same purposes.

Um-brel'la. A light frame covered with fabric and held above the head as a protection against sun or rain. The name in the Latin is from the word *umbra,* "shade," and has been perpetuated in *umbrella,* which means "a little shade," and is similar to the Roman word *umbraculum.* The term *parasol* is now used rather for a sun-shade, the *umbrella* being principally a protection against rain. This distinction is not closely maintained; it is a matter of climate.

Umbrellas were in common use many centuries ago in China, and their paper parasols, called *kittysols,* are largely exported thence.

In Asiatic countries (and, indeed, in Africa, both ancient and modern), the umbrella has, from ancient times, been regarded as a symbol of royalty or nobility. The form exists in the Buddhist *topes* and Hindoo pagodas. It is too much to assume that the umbrella is the type of Chinese architecture, as that is evidently tent-like, and is incident to the swaying of ropes, or of the somewhat pliable materials in a land of bamboo: of that, presently. It is pretty certain, however, that the umbrella, as a sign, had reference to the *linga* in the phallic worship of the East, which was afterward repeated farther west in the worship of Dionysius, at the Arcadian feasts, where he was exposed under an umbrella, which came to be regarded as his emblem, and appears in several basso-relievos and Etruscan vases. As with the treatment by the Greeks of the Egyptian pantheon and rites, so with the Dionysiac worship imported from India; the ceremonies became orgies, and the festivals of Bacchus became a mere saturnalia, where the devotees dressed as satyrs, the antitype of the modern Carnival. Even the more sedate *Father Liber* of the erudite Pliny did not escape infection.

To establish the parallel more distinctly, it may be said that, in the fifth incarnation of Vishnu, the god goes down to tophet with an umbrella in his hand. Dionysius is also represented descending, *ad infernos,* with a small umbrella. In one feast of Athene, a white parasol was borne by the priestesses of the goddess from the Acropolis to the Phalerus.

Mr. Ferguson states, in his "Handbook of Architecture," that the umbrella is shown in the cave of Karli, in India, and supposes the sculpture to be over eighteen hundred years old. The umbrella so used is called a *tee.* The *tee,* or tope finial, is a prominent feature in some Oriental buildings, especially the Chinese. The pagodas are a series of umbrella-like roofs. One, two, and a terminal, like other illustrations of the law of climax, may have had something to do with the triple crown or tiara. The machinery of worship in Europe, and here, so far as imported, is mostly of Asiatic origin, — bells, rosaries, censers, robes, and banners, the common property of the Aryan nations, from the Ganges to the Atlantic. See PRAYING-MACHINE.

The "Tcheou-Li," a book of Chinese ceremonies, about A. D. 300, specifically directs the shape, size, and construction of the umbrella to be raised over the royal car. It had 28 ribs, and an extension-handle. We read of 24 umbrellas being carried before the Emperor of China, when going hunting; and that, in the second Tartar invasion of China, the Emperor's son was made to carry an umbrella over the head of his captor.

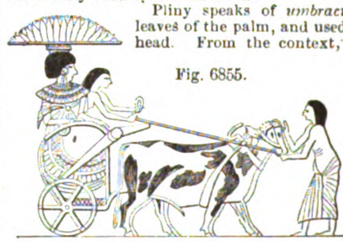
Fig. 6854.

Persian Umbrel'a (from Persepolis).

The accompanying cut (Fig. 6854), from a sculpture at Persepolis, represents attendants carrying a parasol and fly-flap over a Persian chief. The framework of the parasol was probably light, but it does not seem that it was collapsible. The Chinese probably had folding-umbrellas at that time. An umbrella, apparently made of feathers, is represented in a Theban tomb. It is carried over the head of an Ethiopian princess, who is riding in an Egyptian plaustrum, such as Pharaoh or Joseph sent for Jacob, and called "wagon" in the "authorized" translation of the Bible.

Fig. 6856 is a parasol from the Royal Palace, Nimroud. Rawlinson says that the parasol was exclusively used by the monarch.

Fig. 6855.



Egyptian Umbrella (from Thebes).

Pliny speaks of *umbracula* made of split leaves of the palm, and used for covering the head. From the context, it should appear that he referred rather to a palm-leaf hat than an umbrella.

The *flabellum,* or fan, or, as we may call it, the feather-brush or duster, was commonly carried by the attendants of people of rank, and was used as a shade, fan, or fly-brush. See FAN.

The umbrella was the θόλιον of the Greeks, the *umbraculum* of the Latins. It was a parasol or sunshade, carried by the Roman ladies or by attendants, known as *umbellifera.* It was made to open and close, like the modern umbrella, but was somewhat more clumsy. The Greek ladies used it in the theater, as did also the Roman. Its use was considered effeminate in a man. They were commonly of green linen stretched upon a frame and supported by a staff. Such are represented on ancient vases, and frequently referred to by contemporary writers: Aristophanes, Ovid, Anacreon, Martial, Juvenal, etc. The Hamilton vases show several instances of Greek and Etruscan umbrellas. Xerxes and Cleopatra are represented as sitting under canopies or umbrellas, watching the fight or the play. The Greek ladies wore straw hats and bonnets (Pollux, "Theocr."). The Roman men wore broad-brimmed felt hats, *petasus* (*wide-awakes*).

Fig. 6856.

Parasol at Nimroud.

Christie describes an Etruscan vase in which Bacchus presents a dove to a seated female, while an umbrella is held above their heads by another female.

Fig 6857 is from the Harleian Manuscript, No. 603, and represents a servant holding an umbrella over his master. Its use during the Middle Ages in Europe is frequently noted in monkish chronicles.

Fig. 6857.

Anglo-Saxon Umbrella

They are mentioned in Florio's "Worlde of Wordes," 1598 ("*ombrella,* a fan, a canopie; also a testern or cloth of state for a prince; also a kind of round fan or shadowing that they vse to ride with in summer in Italy; a little shade"), and by Ben Jonson, in a comedy, 1616, and were used by ladies in the time of Queen Anne. Du Cange mentions the custom of contracting and expanding them. Cotgrave, in his "History of the English and French Tongues," speaks of the French *ombrelle.* Montaigne refers to its use in Italy.

M. de la Loubère, ambassador

from France to Siam, 1687-88, states that the King of Siam had a triple umbrella, several frames and covers being fastened to the same stick. This was a royal right. The nobles had single umbrellas. Common people stood in the sun. The Siamese monks (*Talapoins*) had palm-leaves cut and folded, so that the stem formed a handle.

Tavernier describes the umbrellas on each side of the throne of the Great Mogul, and those at the court of the king of Ava, whose title was, and perhaps is, "King of the White Elephant and Lord of the Twenty-four Umbrellas." The Mahratta prince, at Poonah and Sattara, was known as "Lord of the Umbrella." The same regard is paid to its use in Burmah, Assam, Yemen, Constantinople, Morocco.

As appears by the "Female Tattler" of December 12, 1709, the umbrella was only designed as a protection between the door and the carriage. Jonas Hanway, who died in 1786, has the credit of contemning public opinion, and defying the coach-men and sedan-chair men, who deemed it their monopoly to protect from rain.

It was made, in those days, of oiled silk, upon a heavy frame. The substitution of silk and gingham, and a light, elastic frame, have contributed to its popularity.

The account in the "Female Tattler" states to the "young gentleman belonging to the custom-house who, for fear of rain, borrowed the umbrella at Will's coffee-house, Cornhill, of the mistress," that "to be dry from head to foot, on the like occasion, he shall be welcome to the maid's pattens." Gay mentions the umbrella as early as 1712, in his poem of "Travia," in which he says: —

"The tucked-up seamstress walks with hasty strides,
While streams run down her oiled umbrella's sides."

Mr. J. Jamieson, a Scottish surgeon, brought with him from Paris, in 1781, an umbrella, which was the first seen in Glasgow, where he resided, and where it attracted universal attention.

About 1774, "umbrilloes" were mentioned as being used in Boston. They were large, blue, with a ferrule like a small pagoda, and wood enough in the handle for a harpoon-stock.

In the manufacture of umbrellas and parasols, the system of the division of labor is carried to a high degree of perfection, enabling the commoner qualities to be produced exceedingly cheap.

In preparing an ordinary umbrella-stick, it passes through 19 separate processes or movements; each of the ribs requires 13 distinct manipulations, making 104 for the 8 ribs. "Weighing" the ribs, to give them all an equal flexure, requires 8 more transfers from hand to hand, and threading the ribs to the stretchers brings up the total series of operations required for the frame to nearly 150. Within comparatively few years, this cost, in London, from $\frac{1}{2}$ *d.* to $2\frac{1}{2}$ *d.* each, for common umbrellas and parasols; one man and four boys can put together 100 frames daily. For covering each frame, women received from 1 *d.* upward.

A tradesman in Bristol, England, has just made a monster umbrella for an African chief. It is 65 feet in circumference, the lancewood ribs being 6 feet long, and there are 140 yards of material in it. It is covered with red, blue, and white chintz, and takes two men to expand it.

Fig. 6858.

Foote's Lock-Stand for Umbrellas.

In Trinidad are colonies of ants, "known as parasol ants, from the fact that each individual carries a leaf in his mouth, which shades his back. These luxurious insects, on being disturbed, rush into their holes and bring out a lot of very large chaps with big heads and tremendous nippers, who at once assume an attitude of self-defence, being, in fact, the bullies of the establishment, while the gentle parasol-bearer stands aside to watch the fun. This is almost as surprising as Sir John Lubbock's statement that some tribes of ants keep milch cows, and also an old beetle, whom they worship as an idol." — TALBOT'S *West India Pickle.*

A traveler near Manjee, a small town at the confluence of the Gogra and the Ganges, mentions a banian-tree which resembled an immense umbrella, being of a pyramidal shape, sloping from a central summit to the extremity of the lower branches. The limbs of these trees extend out a distance horizontally, and then let down to the ground a number of leafless fibers, which presently take root, coalesce, and increase in bulk, so as to support the protracted branches like supplementary trunks. From these new centers of vegetation other arms again spring out, and at their terminations form a third series of stems, so that a full-grown banian-tree composes a whole grove in itself.

The central part, in the instance cited, is over 100 feet high; the diameter of the ground covered is 363 feet from north to south, and 375 feet from east to west. The circumference of the shadow at noon is 1,116 feet. The number of props about 60.

Um-brel'la-stand. The umbrella-stick, above the ends of the bows, is slipped into the notch of one of the disks, and the latter being partially rotated, becomes locked, so that the umbrella cannot be withdrawn without using a key-check. Fig. 6858.

Um'laut. A double dot over the vowels *a, o, u,* in German, indicating a certain quality in the sound of the letter, as in Müller, which is pronounced as "Mueller," nearly.

Un'cial Writ'ing. So called from the letters being an inch (Lat. *uncia*) long. The uncial letters are distinguished from the more ancient by their rounded forms, indicating a cursive style. The ancient letters were all capitals; these were so modified, by the introduction of a cursive style, that a new alphabet grew out of it; what we term smaller letters, or lower case. The uncial shows the modification in form, before the distinction of *capitals* and *lower case* was made.

The passage from John xxi. 19, "Signifying by what death he should glorify God," is from a MS. of the sixth century, the four Gospels and Acts of the Apostles in Greek and Latin.

This form of writing began to take the place of capitals in the middle of the fifth century A. D., and prevailed till the eighth, and in some cases to the tenth century. Its progress was parallel with, or rather a part of the same evolution which, by cursive habits and greater neatness of execution, introduced the *minuscule* or *small-hand* which was adopted in the tenth century, using capitals only for the special positions, occasions, and subjects.

Fig. 6859.

Greek and Latin Uncial Writing.

Un'der-back. The vessel beneath the mash-tun which receives the *wort* from the latter. From the underback the *wort* is pumped into the copper, where it is boiled with the hops. The operation is called *mashing*. See MASH-TUN.

The name *underback* is also applied to a similar vessel in a vinegar factory.

Un'der-cut. (*Founding.*) Those parts of a pattern which hold the sand so as necessarily to tear and break it when the *draw* is made perpendicularly, are said to be under-cut. By using a three-part box, dividing the pattern at a suitable place, or using a *false core* or *draw-back*, difficulties of this kind can always be overcome.

Un'der-ground-railway. One wholly or in large part beneath the street surface of a city.

The city of London is now intersected by a perfect network of subterranean railways, extending from the central business portions of the town to the suburbs. The running hours are from 5.10 A. M. to 12.40 P. M., and, during the busy portions of the day, trains leave and arrive at the principal stations every three minutes. The cars are drawn by locomotive-engines, and are divided, as is usual on English railways, into first, second, and third class; the average fare on the latter, which convey more than two thirds of the whole number of passengers, being twopence.

The first portion of the Metropolitan Underground Railway, from Bishop's Road to Farringdon Street, was opened January 10, 1863. In that year the number of passengers was 9,455,000; in 1864, 11,722,000; in 1865, 15,763,000; in 1866, 21,273,000; in 1867, 23,405,000; in 1868, 27,708,000; and, in 1869, up to June 30, the number of passengers was 20,000,000; receipts, £190,000.

The Fourth Avenue of New York is largely occupied, beneath the street level, by the common track of the Hudson River, Harlem, and New Haven railways.

Un'der-lay. 1. (*Mining.*) When a vein hides or inclines from a perpendicular line, it is said to underlay.

2. (*Printing.*) Paper laid back of the tympan sheet in order to create local pressure on certain parts of the sheet of paper in the act of printing, and thereby increase the strength of the impression at such points.

Un'der-lay'er. (*Mining.*) A perpendicular shaft, sunk to cut the lode at any required depth.

Un'der-lay-shaft. (*Mining.*) A shaft sunk on the course of the lode.

Un'der-lev'el Drift. (*Mining.*) A drift driven from the pumping-pit to draw off the water from dip-workings.

Un'der-lie. (*Mining.*) The *dip, inclination*, or *slope* of a *stratum*, or a vein of ore. *Under'ay.*

Un'der-met'al. The position of a gun when the muzzle is depressed below the line of a level axis.

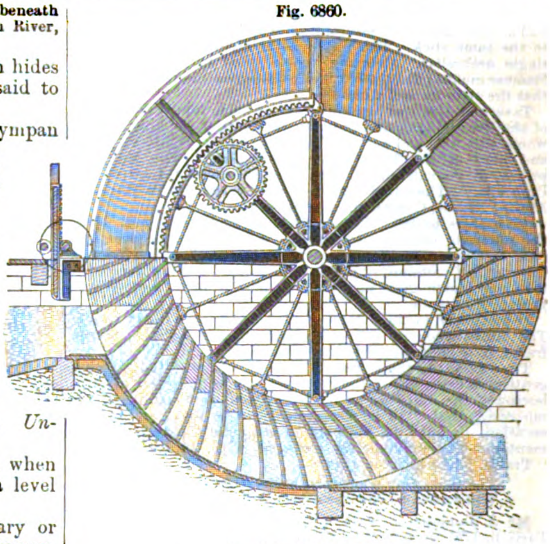
Un'der-pin'ning. 1. Supports, temporary or permanent, introduced beneath a wall already constructed. *Undersetting.*

As a consequence of raising the grade of Chicago streets, many buildings had to be raised and *underset.*

2. A system of sinking brick-lined shafts.

A hole being dug, having a diameter the size of the required cylindrical brick structure, an annular curb of heavy oak is laid at the bottom; the width of the curb is equal to the thickness of the wall which is built thereon. A hole is then dug in the center of the floor, and inclined props are placed beneath the curb. These constitute the underpinning. The earth is then excavated beneath the curb to a depth allowing masons to work. A second curb is laid on the new floor, and the brickwork is laid thereon and carried up to the curb above. Thus the work proceeds, a section at a time; the upper structure in each case being underpinned while a section is being inserted below.

Fig. 6860.



Sagebein Water-Wheel.

Un'der-set'ting. The operation of supporting earth in a cutting when situated beneath rock. A retaining-wall is built against the face of the earth-bank. See also UNDERPINNING; a synonymous word.

Un'der-shot Wa'ter-wheel. A water-wheel moved by water passing beneath: in contradistinction to the *overshot*, in which it is received above; the *breast*-wheel, in which it is received at or nearly on a level with its axis; the *turbine*, in which it runs through; and some others. See list under WATER-WHEEL.

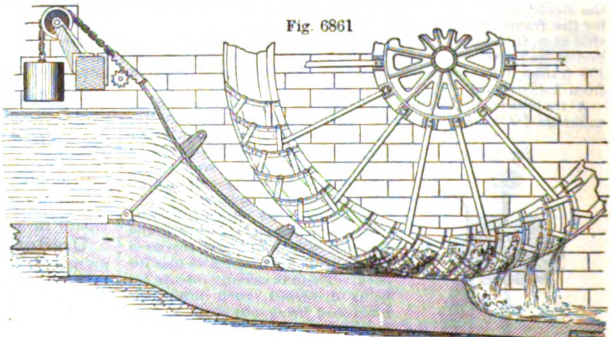
The Sagebein wheel (Fig 6860) is adapted to a very slow flow of water, from $2\frac{1}{2}$ to 3 feet per second, the circumferential velocity of the wheel being from 2 to $2\frac{1}{2}$ feet per second. The buckets are placed tangentially to a circle described, with a radius equal to from $1/8$ to $1/5$ the radius of the wheel, and the pitch being usually small. The depth of the buckets is usually made equal to the hight of the fall when the latter does not exceed $4\frac{1}{2}$ feet, and the width of the wheel is from $1/2$ to $2/3$ of its radius. The diameter of the wheel is usually made equal to 10 feet $\times$ $3/4$ of the fall. In that illustrated, the buckets have a slightly curvilinear shape, and the above-stated proportions have been somewhat departed from, it being intended for running at a higher velocity.

Poncelet's water-wheel (Fig 6861) has buckets of a curvilinear form, open at the back, without a sole-plate, to secure ventilation. The water impinges upon each bucket at nearly the lowest point of the wheel, the shuttle being arranged to draw upward; and as the water enters it follows the curve of the bucket, rises and falls over into the next in succession. In this way the force of the water is expended directly upon the wheel, instead of a portion being wasted in its passage along the sluice. The illustration is of one erected in Catalonia, having a diameter of 16 feet 8 inches, and width of 30 feet. The buckets are of $\frac{1}{4}$ inch wrought-iron, the arms of wrought-iron, and the main shaft is made up of short cast-iron cylinders 4' 6" in diameter, bolted together.

The fall of water was 6' 6", 120,000 cubic feet per minute passing when the periphery of the wheel moved 11 to 12 feet per second. The sluice-gate was formed of cast-iron plates with planed joints flanged and bolted so as to form one large shuttle the whole breadth of the wheel. It was connected by radial tie-rods with the stone apron of the sluice, and could be raised with great facility by racks and pinions, and regulated by the ordinary governor, the weight of the gate being in a great degree supported by the water flowing beneath it on to the wheel, and in part by counterbalance weights.

The sluice-gate moves between the side walls of the pentrough, and cup-leathers at each side prevent the waste of water.

Fig. 6861

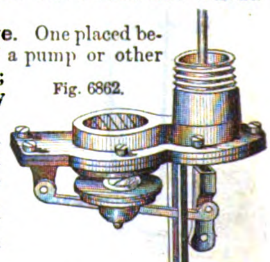


Poncelet's Undershot Water-Wheel.

Un'der-shot-wheel. See UNDERSHOT WATER-WHEEL.

Un'der-shut-valve. One placed beneath the sole-plate of a pump or other object, and not upon it; shutting underneath by an upward motion.

Fig. 6862.



Undershot-Valve.

Un'der-the-Top. (*Mining.*) A term used where it is necessary to leave part of the coal, in the roof of a gallery cut into the form of an arch.

Un-dock'ing. The

process of launching a ship, built in a dry-dock, by allowing access of water to the dock.

Un-hair'ing. (*Leather Manufacture.*) The process of removing hair from hides. This is performed by the action of lime, which dissolves the hair sheath and combines with the fat of the hide to form an insoluble soap. The lime is suspended in water in pits, and the hides placed therein, being occasionally *handled*, that is, *taken out*, *drained*, and *replaced* in the pit, examination determining when the process is complete.

The hides are then removed, laid over a beam, and the hair and epidermis removed by the *unhairing-knife*.

Substitutes for lime have been anxiously sought, and the following have been used; objections occur to some of them from the occurrence of a softening and incipient putrefaction of the hide.

Hanging in a smoke-house heated by a smoldering fire.

Piling in a heap and covering with spent tan.

Steaming.

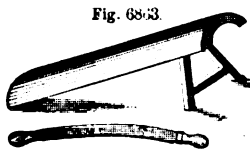
Piling in manure.

Suspension in a confined atmosphere, saturated with spray. See Muspratt, II. 575.

Baths of dilute acids, sour milk, fermented bran or meal. See Muspratt, II. 514.

Warrington used sulphide of calcium, which loosened the hair and softened the epidermis in from 24 to 34 hours.

Fig. 6863.



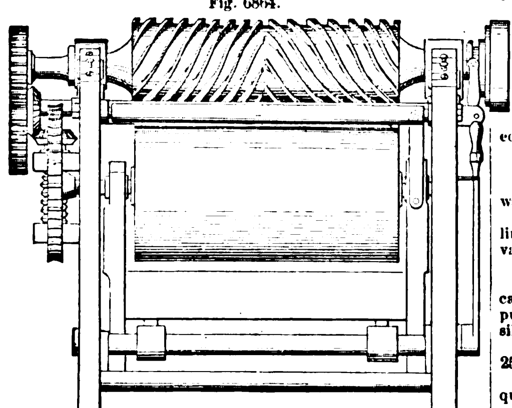
Unhairing Beam and Knife.

Un-hair'ing-knife. A curved, two-handled iron scraper, for removing the hair from hides which are taken out of the lime-pit and laid over the *beam* for that purpose. The beam is semi-cylindrical, and the knife is concave, to fit the curvature.

Un-hair'ing-ma-chine'. One for removing hair, and sometimes flesh, from hides.

Fig. 6864 is a machine for removing hair from hides. It consists of a cylinder having cast upon it helical screw-blades, running from the middle of the cylinder to each end. Below this cylinder, which revolves upon a shaft, is another cylinder larger in diameter than the upper one, the shaft having its bearings in a frame. The two cylinders are caused to revolve

Fig. 6864.



Machine for Unhairing Hides.

by means of suitable gearing, the former revolving much faster than the latter; the latter may also be raised or lowered by means of cams on the shaft.

Un'ion. 1. (*Hydraulics.*) A tubular coupling for pipes. See PIPE-COUPLING.

Fig. 6865 shows several forms.

a is a common union, with a ball to prevent the sinking of the water above it.

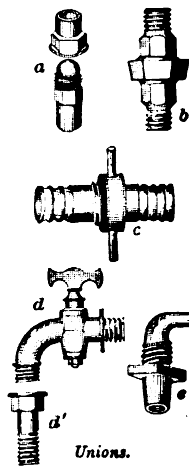
b, a gun-metal steam union.

c, a *hose*-union. See HOSE-COUPLING.

d, a union for bib-cocks, the joint on the end for the *hose*-union *d'*, and the shank end screwed for iron pipe.

e, *ceiling*-union.

Fig. 6865.



Unions.

2. (*Fabric.*) A fabric of flax and cotton.

3. The upper corner of a flag, against the staff, the other portion being the *fly*. See Fig. 2005, page 875, and description.

The name of *union* is derived from the combined crosses of St. George and St. Andrew (the patron saints of England and Scotland respectively), which were united to form the flag of Great Britain when the two countries were united under King James I., who was previously James VI. of Scotland; and a wretched business he, his son, and his two grandsons made of it. The name *jack*, which distinguishes the *union* without the *fly*, was from the said Jacques, who in uniting the countries became the Union Jacques, which the jolly tars made *union jack*.

Un'ion-joint. A pipe-coupling. See UNION; HOSE-COUPLING; PIPE-COUPLING; JOINT.

Un'ion-pump. (*Hydraulics.*) One in which the engine and pump are united in the same frame.

Un'ions. (*Fabric.*) Mixed goods. Cotton, flax, jute, silk, and wool are united in various binary or trinary combinations.

U'nit. A single one of a thing or of a number, forming the basis of count.

The *unit of numeration* is one (1), taken in the *abstract*. *Concrete units* express also character, as one foot, one dollar, etc.

The terms *decimal* and *duodecimal* units express that the numbers increase by scales of ten or twelve respectively.

A *fractional unit* is a single one of the parts expressed in the terms of the denominator, as $\frac{1}{4}$ is the unit of the fraction $\frac{3}{4}$.

A *unit of measure* is a conventional quantity, as a foot, a bushel. Some of these conventional units are specific proportional parts of objects of known magnitude, or determinable by something more than a mere arbitrary measure of comparison.

Such are: —

The English yard = $1/1.08719$ parts of the length of a second's pendulum vibrating in vacuo in the latitude of London at the level of the sea, in a temperature of 60° Fah.

The United States standard foot is $12/39.1012$ of the length of a seconds' pendulum in the City Hall of New York.

A French *meter* is $1/10000000$ of the distance between the equator and the pole, measured on a meridian. A meter is equal to 39.37 inches English. See METRIC SYSTEM.

An hour is $1/24$ part of a mean solar day.

Other units of measure are: —

The *specific-gravity unit*: for solids, 1 cubic foot of distilled water at 60° = 1; for air and gases, 1 cubic foot of air at 60° = 1.

The unit of minute or microscopic measurement, as for the lines in spectrum analysis, is the wave-length of light, the mean value of which is about $1/50000$ of an inch.

A *unit of value* is a conventional quantity.

In England; a pound sterling, represented by a gold coin called a sovereign, weighing 123.374 grains, and having $11/12$ of pure gold. The pound sterling, A. D. 672, was a pound troy of silver.

In the United States: a gold coin, called a dollar, weighing 25.8 grains, one tenth of which is alloy.

A *dynamic unit* is one which forms a basis for expressing the quantity of a force, as

The *unit of mechanical power:* foot-pounds; that is, 1 foot raised 1 foot high per minute.

The *unit of horse-power:* 33,000 pounds raised 1 foot high per minute.

The *unit of atomic weights:* hydrogen, 1.

The *unit of heat*, or *thermal unit*, employed in Great Britain, is the quantity of heat which corresponds to 1 degree of Fahrenheit's scale in the temperature of 1 pound of pure liquid water, at about 39° Fah.

The *thermal unit* of France is the quantity of heat which corresponds to an interval of 1° Centigrade in the temperature of 1 kilogramme of pure water at about 3.94° Centigrade.

Rumford, in 1798, endeavored to ascertain the number expressing the precise relation between the functions of force and heat, known as the *mechanical equivalent of heat*. He used a

solid plunger rotating against the bottom of an iron cylinder submerged in a box of water. Mayer and Joule farthered the experiment, the latter using paddle-wheels rotated in oil, mercury, or water, by the force of a descending weight. The conclusions were, that the descent of 772 pounds 1 foot would raise the temperature of 1 pound of water 1° Fah.; therefore, 772 pounds = 1 unit of heat, and conversely, 1 unit of heat would produce a force of 772 foot pounds; consequently, 42.7 units of heat must be equal to 33,000 foot pounds = 1 horse-power.

The London unit of illumination for photometric estimate of gas (and it is understood that the Metropolitan Gas Company of New York is similar) is the light of a sperm candle burning 120 grains per hour.

The standard for gas is that the flame, burning at the rate of five cubic feet per hour, shall give a light equal to the light of 14 sperm candles, each consuming at the rate of 120 grains per hour.

The *units of electricity*.

The *unit of resistance* of the British Association (B. A. unit) is called an *ohm*, from the German savant Ohm, who reduced the measurement of electric forces to a system.

Siemen's *unit of resistance* = .9564 of an *ohm*.

Varley's *unit* = about 25 *ohms*.

The *unit of tension*, or electro-motive force, is called a *volt*, from the illustrious name Volta. It does not differ greatly from a Daniel's cell, which is = 1.079 *volt*.

The *unit of quantity* is called a *farad*, from the philosopher Faraday; it is that quantity of electricity which, with an electro-motive force of one *volt*, will flow through a resistance of one *megohm* (1,000,000 *ohms*) in one second.

The *unit of current* is a current of one *farad* per second.

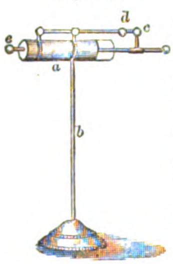
The *unit of work* is that which will produce a velocity of one meter (39.37 inches) per second, in a mass weighing one gramme (15.44 grains) after acting upon it one second of time.

The *electro-chemical unit* is a quantity of current that will decompose .143 grain of water, or generate 1.02 cubic inches of gas per second, the amount of zinc consumed in each cell being .513 grain.

U'nit-jar. (*Electricity.*) An instrument devised by Sir W. Snow Harris for measuring definite quantities of electricity.

It consists of a small Leyden jar *a* insulated by being mounted upon a glass rod *b*. Attached to the brass wire which connects the inner coating of the jar with an electrical machine is a sliding brass-ball *c*. The electricity repelled from the exterior coating is conveyed to the surface to be charged from the ball *e*. When the jar is charged to a certain amount, determined by the distance apart of the balls *d c*, a spark passes between these balls and discharges the jar, which is again recharged by the machine; by counting the number of sparks and noting the distance between the balls, the number of equal but arbitrary units which have been repelled from the outer coating on to a larger surface, as a large Leyden jar or battery, may be ascertained.

Fig. 6866.



Unit-Jar.

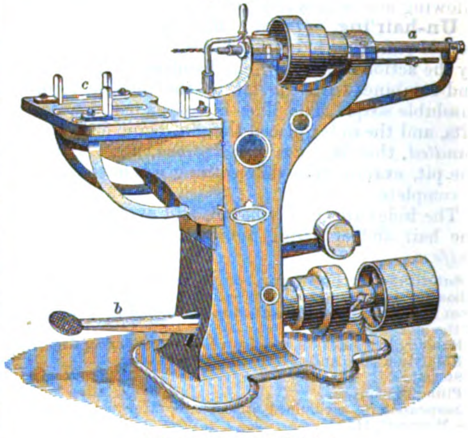
U-ni-vers'al Bor'ing-ma-chine'. (*Wood-working.*) A machine adapted to a great variety of work with tools of varying sizes, and the work presented in numerous positions.

In the machine (Fig. 6867) the mandrel *a* which carries the auger is traversed by a foot-lever *b*. The table *c* has adjustable rests enabling the wood to be presented to the tool at any desired horizontal angle, and may be inclined and held at any angle not exceeding 45° with the bit. It may also be raised or lowered to suit the character of the work. Three cone-pulleys are attached for graduating the speed of the mandrel to suit different-sized bits.

U-ni-vers'al Chuck. A chuck having movable dogs on a face-plate, so operated as to move radially simultaneously, to adapt them to grasp objects of varying sizes.

U-ni-vers'al Com'pass. (*Drafting.*) A compass having tubular legs containing extension-pieces, which may be drawn out to strike a large circle, and fixed at the required length by set-screws. The extension-pieces are also tubular, each receiving either leg of a small bow-compass, one having a plain point and pen and the other a plain point and pencil-holder; these are used as parts of the large compass,

Fig. 6867.



Universal Boring-Machine.

but both may be withdrawn and used independently for drawing small circles.

U-ni-vers'al Coup'ling. One in which the parts united are capable of assuming various angular relations to each other. A *gimbal-joint* is a familiar instance, — an invention of that versatile gentleman, Dr. Hooke. See UNIVERSAL JOINT; FLEXIBLE COUPLING.

Fig. 6868.

Universal Compass.

U-ni-vers'al In'stru-ment. A reflecting instrument invented by Professor Piazzi Smyth. It is a sort of reflecting circle, in which a spirit-level with a very small bubble is so placed that by means of a lens and a totally reflecting prism an image of the bubble is formed at the focus of the telescope, and the coincidence of the center of that image with the cross-wires shows when the line of collimation is truly horizontal.

U-ni-vers'al Joint. A device for connecting two objects, as the ends of two shafts, so as to allow them to have perfect freedom of motion in every direction within certain defined limits.

The gimbal-joint was invented by Dr. Hooke.

In one form (*a*, Fig. 6869) it is the common mode of uniting the tumbling rods which connect the horse-power and the thrashing-machine, clover-huller, wood-saw, or other agricultural implement.

The ends of two coupling-rods are pivoted to the arms of a cross having a freedom of motion in planes at right angles to each other. This allows flexure in any direction.

In another form (*b*) the heads on the ends of the coupling-rods are pivoted by pins in a ring; the pins are at right angles, and the effect the same as that just described.

c is a ball-and-socket joint in which the ball of one section is held in the socket of the other by means of an annular cap secured by its flanges to those of the socket.

A somewhat neater job (*d*) may be made by making a screw cap instead of a flanged cap.

Mariners' compasses, barometers, chronometers, and some other seafaring instruments are mounted in gimbals (*e*), so as to maintain an even position, horizontal or perpendicular, as the case may be, whatever may be the changes in the position of the vessel.

f is Dr. Hooke's gimbal. A ring is suspended by studs on diametrically opposite sides, so as to have a freedom of motion in one vertical plane, and within this ring the object itself is suspended on an axis through the diameter and at right angles to the former.

The double gimbal (*k*) has been contrived for positions where a flexure of over 140° is required.

It is used to obviate the vibratory and unsteady motion incident to the action of the ordinary form of this joint. Between the two shafts to be connected, a short intermediate shaft is introduced, making equal angles with the two principal shafts, connected with each by a Hooke joint, and having both its own forks in the same plane.

g is a flexible joint for water-mains. The sphero-segmental end of one pipe passes into the enlarged end of the other, and is surrounded by an annular water-tight packing.

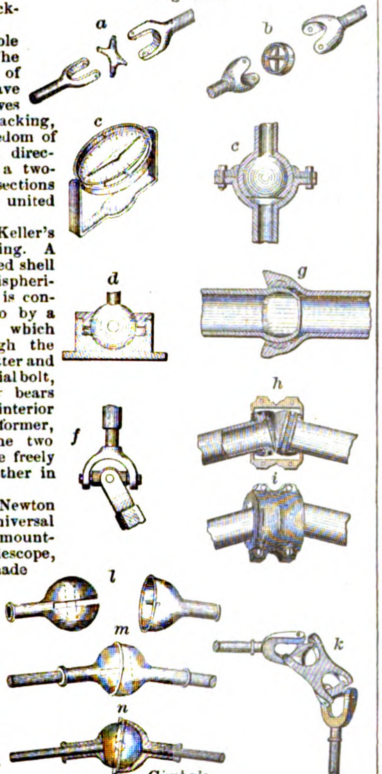
h i, a flexible pipe-joint. The flanged ends of the pipes have annular grooves to receive packing, and have freedom of motion in all directions within a two-part box, the sections of which are united by bolts.

l m n, Keller's shaft-coupling. A globular slotted shell enters a hemispherical shell, and is connected thereto by a pin or bolt which passes through the sides of the latter and through an axial bolt, which merely bears against the interior wall of the former, permitting the two shells to move freely about each other in all directions.

Sir Isaac Newton contrived a universal joint for the mounting of his telescope, which was made about 1675, and is now in the possession of the Royal Society, to whom it was presented by the illustrious philosopher.

See Coupling; Ball-and-socket Joint; Gimbal.

Fig. 6869.



Gimbals.

U-ni-vers'al Syr'inge. (*Surgical.*) A syringe to be used for various purposes, having irrigating-nozzles of various shapes and sizes, for reaching different portions of the body, washing out wounds and ulcers, injecting caustic solutions, etc. The various attachments are applicable to the uterus, male and female urethra, and bladder; ear, larynx, nares; a hard rubber stop-cock fits the catheter, or trocar, for hydrocele, etc.

Fig. 6870.

Newton's Universal Joint.

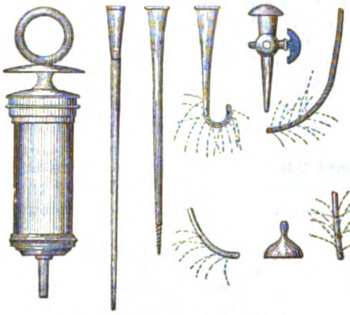
Un-load'ing Ma-chine'. An apparatus for removing freight from boats, cars, or wagons.

The usual form for unloading freight in bulk is that of a series of cups on an endless band. See Elevator.

For unloading freight in bags, sacks, boxes, barrels, and other packages, the device generally consists of a traveling platform or endless chain.

One is at St. Louis, belonging to the Grain-Elevator Company. At intervals of 4 feet on the moving platform are fixed blocks, to hold barrels and hogsheads in place, the width being 4 feet, sufficient for a hogshead of sugar. It is run by steam,

Fig. 6871.



Tiemann's Universal Syringe.

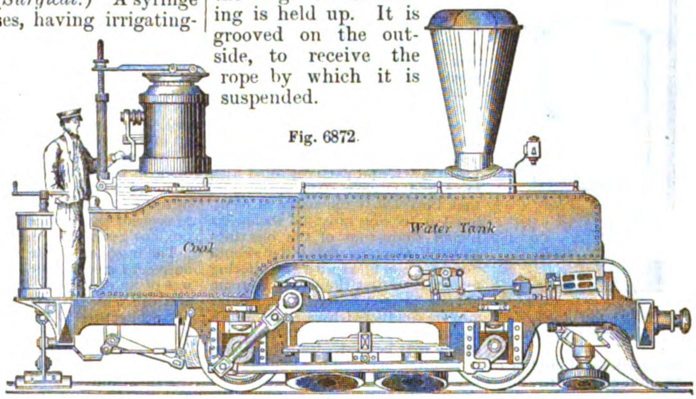
and is capable of unloading 1,000 barrels of sugar, 700 barrels of salt, or 150 hogsheads of sugar per hour. Sacks of grain can be unloaded as fast as they can be put on and taken off. It extends a distance of 50 feet, and reaches from the guard of the boat from which goods are to be unloaded a considerable distance into the warehouse. It is also arranged so that it can be adjusted to high or low water.

U'no-rail. A traction system for ordinary wagons, in which a single rail is laid for the locomotive, which has nearly horizontal wheels to grasp the rail. The wagons are coupled on the rear. See Fig. 6872; also Center-rail.

Up'cast-pit. (*Mining.*) The pit up which the air ascends after ventilating the mine; in contradistinction to the *downcast*.

Uph'roe. (*Nautical.*) A long piece of wood with several holes, through which pass the cords by which the ridge of an awning is held up. It is grooved on the outside, to receive the rope by which it is suspended.

Fig. 6872.

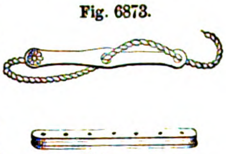


Uno-Rail System.

The *uphroe* and its cords form a *crow's-foot.* Sometimes spelt Euphroe (which see).

An analogous device is also adapted in some forms of *bag-holder*, and shown in the upper figure.

Fig. 6873.



Uphroe.

Up'per. The part of a boot or shoe above the sole and welt and forward of the ankle-seams.

Up′per-leath′er. The vamps and quarters of boots and shoes.

Up′per-ma-chines′. (*Boot-making.*) A term which includes all those for cutting out or preparing the uppers of boots or shoes. Among these are *crimping, trimming, seam-rolling,* and *turning* machines.

Up′right. 1. (*Carpentry.*) A pillar or post in a frame or other structure.

2. (*Steam.*) A term synonymous with *vertical*, as applied to a boiler whose hight is greater than its width; and to a steam-engine in which the stroke is perpendicular. See list under STEAM.

3. (*Wood-working.*) A term applied to a molding-machine whose mandrel is perpendicular. See Fig. 4916, page 2133.

Up-set′ting. Contracting a heated metallic object by endwise blows. In thickening the end of a rod to form a head it is *spread* by blows directed endwise.

Shortening tire, to enable it to bind the fellies more firmly, is called *upsetting*, and is presumed to be done by cutting the tire, and then shortening by the process described, after which the tire is re-welded. It is, however, oftener done by cutting out a piece and re-welding. The name is retained, but no *upsetting* occurs. See TIRE-SHRINKER; TIRE-UPSETTER.

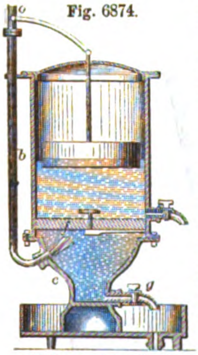
Up-set′ting-press. See FORGING; STEEL-PRESS; TIRE-UPSETTER; etc.

Up′take. (*Steam.*) The upcast pipe from the smoke-box of a *steam-boiler* furnace, leading to the chimney or stack.

Up′ward Fil′ter. A filter in which the flow of the liquid is upward, giving a certain degree of facility for cleansing the material, by directing a current of clean water in the reverse direction, and giving a downward discharge.

In White and Aveline's artificial spring or upward filter (English), the water is taken from a cistern and admitted by a pipe *b* into the lower chamber *c* of the filter. It then passes through the porous stone *f* into the upper chamber, whence it is drawn as required. A float on the surface of the water acts upon a faucet *o* to allow the flow of water as the supply of filtered water fails.

Fig. 6874.



White and Aveline's Upward Filter.

When the water in lower chamber *c* becomes muddy, the faucet *g* is opened and the contents discharged, thus flushing the chamber and washing off the bottom of the stone. See also FILTER.

In Turkey, a method of filtering water by ascension has been practiced, the arrangements for which are contrived as follows: —

Two wells are dug at a small distance apart, and partially filled with sand and gravel. The opening of that into which the water to be filtered is to run must be somewhat higher than that of the one into which it ascends; this latter should not be quite filled with the filtering material, so that there may be room for the filtered water, or the water may be conducted by a spout into a reservoir Two casks, tubs, or other vessels may be used. By this method the particles of sand or other filtering material used do not rise and mingle with the filtered water in the receiving-vessel.

U-ran′i-co-plas′tic In′stru-ments. (*Surgical.*) For ingrafting in cases of deficiency of the soft palate. The instruments are similar to those used in *staphyloraphy*, operation for cleft palate. See STAPHYLORAPHIC INSTRUMENTS.

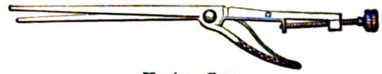
U-ra′ni-um. Equivalent, 60; symbol, U.; specific gravity, 18.4; fusible under the blow-pipe. Used in coloring porcelains and enamels.

Ur′chin. One of a pair of rapidly revolving small card cylinders, arranged around the periphery of a large card drum.

The *urchins* of a pair are of unequal size, and are called the *worker* and *cleaner* respectively. The former takes the tussocks from the large card drum, disentangles them, and parts with them to the *cleaner*, which returns them again to the large drum. They then pass to the next pair of *urchins*, and so on, being thus laid straight, ready for spinning. See CARDING-MACHINE.

The name *urchin* is derived from a certain resemblance it bears to the little animal the urchin, or hedge-hog, which is covered with spines.

Fig. 6875.



Urethra-Cutter.

U-re′thra-cut′ter. (*Surgical.*) An instrument for enlarging the urethral canal by cutting, in case of stricture.

U-re′thra-syr′inge. (*Surgical.*) A syringe with a long nozzle, for introducing medical preparations or irrigating any prescribed portion of the mucous membrane lining the male urethra.

Fig. 6876.

Urethra-Syringe.

The glass barrel is graduated so as to determine the quantity injected.

U-re′thra-tome. (*Surgical.*) *a.* A knife for dividing strictures of the urethra.

b. The instrument of Le Cat, with which he divided the skin and laid open the urethra in lithotomy.

U′ri-nal. A vessel to receive urine.

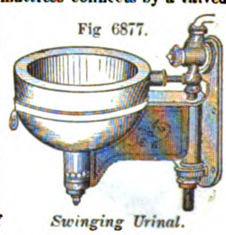
A public basin for convenience of passers by, or in *cabinet d'aisance.*

A reservoir, with conductor, adapted to the penis in cases of incontinence of urine. Its shape and character depend upon its adaptation for the person walking, sitting, lying.

The *gastra* or vase placed in the streets of ancient Rome.

One form is adapted to the mattress, for a bedridden patient. A bowl in the depression of the mattress connects by a valved tube with the chamber-pot. The tube passes through the lid of the vessel, and the valve yields to the fecal discharge

Fig 6877.



Swinging Urinal.

The swinging urinal (Fig. 6877) turns on a vertical hinge, and on being swung into position for use, opens a valve admitting a jet of water for cleansing it.

Burton's urinal has a cascade dome of water, which continually falls into the basin and runs into the outlet, acting as a trap to prevent the upward passage of noxious gases from the drain.

The most elaborate system of urinals in any public building on record was that in the Coliseum of Vespasian. The building was of an oval form, the major and minor diameters being 620 and 513 feet. Hight. 157 feet, in 4 stories, of different orders of architecture. The area of the site is 249,804 feet. The elliptical arena is 287 by 180¼ feet; not quite an acre.

It was calculated to seat 23,362 persons, and each story had its urinals for the respective sexes. The drains were of stone, carefully jointed and luted, and led down through the pillars and the masonry of the staircases, carrying off also the rain-water, which fell in the uncovered building of nearly 6 acres. Few buildings have been so well calculated for large gatherings of persons who remain for several successive hours. All the contents of the drains were eventually conducted to the Cloaca Maxima. This was the chief sewer of Rome, and was built by Tarquinius Priscus (558 B. C.) and his successors. It was 14 feet in width, and 32 feet high, having a sectional area of 448 feet. See CRESY, edition of 1865, pages 110–116.

U-ri-nom′e-ter. (*Surgical.*) A hydrometer adapted for indicating the density, natural or otherwise, of human urine.

Diodorus Siculus relates that the second Sesostris was cured of blindness by washing his face in the urine of a chaste female. He tried that of a great many, till he met with an effective sample. He burnt on suspicion all the persons who proved ill

adapted to his need, including his own wife. He erected two obelisks at Heliopolis to celebrate the cure. The monolith in the Place Concorde, Paris, is understood to be one of the pair.

Urn. A vessel enlarged in the middle and provided with a foot or pedestal; used for holding liquids, for ornamental purposes, and, anciently, for preserving the ashes of the dead after cremation.

The difference between the *urn* and the *vase* is not very obvious. The latter term, however, would seem to be more generic, embracing that class of vessels generally which are oval or bounded in vertical section by lines of double curvature.

Fig. 6878.

Urinometer.

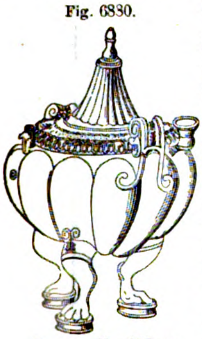
Fig. 6879.

Ancient Urns and Bottles.

In Fig. 6879, the three to the left are Egyptian; the next, Etruscan; the succeeding one, Chinese; and the last from Egypt.

Urns are now used as a part of table service, for drinks utterly unknown to the European nations, — *coffee, tea*, and *chocolate*.

Fig. 6880.



Roman Urn (Museo Borbonico).

Fig. 6880 is a Roman urn from the Museo Borbonico.

See also Rawlinson's "Five Great Empires," Vol. I. page 336.

Urns were used anciently for the ballot, for wine, perfumes, and for cinerary remains. Those for ballots were the wide-mouthed *cistæ*, for holding tickets for the people; narrow-mouthed *cistellæ*, for receiving the votes.

Use. (*Forging.*) A slab of iron welded to the side of a bar near the end, to be drawn down by the hammer in prolongation of the length of the bar. One mode of building up heavy shafts for paddle-wheels, etc.

U'sine. A glass-house.

U'ter-ine Di-lat'or. An instrument for dilating the *cervix uteri*, when contracted. The instrument is made like a forceps, with blades about two inches in length, and answers in the place of graduated metallic bougies in distending the internal *os*.

Fig. 6881.

b

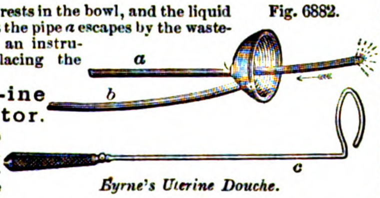
Uterine Dilators.

Ellinger's (*b*) has two pivoted braces connecting and strengthening the blades, and a graduated arc attached to one hand for indicating the amount of dilation.

U'ter-ine Douche. (*Surgical.*) A form of irrigator for the uterus.

The cervix rests in the bowl, and the liquid introduced at the pipe *a* escapes by the waste-pipe *b*. *c* is an instrument for placing the douche.

Fig. 6882.



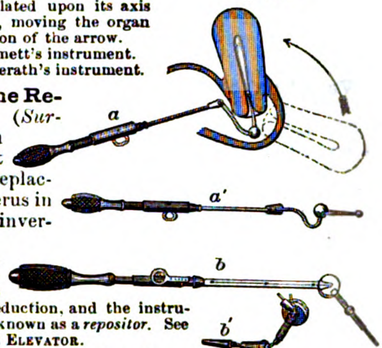
Byrne's Uterine Douche.

U'ter-ine El'e-va'tor. (*Surgical.*) An instrument for replacing the prolapsed uterus, restoring it to its natural position. The instrument includes various members; one enters the *cervix* and extends to the *fundus*. The entering portion is then oscillated upon its axis on the stock, moving the organ in the direction of the arrow.

a a' is Emmett's instrument.

b b', Noeggerath's instrument.

Fig. 6883.



Tiemann's Uterine Elevators.

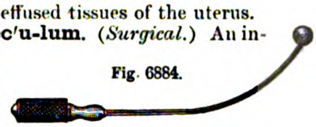
U'ter-ine Re-dress'or. (*Surgical.*) An instrument used in replacing the uterus in cases of inversion.

The operation of restoration is known as reduction, and the instrument also is known as a *repositor*. See also UTERINE ELEVATOR.

U'ter-ine Scar'i-fi-ca'tor. (*Surgical.*) A lancet concealed in a cannula, and used in scarifying engorged or effused tissues of the uterus.

U'ter-ine Spec'u-lum. (*Surgical.*) An instrument for distending the canal of the uterus to expose the interior surface of the latter, as in cases of polypus or cognate disorders. See SPECULUM.

Fig. 6884.

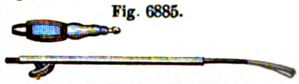


Uterine Redresser.

U'ter-ine Sup-port'er. (*Surgical.*) An application within the vagina to sustain the womb in cases of *relaxation* or *prolapsus*.

It consists of a cup to receive the *cervix uteri*, and a supporting bow. It is made of hard rubber, and weighs but little more than half an ounce.

Fig. 6885.



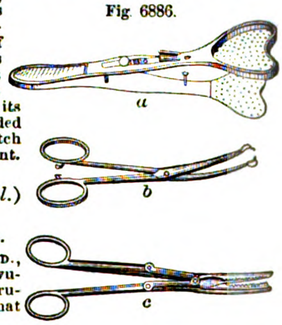
Storer's Uterine Scarificator.

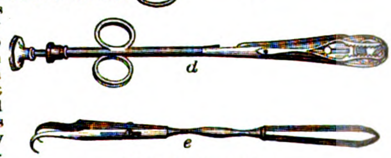
From the cup, in which the *cervix uteri* rests, the bow sweeps down the posterior wall of the vagina, and the lower portion rests upon, and is supported by, the *levator ani* muscle near its attachment to the *os pubis*. The entire posterior or convex portion of the bow resists the action of the downward tendency of the uterus in the cup, while the bladder pushes the anterior wall of the vagina into the concavity of the bow, which in turn is so constructed that it clasps the parts, and is thereby aided in keeping its position. Room is provided for the urethra in the notch at the base of the instrument. See also PESSARY.

Uv'row. (*Nautical.*) See UPHROE.

U'vu-la-for'ceps. Celsius, first century A. D., describes the use of the uvula-forceps; and an instrument supposed to be for that purpose was found by Dr. Savenko in 1819 in a house in Pompeii. It is pictured in Smith's "Dictionary of Antiquities," page 274, and is in the Museum at Portici, together with lancets, spatulas, a cautery, catheters, needles, a tenaculum, probes, etc., found at the same time and place. See SURGICAL INSTRUMENTS.

Fig. 6886.





Uvula-Instruments.

U-vu'la-tome. A cutting instrument for operating on the uvula.

a, tongue-holding forceps.
b, vulsellum.
c, uvula-scissors with claws.
d, Tiemann's uvulatome.
e, Green's double hook.

V.

Vac'ci-na'tor. (*Surgical.*) An instrument for introducing vaccine virus beneath the skin.

The puncturing-tube, with virus in its aperture, is pressed through the skin, and the virus driven into the wound by the force of the spring when the trigger is pushed in.

"The king of Prussia has commanded his army to be inoculated [vaccine matter], and it is believed that Nassau and Bavaria will compel a universal inoculation in their dominions. Exterminating the small-pox and annihilating the little princes and states of Germany, are the two great projects of the reforming part of Germany." — *Monthly Magazine*, London, May 1, 1801.

Inoculation, which, prior to the great discovery of Jenner, was regarded as the best protection against the horrors of the small-pox, was practiced in China at a very early period, and probably found its way to Europe by the same secret channels as those arts whose footsteps are so difficult to trace. Western Europe obtained it from the Turks in 1721, Lady Mary Wortley Montagu having made the first experiment of its efficacy by inoculating her son while residing at Constantinople, in 1718.

Vaccination was discovered by Jenner in 1796. *Inoculation* is the older and more generic term; the name *vaccination*, derived from the source of the pustule matter coming later, as we see in the current news of that day.

Vac'u-um-ap'pa-ra'tus. A mode of or device for producing a proximately complete or partial vacuum.

See AIR-PUMP for the most familiar form, and list under AIR-APPLIANCES for a number of less common devices.

See CONDENSER for the applications of a jet or cold surface to the production of a proximate vacuum in steam-cylinders.

See ASPIRATOR, DEPURATOR, and TROCAR, for various medical uses.

See AIR AS A WATER-ELEVATOR; EJECTOR; INJECTOR; STEAM-JET; Sprengel pump (Fig. 393, page 170), for applications of a blast of steam or air for the production of a partial vacuum for various purposes.

See VACUUM-PAN for one of the earliest uses of the idea in evaporating solutions.

Vac'u-um-brake. (*Railway.*) A form of steam-operated car-brake, in which the general construction of the brake is analogous to that of the Westinghouse. The power employed is the pressure of the atmosphere produced by creating a vacuum instead of that due to compressed air. It is the invention of J. Y. Smith of Pittsburgh.

Vac'u-um-cyl'in-der Cock. (*Steam-engine.*) A valve in a steam-cylinder to allow air to enter behind the piston when a partial vacuum has occurred in the cylinder.

Vac'u-um-fil'ter. One in which the operation is expedited by exhausting the air beneath the filtering-machine.

Vac'u-um-gage. (*Steam-engine.*) An instrument for indicating difference between the external atmospheric pressure and the pressure inside a partially exhausted vessel; such as

A steam-boiler which has become cold and in which the steam has condensed.

A condenser in which the steam from the cylinder is condensed.

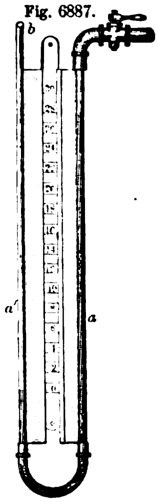
The receiver of an air-pump. See BAROMETER-GAGE.

Fig. 6887 shows a gage attached to the condenser to indicate the perfection of the vacuum in the latter.

It consists of an inverted siphon-tube half filled with mercury, one end *b* having a minute opening communicating with the air, and the other connecting with a cock leading to the condenser. When this is opened, the engine being in operation, the mercury rises in the leg *a* and descends in *a'*. The zero at the lower part of the sliding-scale is brought in apposition with the upper surface of the mercurial column in *a'*; the difference in inches between this and that in the other leg is shown by the scale, and shows the difference between the atmospheric pressure and that inside the condenser.

Vac'u-um-pan. A vessel for boiling saccharine juices in vacuo in the process of making sugar. It was the invention of Howard, an Englishman (Nov. 20, 1813), and is the leading feature in the improved sugar-apparatus.

Fig. 6887.



Vacuum-Gage.

It was formerly made of copper, but has been lately made of iron. Its form is usually nearly spheroidal, but it has been made cylindrical. In the spheroidal form, it is made in two segmental or nearly semi-globular portions, which are united at the equator by exterior flanges having holes for bolts. At the top is a dome, into which the vapor rises, and from which it is drawn either by a pump or a condenser. In the Degrand train, the vapor is condensed by an ingenious device which is the chief feature of novelty in his apparatus. (See CONDENSER, DEGRAND.) At the bottom of the pan is the discharge-pipe, guarded by a valve or stop-cock. Another pipe introduces the juice or sirup, and this has also its stop-cock, and may proceed from a reservoir or from the chamber of the pump which injects the liquid to be treated. In some cases, an optional discharge-pipe leads to another pan, and in working "the double effect," the vapor from the boiling liquid in one pan is made to boil the sirup in the next pan. The heating is done by steam under pressure introduced into a steam-jacket around the lower hemisphere of the pan, and by a coil which occupies a position around the inner surface of the said lower hemisphere. Stop-cocks enable the regulation of the flow of steam, and means are afforded for withdrawing the water of condensation. In addition to the described means for introducing and withdrawing the juice, or sirup, heating the liquid, and withdrawing the vapor, windows on opposite sides enable the boiling to be observed, the engineer looking through one while the other admits light. An unpracticed eye has some difficulty in distinguishing anything, but the engineer can readily detect the condition and progress of the boiling mass. A proof-stick affords means for withdrawing a small portion for testing; a gage-glass shows the hight of the liquid in the pan; a steam-gage, the pressure in the steam-jacket and coil; a thermometer, the temperature; and another gage, the pressure in the pan.

The peculiar feature of the *vacuum-pan*, from whence is derived its value and its name, consists in its being adapted to boil while a portion of the atmospheric pressure is removed. This is accomplished by making it air-tight, and withdrawing the air and vapor from the upper hemisphere by means of air-pump or condenser, as has been stated. By the exclusion of the air, the quality and quantity of the crystallizable sugar are increased, a smaller proportion of grape-sugar or molasses being obtained. A part of the atmospheric pressure being removed also enables the juice or sirup to be boiled at a lower temperature.

The vacuum-pan was long used in the sugar-refineries of England and the United States before it was introduced into the sugar-houses of the plantations. It is now generally known in Cuba, Brazil, and Louisiana, where the business is conducted extensively and methodically. The old Jamaica train of open kettles, however, holds its own where the means of the proprietor or the extent of the plantation forbid the outlay for the vacuum-train.

For plantation use, several vacuums are used in combination, as is more particularly described under SUGAR-MACHINERY, it being the practice to boil the juice to a given gravity after the first defecation and filtering, and after a second treatment in defecators and filters to boil it down to the point of granulation. The usual form of the Derosne vacuum-train is what is called the *double effect*; that is, two pans stand side by side, one of which is boiled by the steam rising from the sirup in the other, the sirup being also drawn at intervals from the first to the second. A *treble effect*, by extending the principle to a third pan, has also been tried, without valuable results from the amplification of the idea.

In the Yngenio San Martin sugar-works, a train of three pans is used, the middle one being the largest, and discharging its steam into the others. The Degrand condenser is used in connection with the pans. See Fig. 1421, page 609

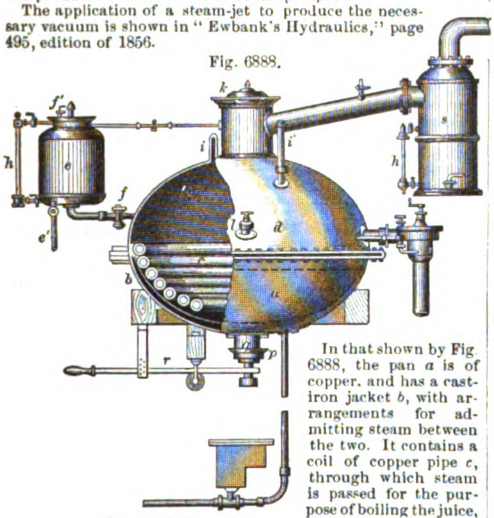
In using the vacuum-pan, the sirup is run in as quickly as possible, until the whole of the heating surface is covered; the steam is then turned on, and the temperature maintained at 180° to 190°. When the sirup begins to granulate, the temperature is lowered to 160°; and just before the evaporation is completed and the sugar is ready to be run off, the temperature is reduced to 145°, or the lowest temperature at which proof-sugar, or concentrated sirup, boils at 3 inches below a perfect vacuum. When this point is arrived at, which is ascertained by withdrawing a sample by means of the proof-stick, another measure of sirup is added, and the process is repeated until the whole charge is admitted.

At each successive addition, the crystals increase in size, those first formed serving as nuclei. The process of crystallization is completed by drawing off the proof-sugar, which consists of the highly concentrated sirup, in which a great number of small crystals are floating, into the heater, which consists of an open pan with a steam-heated jacket, where the sirup is heated to 180° and stirred with wooden paddles to promote granulation.

The Rillieux vacuum-pan (patented August 26, 1843, and December 10, 1846) is of cast-iron, and cylindrical in form; it is used in trains of either three or four pans, and has given great satisfaction. It is the invention of N. Rillieux of New Orleans. The juice is clarified, filtered, and then led into the back part of the first pan, a stop-cock in the pipe regulating the flow. A pipe from the front part of the first pan leads to the back part of the second pan, the flow being similarly regulated. The same as to the third pan, in which the juice reaches a gravity of 28° Beaumé, and from whence it is drawn by a pump and discharge into a second defecator; it thence goes to the filters, and, being conducted to the fourth pan, is there boiled to the point of granulation. A partial vacuum is maintained by the exhaustion of the vapor from the domes above the pans. The vapors from the first pan pass to the steam-coil in the second and last pan, and heat the juice therein; that from the second into the coil in the third; and that from the third and fourth into the condenser; the hollow columns and connecting-pipes being the means of communication. When a train of three pans is used, the second one is dispensed with. The water of condensation is removed, and disposed of according to its quality, whether the produce of boiler-steam or of sirup-vapor.

The application of a steam-jet to produce the necessary vacuum is shown in "Ewbank's Hydraulics," page 495, edition of 1856.

Fig. 6888.



Vacuum-Pan.

In that shown by Fig 6888, the pan *a* is of copper, and has a cast-iron jacket *b*, with arrangements for admitting steam between the two. It contains a coil of copper pipe *c*, through which steam is passed for the purpose of boiling the juice, and has a flanged dome *d*, connected to it by bolts. *e* is a measuring-vessel, containing about 35 gallons, which is connected with the juice-vat by a pipe *e′*, and with the pan by a pipe *f*, each provided with suitable cocks; a cock, *f′*, in the top, admits air. The pan is connected by a pipe with the condenser, which is provided with a coil, through which the steam passes and serves to partially evaporate the juice, which, in its turn, condenses the vapors from the pan, and forms a partial vacuum therein. The pan and vessel *e*, being put into communication, a partial vacuum is formed in the latter, and, on turning the cock *e′*, the juice ascends into the measure, whence it is drawn into the pan, closing *e′*, opening *f f′*, and allowing atmospheric pressure to act. *s* is an overflow-vessel, for catching any sirup which may boil over from the pan.

h h are gages for ascertaining the quantity of liquid in the measuring and overflow vessels; *i*, a mercurial gage, for indicating the amount of the vacuum. *i′*, a thermometer; *k* is a man-hole, for obtaining access to the interior of the pan, and *l* the proof-stick, for ascertaining the progress of the boiling and granulation. *m* is a valve, for admitting steam to the worm, and *n*, a smaller valve, admitting steam into the interior of the pan for cleansing. *o* is one of the two windows through which the progress of the operation may be viewed. The sugar is run out of the pan by depressing a gun-metal saucer *p*, fitted to the discharge-opening *q*, at the base of the pan, and raised or lowered by the lever *r*. In some cases, a cock is substituted for the saucer.

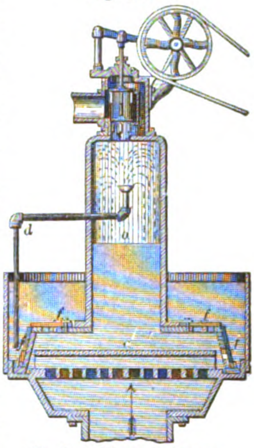
Connected with the boiler and the pan is an expansion-vessel, for reducing the pressure of the steam to the point required in the pan.

In Tooth's apparatus, the juice, at the moment of granulation, is pumped down through a rose at the top of the vacuum-pan, and thus distributed in streams through the air contained therein, exposing a much larger surface for evaporation. The evaporating-chamber is an elongated cylinder, having a top and bottom like that of the ordinary round pan. The juice, on its way to the chamber, passes through a number of pipes in a steam-heated cylinder.

Vac′u-um-pump. (*Steam-engine.*) 1. A pump used for withdrawing the air from a boiler or chamber, in order that it may be filled with water forced in under atmospheric pressure. It is employed in connection with marine engines.

2. A pump in which the condensation of steam is availed of to produce a vacuum for the purpose of raising water.

Fig. 6889.



Burdon's Vacuum-Pump.

In Burdon's (Fig. 6889), the steam is admitted into the chamber *a* through puppet-valves automatically operated by connection with the engine, forcing out any water which may be contained therein through the eduction-valves *f*, which cover a number of ports in the top and sides of the larger lower chamber. On coming in contact with the more expanded water-surface in this lower chamber, the steam is partly condensed, causing a partial vacuum, and allowing the water to flow through the pipe *d* into the upper chamber, where it is discharged in the form of spray, occasioning the total condensation of the steam, which closes the steam induction-pipe and raises the gravitating valve *c*, which covers a large number of openings in the bottom of the chamber through which the water rises. A fresh influx of steam then takes place, and the operation is continuously repeated.

Cameron's consists of a spiral tube partly filled with mercury and surrounding a central tube, having a partition in its middle, an induction-valve at each end, and an eduction-valve near each end. The ends are journaled in hollow boxes connected with tubes leading to the well or cistern, and by rotating the apparatus alternately in reverse directions, a vacuum is produced at one end, causing a flow of water into one end of the pipe and a plenum at the other, by which water already received in that end is expelled.

See also Pulsometer; Steam Vacuum-pump.

Huffer, in his patent, No. 37,344, January 6, 1863 (reissued August 25, 1874), claims the use of exhaust steam from an engine to condense in a vacuum-chamber, and so raise water to turn a wheel.

Vac′u-um-valve. A reversed safety-valve, opening inwardly to the pressure of the atmosphere when there is a negative pressure in the boiler.

Vad′mel. A coarse frieze of the Orkney Islands. Wadmarel.

Vag′i-nal Spec′u-lum. (*Surgical.*) An instrument for distending the vagina to expose its walls and the mouth of the uterus. See Speculum.

Vag′i-nal Syr′inge. (*Surgical.*) An instrument for injecting or irrigating the vagina. There are several forms; the ordinary cylindrical-shaped barrel with an opening in its hemispherical end.

One form has a distending cylinder and an interior rose for a spray or jet. A form in which the jet is backward and outward, etc. See SYRINGE.

Vak'ka. A large canoe of the Friendly Islands, used with an outrigger.

Val'ance. 1. The drooping ledge at the parting of a trunk.

2. A curtain depending from a horizontal frame and screening the space beneath.

3. A *lambrequin*, or drooping curtain hiding the curtain-rods of a window.

Va-len'ci-ennes' Lace. A variety of lace, whose meshes are of the form of an irregular hexagon. It is formed of two threads, partly twisted and plaited at top of the mesh. The pattern is worked in the net.

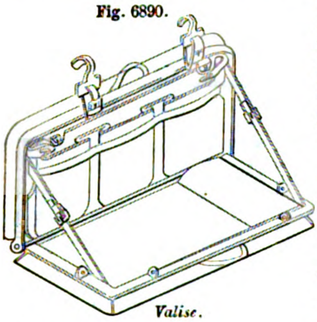
Va-len-tin's' Knife. A knife with two parallel blades for making thin sections for microscopic objects.

Va-let' a Pa-tin'. (*Surgical.*) The ligature-forceps. It has two hinged branches, approached or separated by a screw or running ring. Used for seizing vessels that are to be tied. See also TENACULUM-FORCEPS.

Va-lise'. 1. (*Military.*) A cylindrical portmanteau of leather, 18 inches long, is placed on the saddle of each off-horse of an artillery-carriage, and is used for carrying the smaller articles of the driver's personal equipment.

2. A small trunk or portmanteau, to hold a traveler's equipment for short journeys.

Fig. 6890.

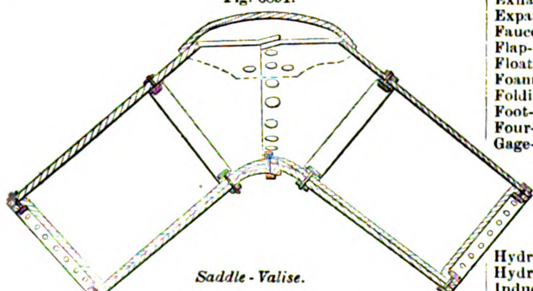


Valise.

Fig. 6890 shows one which may be hooked up in a tent to form a shelf.

Fig. 6891 is a cylindrical valise, to fit behind the cantle of a saddle.

Fig. 6891.

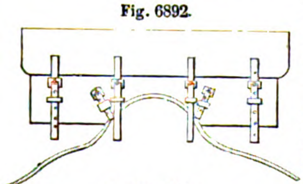


Saddle - Valise.

Va-lise'-lock. A small trunk-lock.

Va-lise'-sad'dle. A valise-saddle is placed on each off-horse of an artillery-carriage. It is used for carrying the driver's valise, but may be employed for riding on in case of necessity.

Fig. 6892.



Saddle - Valise

Fig. 6892 shows a valise made hollowing beneath, for this purpose. It has side-fastenings and straps attached to the lower portion.

Val'ley. (*Building.*) The internal angle formed by the junction of two inclined sides of a roof.

Valve. A lid, cover, leaf, ball, box, disk, plug, or plate, lifting, oscillating, rotating, or sliding in connection with a port or aperture, so as to permit or prevent the passage of a fluid through the port which it guards.

Valves are of several classes.

1. *Rotary;* such as *cocks, faucets, throttle-valves.*

2. *Lifting;* raised clear of the seat by power beneath; such as *ball, conical, cup, safety, poppet.*

3. *Hinged;* such as *clack, butterfly.*

4. *Sliding;* such as the *slide,* D.

5. *Spring;* such as some forms of safety-valves.

6. *Inverted cup;* such as *quicksilver-valve, air-trap,* etc. *Cornish.*

7. *Key;* such as those of the *organ, flute,* etc.

Other names are derived from peculiar shape, application, mode of actuation, function, etc.

See under the following heads: —

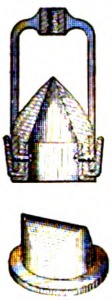
Alarm-check valve.
Annular valve.
Automatic valve.
Back-pressure valve.
Balanced feed-valve.
Balanced slide-valve.
Balanced valve.
Ball-cock.
Ball valve.
Bib-valve.
Blow-through valve.
Blow-valve.
Brine-valve.
Bucket-valve.
Butterfly-valve.
Check-valve.
Chimney-valve.
Clack-valve.
Clapper-valve.
Cock.
Communication-valve.
Cone-valve.
Conical valve.
Core-valve.
Crown-valve.
Cup-valve.
Cut-off valve.
Cylindrical valve.
Delivery-valve.
Discharge-valve.
Disk-valve.
Double-beat valve.
Double seat valve.
D-valve
Equilibrium-valve.
Escape-valve.
Exhaust-valve.
Expansion-valve.
Faucet (varieties; see FAUCET).
Flap-valve.
Float
Foam-cock.
Folding-valve.
Foot-valve.
Four-way cock.
Gage-cock.
Globe-cock.
Globe-valve.
Governor-valve.
Grease-cock.
Gridiron-valve.
Hanging-valve.
Hydrant-valve.
Hydraulic valve.
Induction-valve.
Injection-valve.
Internal safety valve.
Key-valve.
Kingston's valve.
Lever-valve.
Lock-up safety-valve.
Long-slide valve.
Main check valve.
Measuring-faucet.
Meter-valve.
Molasses-gate.
Mud-valve.
Oil-cup.
Organ-valve.
Oscillating-valve.
Pet-cock.
Pipe-valve.
Piston-head valve.
Piston-valve.
Plug-valve.
Pneumatic valve.
Pneumatic-tube valve.
Pot-lid valve.
Priming-valve.
Pump-valve.
Puppet-valve.
Purging-cock.
Quicksilver-valve.
Regulation-box.
Relief-valve
Reverse valve.
Rotary-valve.
Safety valve.
Screw down valve.
Sea-cock.
Segmental valve.
Self acting valve.
Slide-valve.
Sluice-valve.
Snifting-valve.
Spherical valve.
Spring-balance valve.
Spring-valve.
Starting-valve.
Steam heater valve.
Steam-regulator valve.
Steam-valve.
Stop-cock.
Submarine valve.
Suction-valve.
Sweetening-cock.
Syringe-valve.
Tail-valve.
Test-cock.
Three-way cock.
Throttle valve.
Tidal valve.
Trap-valve.
Tripping-valve.
Trunnion-valve.
Two-way cock.
Vacuum-valve.
Valve-bucket.
Valve-cock.
Valve-coupling.
Valve-file.
Valve-gear.
Valve-motion.
Water-check.
Water-closet valve.
Water-gate.
Wicket.

The heart is constructed upon the principles of hydraulics, and is furnished with a valve.

Harvey deduced the circulation of the blood from Aquapendente's discovery of the *valves* in the veins. Servetus, who was burnt at Geneva, 1553, was engaged in the search, and came near anticipating the theory which Harvey completed in the following century. See PULSOMETER, page 1825; SPHYGMOMETER, page 2265.

Fig. 6893 is a caoutchouc pump-valve, which opens to allow

Fig. 6893.



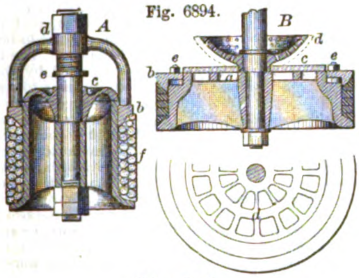
Perreaux's Pump-Bucket Valve.

water to pass upward as the bucket descends, and closes as the bucket rises. It may have been suggested by the *mitral* valve of the heart.

Valve-buck'et. (*Hydraulics.*) A bucket provided with a valve; the bucket or sucker of a pump. In *A*, the valve *c* slides upon the bucket-rod, its upward movement being limited by the stop *e*; *b* is a ring having an attached fork, which is pressed down by the nut *d* and serves to tighten the packing *f*.

B is of brass, and is formed with a grid *a* on top; the ring *b* by which the packing is adjusted is pressed down by screws *e e*; the valve *c* is a disk of vulcanized rubber, strengthened by canvas, which slips easily round upon the grid, so as not to strike always on the ribs in the same part; *d* is a perforated gun-metal guard, against which the valve strikes as the water passes through the bucket.

Fig. 6894.



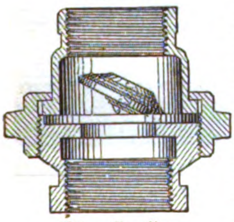
Valve-Bucket.

Valve-cham'ber. (*Hydraulics and Steam.*) A chamber in which a pump or steam-valve works. See list on previous page.

See PUMP; STEAM-ENGINE; etc.; and list under VALVE.

Valve-cock. A form of faucet in which the closure of the passage is by a valve on a seat. See COCK; FAUCET; etc.

Fig. 6895.



Valve-Coupling.

Valve-coup'ling. A pipe-coupling which includes a valve-plate, as in Fig. 6895. Between the faces of the coupling is interposed a circular disk of leather with a segmental piece taken out, so as to leave a central circular portion attached to one side, which forms a stop-valve, the concentric portion of the same forming a packing.

Valve-file. A file with two acute and two obtuse angles; used in filing *valve* and *key ways*, grooves for *fins*, *feathers*, *splines*, etc.

Fig. 6896.

Valve-File.

Valve-gear. The combination of mechanical devices through which the valves of a steam or other engine are operated.

These are shown in the various engines to which they are specially applied. See CUT-OFF; LINK-MOTION; STEAM-HAMMER; STEAM-PUMP; PORTABLE ENGINE; CORNISH ENGINE; DRAINING-ENGINE; STATIONARY ENGINE; OSCILLATING-ENGINE; etc. See list under STEAM-ENGINE; and also list under VALVE.

The first means for shutting and opening the passages in the pipes of steam-engines were cocks, as we see in Worcester's, Papin's, Savery's, and Newcomen's; and these were all worked by hand and required close attention. A boy named Humphrey Potter being in charge of the cocks of one of Newcomen's pumping-engines, and desiring time for play (it is said), managed to fasten the lever-handles of the spigots by means of rods and string to the walking-beam of the engine, so that each recurrent motion of the beam effected the change required. This was the first automatic valve-motion, and was afterward improved by Beighton, in 1717. See LINK-MOTION, etc., and list under STEAM-ENGINE.

Valve-seat. (*Steam.*) The flat or conical surface upon which a valve rests.

Vamp. The part of a boot or shoe upper in front of the ankle seams.

Van. 1. A large covered wagon.

2. A shovel used in sifting ore. A peculiar rocking motion is given to the shovel, separating the ore powder into grades of varying gravity. This is called *vanning*.

Va-na'di-um. (Equivalent, 68.6; symbol, V.) A rare, white, brittle, very infusible metal, not known in the arts.

Vand-kik'kat. A form of water-telescope invented in Norway, and used for viewing submerged objects.

Vane. 1. A device attached to an axis, and having a surface exposed to a moving current of fluid, so as to be actuated thereby.

To indicate *direction of motion*, as in a weathercock or anemoscope.

Or *rate of motion*, as in an anemometer or velocimeter.

Or *amount* of fluid passing, as in a water-meter.

Or to obtain *power*, as in a smoke-jack or windmill.

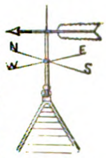
2. Conversely: a blade, paddle, wing, float, or spiral flange attached to an axis, by whose rotation the motion of the fluid of submergence is obtained in the fanning-mill, blower, liquid meter, or spiral pump.

Or by which a body is moved, as with the paddle-wheel or propeller.

3. A target or sight.

Hence: —

Fig. 6897.



Wind-Vane.

1. *a.* A *weather-cock*, flag, or arrow, or other thin object, which points in the direction whence the wind proceeds. It has an unequal surface exposed to the action of the wind on the respective sides of the vertical axle on which it oscillates as the wind veers. See ANEMOSCOPE; ANEMOMETER; WIND-GAGE.

A *dog-vane* is one placed on the weather side of the quarter deck to show the steersman the direction of the wind. It is usually made of cork, stuck with feathers, and suspended by a string from a staff.

b The arm of a windmill against which the wind acts. See WINDMILL.

2 A board on the arm of a fan, fly, or upon a rotating axis.

Fig. 6898.

Staff-Vane.

a The *wing* of a fanning-mill, winnowing-machine, or blower, which impinges upon and drives the air. See FAN; BLOWER; WINNOWING-MACHINE; etc

b. The thread or extended spiral flange of a screw-propeller, which impinges upon the water and impels the vessel.

3 (*Surveying.*) *a.* A *staff-vane*, or surveyor's target, is a horizontal piece of wood, slipping on a leveling-staff, and having an aperture through which the graduations on the staff are observed. It is raised or lowered to any point on the staff, to indicate the plane of apparent level at which it is cut by the axis of the telescope. See also Fig. 2913.

Fig. 6899.

Sight-Vane.

b. The sight of a quadrant or similar instrument for the measurement of angles It is a piece of brass standing perpendicularly to the plane of the instrument. The *foresight-vane* is opposite to the *fore* horizon-glass; the *backsight-vane*, to the other glass.

Van-fosse. (*Fortification.*) A wet ditch at the outer foot of the glacis.

Vang. (*Nautical.*) A rope, one on each side, to steady laterally the peak of a gaff. It is usually a *pendant*, with a *twofold purchase*.

Van'ning. An operation for testing the quality of auriferous sand, or of ore when stamped.

A portion of the powder or slime is immersed in water, and shaken to and fro in a shovel till the agitation and the action

of the water with the occasional removal of the coarse matter of the top enable the rich collection at the bottom to be examined and its approximate value estimated.

The shovel is concave-bladed, is 14 inches long, 13 inches wide, pointed, and has a handle 4 feet long.

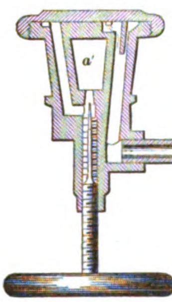
Va'por-a'ri-um. (*Surgical.*) A vapor-bath.

Va'por-burn'er. A device for burning previously vaporized liquid hydrocarbons. It has a metallic portion, which is so heated by the flame as to vaporize the liquid passing through it.

It is used in lamps, and in heating and cooking stoves. In Fig 6900, the expanded cap is exposed to the flame in a', and has a channel inside running around near its circumference with connecting grooves.

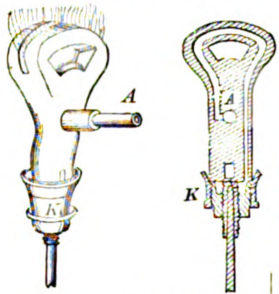
In Fig. 6901, the retort or generator has two jaws with circuitous passages in which the liquid is vaporized. The oil enters by a lateral pipe A, passes through the jaws, down to the foot of the stem, and the vapor passes upward, and is ignited between the jaws. The adjustable collar K regulates the supply of atmospheric air to the vapor.

Fig. 6900.



Vapor Lamp-Burner.

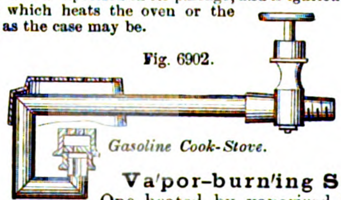
Fig. 6901.



Generator for Vapor-Lamps.

Fig. 6902 is an adaptation to cooking and heating stoves. The oil is heated and vaporized in its passage, and is ignited beneath the plate which heats the oven or the chamber, as the case may be.

Fig. 6902.



Gasoline Cook-Stove.

Va'por-burn'ing Stove. One heated by vaporized hydrocarbon. See VAPOR-BURNER.

Va'por-en'gine. See STEAM-ENGINE; AËRO-STEAM-ENGINE; ALCOHOL-ENGINE; AMMONIA-ENGINE; GAS-ENGINE; etc.

In 1850, a French inventor, M. Prospère Vincent du Trembley, brought into notice what is now known as the "binary vapor-engine," or the "combined vapor-engine." He constructed a number of these engines, and published a work describing their peculiarities and their operation, — "Manuel du conducteur des machines a vapeur combinees ou machines binaires," Lyons, 1850.

In this class of engines, one cylinder has its piston impelled by steam, usually, and the fluid, having done its work there, is exhausted into another part of the apparatus, where it is allowed to communicate its unutilized heat to some liquid volatile at a lower temperature; and the vapor of this second liquid, by its expansion in a second cylinder, yields additional useful work. Ether, chloroform, and carbon bisulphide, or, as the latter is popularly termed, bisulphide of carbon, have all been tried without permanent success. Du Trembly used the vapor of ether.

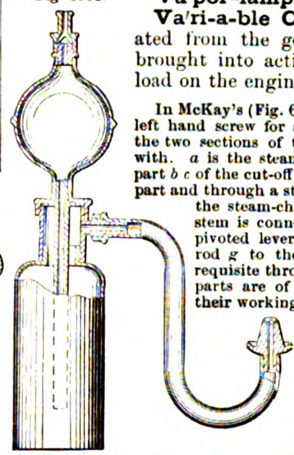
The vapor of heated bisulphide of carbon has been used as a motor, and its tendency to absorb the lubricant in the cylinder may be rectified by adding to the bisulphide a certain quantity of oil, which will pass over with the vapor. Ellis's patent. See BISULPHIDE-OF-CARBON ENGINE.

Va'por-in-hal'er. (*Surgical.*) One for administering vapor produced by drawing or forcing atmospheric air through a liquid, or a sponge saturated with a liquid.

In Fig. 6903, air is forced through the tube into the liquid by contraction of the bulb, and is ejected from the nozzle, whose pipe communicates with the space above the liquid.

Va'por-iz'ing-stove. One for furnishing steam to dampen the air of apartments, conservatories, etc. It has usually a gas, oil, or alcohol lamp beneath a pan of water.

Fig. 6903.



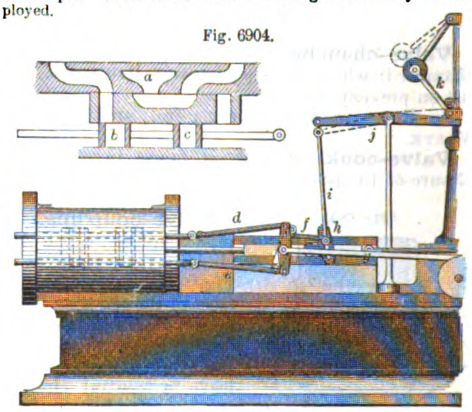
Vapor-Inhaler.

Va'por-lamp. See VAPOR-BURNER.

Va'ri-a-ble Cut-off. One actuated from the governor, so as to be brought into action according to the load on the engine. See CUT-OFF.

In McKay's (Fig. 6904), the usual right and left hand screw for spreading or approaching the two sections of the cut-off are dispensed with. a is the steam-valve; the stem of each part b c of the cut-off passes through the other part and through a stuffing-box at each end of the steam-chest, and the end of each stem is connected by a rod d e to the pivoted lever f, itself connected by a rod g to the eccentric; by this the requisite throw is produced. The two parts are of box form, or hollow on their working faces, so as to be always balanced. The link h is connected by the rod i and lever j to the collar of the governor k; it is connected to a block sliding in the same guides as the lever f, and moves with it, serving to tilt it, and, through the medium of the rods d e, bringing the two parts of the cut-off together to diminish the steam supply, or spreading them to increase it, according as the governor-balls spread out or collapse. Other forms than the ball-governor may be employed.

Fig. 6904.

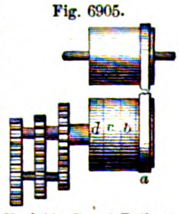


Variable Cut-Off.

Va'ri-a-ble-speed Pul'ley. Arrangements of pulleys and gearing for transmitting different speeds are shown in the accompanying illustrations.

Fig. 6905 is for transmitting three different speeds. The right hand pulley a is a loose one. The next pulley b is fast to the shaft which carries the smallest cog-wheel. The tubular shaft of the next pulley c is sleeved on the central shaft, and runs the middle cog-wheel. The shaft of the third pulley d is an outer sleeve, and is fast to the largest cog-wheel. By slipping the band on to one or the other of the fast pulleys, variable speeds are communicated to the lower cog-wheel shaft, as relative sizes of the pairs of wheels will indicate.

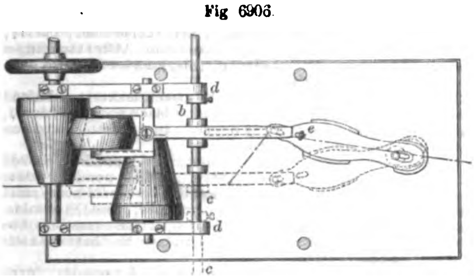
Fig. 6905.



Variable-Speed Pulleys.

Olmsted's (Fig. 6906) is designed for controlling the speed of light machinery, particularly sewing-machines. The idler-pulley a is journaled in a swinging frame, and is brought into frictional contact with the cone-pulleys b c, the former of which is the driver and the latter the follower, by depressing the treadle d; a spring or weight raises the idler out

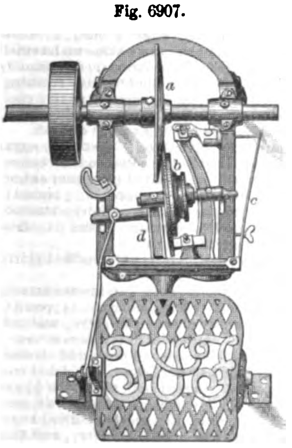
Fig 6906.



Olmsted's Variable-Speed Pulley.

of gear with the pulleys *b c*. The doubly conical form of the idler *a* causes it always to have an equal bearing on the cone-pulleys when in gear, and by shifting the treadle and swinging frame to the right or left, the relative velocities of the driving and driven cone pulleys may be varied as desired.

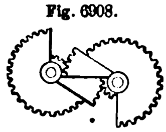
Fig. 6907.



Wright's Variable-Speed Pulley.

Wright's variable-speed attachment (Fig. 6907), for sewing-machines, etc., consists of two disks *a b* with slightly rounded faces; the former is placed on the driving shaft, and the latter runs in a frame which swings slightly. When in normal position, the face of the driving-disk *a* bears near its center, against the face of the disk *b*, driving it at the lowest rate of speed. On swinging the frame, by the treadle or otherwise, the distances of the contacting points of the two disks from their centers are varied to produce different speeds.

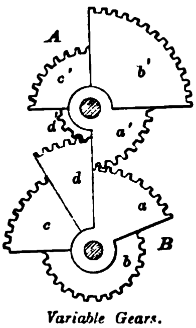
Fig. 6908.



Variable Gears.

Va'ri-a-ble-speed Wheel. A contrivance for obtaining alternately accelerated and retarded circular motion.

Fig. 6909.



Variable Gears.

Each wheel has three cogged portions of varying radii, which mesh with counterpart portions of the opposite wheel. While the *driver* has a regular speed of rotation, three rates of motion are imparted to the *driven*-wheel, according to the radii of the portions in contact at different times.

In another form, each wheel has four cogged sectors; the section of extreme range being divided by those of medium and equal radii. The sectors are arranged on different planes, and the velocity imparted is proportioned to the relative radii of the parts in contact.

Thus, in Fig. 6909, in the two compound gear-wheels *A B*, the respective segments *a a*, *b b*, *c c*, and *d d* mesh together, an arrangement by which four different rates of speed may be obtained, either *A* or *B* being used as the driver, or double that number, in case they alternately perform this function

Va-ri-a'tion-com'pass. A compass designed for observing the magnetic bearings of celestial objects in order to determine the deviation of the magnetic needle from the true meridian.

The angular difference between the magnetic bearing of a circumpolar star when at its greatest eastern or western elongation and its polar distance gives the deviation directly; but any celestial object may be employed, its true bearing being readily calculated when its declination and the latitude of the place are known. At sea the sun is the object commonly observed. See AZIMUTH-COMPASS.

In a more restricted sense, a compass provided with a long needle, which oscillates in a graduated circle, and has appliances for measuring and reading the small diurnal changes in the magnetic variation.

Variation or declination is the horizontal angle which a needle makes with the meridian.

The changes of declination are of three kinds.

1. *Secular.* That which takes place in cycles. At London, in 1550, the variation was 11° 17′ E.; about 1660 it was 0°. It then began to deviate to the west till it attained its maximum in 1815, 24° 17′ 18″. In 1865 it was 20° 38′.

2. *Annual.* This was first remarked at Paris by Cassini.

3. *Diurnal.* First remarked at London, by Graham, 1722. The changes are greatest in summer, least in winter. The needle declines toward the west from 8 A. M. till 2 P. M., and then to the east till 8 or 9 P. M. See MAGNETOMETER.

The variation of the compass was known to the Chinese philosopher, Keon-tsoung-chi, in the twelfth century. He determined it to be from 2° to 2° 30′ at Pekin. The French savans who formed part of the plundering host at Pekin a few years since, found time, after participating in the scramble for *loot*, to test the correctness of the former observation. They found it to be about the same. What their ancestors were about in the twelfth century may be seen by reading the lives of the Capets. The same century saw 25 popes ruling in Rome.

Gerbert, Alhazen, and Roger Bacon relieve that and neighboring centuries of their dreariness.

The Chinese mode of suspending the needle was by a silken string, the most delicate which has yet been devised, and the one adopted at the magnetic observatories which are acting in concert in so many parts of the world. See COMPASS.

The variation of the compass was again noticed by Columbus in 1492, and Sebastian Cabot in 1540.

The western line of no variation was discovered by Columbus in 1492, about 100 miles west of the Azores. It has since shifted.

"Columbus has not only the incontestable merit of having first discovered a 'line without magnetic variation,' marking a memorable era in nautical astronomy, but also of having, by his considerations on the progressive increase of westerly declination, in receding from that line, given the first impulse to the study of terrestrial magnetism in Europe.

"We know positively from the Chinese 'Penthsaayan,' which was written under the dynasty of the Song between 1111 and 1117, that the manner of measuring the amount of westerly declination had been then long understood. That which belongs to Columbus is not the first observation of the existence of the variation (which, for example, is noted in the map of Andrea Bianco, in 1436), but the remark which he made on the 13th of September, 1492, that 2½° east of the island of Corvo the magnetic variation changes, passing from N. E. to N. W." — HUMBOLDT.

"The first variation-compass was constructed before 1525, by an ingenious apothecary of Seville, Felipe Guillen. So earnest were the endeavors to learn more exactly the direction of the curves of magnetic declination, that in 1585 Juan Jayme sailed with Francisco Gali from Manila to Acapulco for the sole purpose of trying in the Pacific a declination-instrument which he had invented."

"The cosmographer Alonso de Santa Cruz, one of the instructors of Charles V., undertook the drawing up of the first general 'Variation Chart,' although indeed from very imperfect observations, as early as 1530, or a century and a half before Halley.

"The 'movement' of the magnetic lines, the first recognition of which is usually ascribed to Gassendi, was not even yet conjectured by William Gilbert; but at an earlier period Acosta, 'from the information of Portuguese navigators,' assumed four lines of no declination upon the surface of the globe. Hardly had the inclinometer, or dipping-needle, been invented in England by Robert Norman, in 1576, than Gilbert boasted that by means of this instrument he could determine the position of a ship in a dark and starless night."

Pope Alexander VI adopted the line of no variation discovered by Columbus 100 miles west of the Azores, as the easterly limit of the papal grant to the Spaniards, May, 1493 He was not aware, no blame to him, that the line was slowly moving east, and would soon be far removed from its first-observed position. It was reserved for a future age to show the incorrectness of the then received opinion that "magnetism is an effluvium issuing forth from the root of the tail of the Little Bear."

Halley, in 1683, sketched his theory of four magnetic poles or points of attraction, and of the periodical movement of the magnetic lines of no variation. In 1698-1702 he made several voyages of observation, and the result was a general "variation-chart," in which the points of equal variation were connected by curved lines.

Hansteen's chart (1787) gives the western and eastern lines of no variation at the date of his writing. These are given under MAGNETOMETER (which see).

Variation-charts are now in common use at sea. An excellent one, derived from the most recent observations, is published from time to time by the British Admiralty.

Before chronometers had attained their present excellence, and lunar observations were commonly practiced, it was proposed to determine the longitude at sea from the variation of the compass: but owing to the difficulty of its being accurately determined from such an unstable observatory as a ship's deck, and from other causes, this method was found to have no practical value.

Var'i-cose Stock'ing. Elastic hose to compress and support distended veins in the leg and foot. See next article.

Fig. 6910.

Varicose-Vein Bandage.

Var'i-cose-vein Band'age. An elastic bandage applied to any part of the body in order to compress and retain varicose veins.

Similar bandages are used in the treatment of weak, swollen, or ulcerated limbs, and tumors, and for supporting the body in cases of corpulence and of abdominal weakness.

They are termed anklets, belts, knee-caps, stockings, etc., according to their particular function and place of application.

Var'nish. A solution of gum or resin in oil or spirit, which in drying leaves a smooth hard coating on a surface to which it has been applied. The gums principally used in the preparation of oil-varnishes are amber, animè, and copal. The first is hard, tough, and soluble with difficulty; it makes an excellent varnish, but is expensive, and dries slowly. Animè dries quickly, is nearly as hard and insoluble as amber, but is deficient in toughness, is liable to crack, and turns dark on exposure to air and light. Copal is next in durability to amber, and the paler kinds when made into varnish become lighter on exposure; it is more largely used than any other gum in preparing oil-varnishes, animè being frequently added to impart drying properties.

Mastic is a soft rosin; it may be mixed with spirits of wine or turpentine, forming a brilliant varnish, which flows readily and works easily; it may be removed by friction with the hand, and is hence used for pictures and other delicate works. Dammar is softer than mastic, with which it is sometimes mixed, forming a clear colorless varnish, suitable for maps, etc.

Common rosin, dissolved with the assistance of heat in linseed-oil or turpentine, is used as a varnish for some common purposes, and is mixed with other varnishes to impart brilliancy, but unless sparingly used renders them liable to crack. Lac and sandarach form the bases of most spirit-varnishes; they are dissolved in strong alcohol, and applied to articles which are not exposed to the weather.

Linseed-oil boiled with substances for clarifying and imparting drying properties is the usual vehicle for oil-varnishes.

The general mode of preparation is nearly the same for all. The oil is boiled in a *set pot* in a masonry or brickwork furnace, and is gradually poured upon the gum while in a state of fusion in the *gum-pot*, the mixture being constantly stirred during the process. Brass or copper wire sieves having about 40 meshes to the inch are used for straining the ingredients. The turpentine is afterward added while hot, and thoroughly incorporated by stirring, and the varnish strained into proper vessels, which are set by to allow it to become clarified. A moderate degree of heat only should be employed during the process, too great heat rendering the varnish sticky and injuring its flowing properties. In preparing spirit-varnishes on a large scale, a still may be advantageously employed. The gum and spirit are mixed, and sufficient heat applied to cause a gentle boil. The spirit which distills over is afterward combined with the varnish.

Subjoined are some of the recipes employed: —

Amber 1 *a* Gum amber (fused), 6 pounds; hot clarified linseed-oil, 2 gallons Boil until it *strings* well, and when somewhat cooled add 4 gallons spirits of turpentine. To make it dry quicker, boiled oil may be used, or dryers may be added during the cooling.

b. Amber, 4 ounces; pale boiled oil, 1 quart. Proceed as before.

c. Pale transparent amber, 5 ounces; clarified, or pale boiled oil and turpentine, each 1 pint.

2 *Bessemer*. Pale copal varnish, 1 part; turpentine, 6 parts; agitate with about $\frac{1}{30}$ part of dry slaked lime. After standing a few days, it is drawn off; 5 parts of this, and 4 of bronze powder form Bessemer gold-paint.

3 *Black amber varnish* (used by coach-makers). Melted amber, 1 pound; drying oil, hot, ½ pint; black rosin, powdered, 3 ounces; Naples asphaltum, 4 ounces. Incorporate, and when partially cooled, add turpentine 1 pint.

4. *Black iron-work*. Fused asphaltum, 48 pounds; boiled oil, 10 gallons; red lead and litharge, each 7 pounds; white copperas, dried and powdered, 3 pounds. Boil for 2 hours, and add hot linseed-oil, 2 gallons; dark gum amber, fused, 8 pounds. Boil about 2 hours longer, until a drop of the mass may be rolled, when cool, into a pill; then withdraw the heat and stir in 30 gallons turpentine.

5 *Black Japan*. *a*. Naples asphaltum, 50 pounds; dark gum animè, 8 pounds. Fuse; add linseed-oil, 12 gallons; boil as before; add dark gum amber 10 pounds, fused and boiled with 2 gallons linseed-oil; add dryers, and proceed as before.

b. Burnt umber, 8 ounces (ground in oil); asphaltum, 4 ounces, dissolved in heated oil. Mix, and add what remains of 1 gallon boiled oil; boil, and thin with turpentine

c Litharge, 4 parts; boiled oil, 87; spirits turpentine, 2; red lead, 6; umber, 1; gum-shellac, 8; sugar of lead, 2; white vitriol, 1 All the ingredients except the turpentine and a small quantity of the oil, are boiled together for 5 hours, continually stirring; the oil is added from time to time to allay frothing, and the turpentine is mixed in when the varnish is nearly cool.

6. *Body*. *a*. Best African copal, 8 pounds; drying oil, 2 gallons; turpentine, 3½ gallons. Made like amber varnish.

b. Pale gum copal, 8 pounds; clarified oil, 2 gallons; sugar of lead, ⅛ pound; turpentine, 3 gallons. Proceed as before, and mix while hot with a varnish composed of pale gum animè, 8 pounds; linseed-oil, 2 gallons; white copperas, ¼ pound; turpentine, 3½ gallons. The mixture is immediately strained into vessels This varnish is used on carriage bodies; it dries in about 4 hours in summer, and 6 in winter.

7. *Bookbinders'*. Gum sandarach, 3 ounces; rectified spirit, 1 pint. Dissolve cold, frequently stirring.

8. *Carriage*. *a*. (*Spirit*, for interior work.) Gum sandarach, 1½ pounds; pale shellac, ¾ pound; clear pale rosin, ½ pound; alcohol (specific gravity, .8220), 3 quarts. Dissolve, and add pure Canada balsam, 1½ pounds Dries in 10 minutes or less.

b. (*Oil*.) Pale African copal, 8 pounds. Fuse; add clarified linseed-oil, 2½ gallons. Boil until stringy, and add dried copperas and litharge, each ¼ pound. Again boil, thin with 5½ gallons turpentine, and mix with a varnish composed of gum animè, 8 pounds; clarified linseed-oil, 2½ gallons; dried sugar of lead and litharge, each ¼ pound. Boil as before, and thin with turpentine.

c. (*Second quality*.) Gum animè, 8 pounds; clarified oil, 3 gallons; litharge, 5 ounces; dried and powdered sugar of lead and white copperas, each ¼ pound. Proceed as before, and thin with turpentine, 5½ gallons.

9 *Chinese* Mastic and sandarach, each 2 ounces; alcohol, 1 pint. Dries in 6 minutes.

10. *Copal*. *a* Pale hard copal, 2 pounds. Fuse, boil with 1 pint drying oil, and thin with turpentine.

b. Copal melted, dropped into water, and dried, 3 to 4 ounces. Powder, and add in small quantities at a time to 1 pint turpentine, heated in a water-bath.

c. (*Japanner's Copal*) Pale African copal, 7 pounds; drying oil, ½ gallon; turpentine, 3 gallons. Proceed as in *a*.

d. (*Spirit*) Copal, prepared as above, 4 ounces: gum sandarach, 6 ounces; mastic, 2 ounces; pure Chio turpentine, 3 ounces; powdered glass, 5 ounces; alcohol, 1 quart. Dissolve by gentle heat.

e. Coarsely powdered copal and glass, each 4 ounces; camphor, ½ ounce; alcohol, 1 pint As above.

11. *Crystal*. *a*. Pale Canada balsam and rectified spirits of turpentine, equal parts. Used for drawings, tracing and transfer paper

b Mastic, 3 ounces: alcohol, 1 pint. For pencil-drawings.

12 *Flexible* (also called *balloon* or *caoutchouc* varnish). *a*. India-rubber, in small pieces, 1½ ounces; chloroform, ether (washed), or bisulphide of carbon, 1 pint. Dissolved cold.

b Dried white copperas and sugar of lead, each 3 ounces; litharge, 8 ounces; linseed-oil, 1 gallon. Boil until stringy, cool slowly, and draw off the clear portion; if too thick, add drying oil.

c. India-rubber, 1 ounce; drying oil, 1 quart. Dissolve by heat.

13 *Furniture*. White wax, 1 part; spirits turpentine, 4.

14. *Gilder's* Pale lac, in grains, gamboge, dragon's blood, and annotta, each 12½ ounces; saffron, 3½ ounces. Each gum is dissolved separately in 5 pints alcohol, and the annotta and saffron are separately infused in a like quantity of alcohol. The ingredients are mixed to form any particular tint desired.

15. *For gun barrels* Shellac, 1½ ounces; dragon's blood, 3 drams; alcohol, 1 quart. Applied after browning

16. *Lac Varnish*. *a*. Seed lac or shellac, 8 ounces; alcohol or naphtha, 1 quart.

b. Pale shellac, 5 ounces; borax, 1 ounce; water, 1 pint.

Digest at nearly the boiling-point until dissolved, and strain. Used for water-colors, inks, etc.; when dry, it is waterproof.

c. (*Lacquer for brass-work, etc.*) Turmeric (ground), 1 pound; alcohol, 2 gallons. Macerate for 1 week, strain by expression, and add gamboge, 1½ ounces; pale shellac, ¾ pound: gum sandarach, 3½ pounds. Strain, and add turpentine-varnish, 1 quart.

Other lacquers are prepared in a similar way from alcohol and shellac, a solution of the coloring ingredients, as dragon's blood, gamboge, etc., being kept on hand and added to produce any required tint.

16. *Mahogany.* Gum animé (sorts), 8 pounds; litharge and sugar of lead (powdered and dried), each 4 ounces. Prepare as in "body" varnish, and thin with turpentine.

17. *Mastic.* Pale gum mastic, 5 pounds; pounded glass, 3 pounds; turpentine, 2 gallons. Put in a round vessel and roll until dissolved.

18. *Oak* or *wainscot.* *a.* Clear pale rosin, 3½ pounds; turpentine, 1 gallon.

b. Add to the above 1 pint Canada balsam.

19. *Patent leather.* 1st coat. Pale Prussian blue (containing alumina), 5 ounces; drying oil, 1 gallon. Boil to the consistency of single size. When cold, grind with a little vegetable black. 2d coat. A little more Prussian blue is added to the above. 3d coat. The oil is boiled until stringy, and a little pure Prussian blue and vegetable black are added. The last coat, or finishing varnish, is similarly prepared, but contains ½ pound pure dark Prussian blue and ¼ pound pure vegetable black per gallon; a little copal or amber varnish is often added.

20. *Spirit.* *a.* (*Brown hard*) Gum sandarach, 3 pounds; pale shellac or seed lac, 2 pounds; alcohol, 2 gallons. Dissolve, and add turpentine-varnish, 1 quart. Agitate well, strain, allow it to stand for a month, and draw off the clear portion.

b. (*White, hard*) Gum sandarach, 5 pounds: camphor, 2 ounces; coarsely pounded glass, 3 pounds; alcohol, 7 quarts. After straining, add 1 quart Canada balsam.

c (*Soft, brilliant.*) Sandarach, 6 ounces; elemi, 4 ounces; animé, 1 ounce; camphor, ½ ounce; alcohol, 1 quart. Proceed as before. Gum benzoin, balsam peni, balsam tolu, oil of lavender, or essence of musk or ambergris may be added to impart a scent.

21. *Transfer.* Mastic and sanderach, each 4 ounces. Dissolve in 1½ pints alcohol, and add Canada balsam, ½ pint.

22. *Wax.* *a.* Pure white wax, 1 pound. Melt with a gentle heat; add warm spirit of specific gravity .830, 1 pint. Mix thoroughly, and grind to a paste on a slab with a muller, adding more spirit, as required; the paste is then made into an emulsion with 3½ pints water in a marble mortar. Used as a varnish for paintings. When dry, it is equally heated by passing a hot iron over its surface, or otherwise, and after cooling, is polished with a linen cloth.

b. (*For Furniture.*) Wax, 5 ounces; spirits of turpentine, 1 quart.

23 *French Polish.* Gum sandarach, 14 ounces: shellac, 14 ounces; gum mastic, 7 ounces; alcohol (specific gravity, 0 8295), 7 pints. Pulverize the gums, and effect their solution by agitation, without the aid of heat. For porous woods, 7 ounces Venice turpentine are added.

24. *Shellac Varnish.* 2½ ounces shellac, coarsely pulverized; 1 pint alcohol. Keep in a warm place for a few days, frequently shaking it until the gum is dissolved; strain.

25 *Bookbinder's Varnish.* Dissolve 5 ounces shellac in 1 quart alcohol; boil a few minutes with 10 ounces of recently heated animal charcoal; if not then perfectly colorless, add a little more charcoal. When colorless, strain through silk, and afterward filter through blotting-paper. If wanted perfectly pure, strain when cold.

26. *Colored Spirit-Varnish*, for coating brass and other alloys. 2 parts seed lac, 4 sandarach, 4 elemi, 40 alcohol.

Alcoholic solutions of gummi-gutta, and dragon's blood, or fuchsin, picric acid, martins yellow, and coralline, are separately prepared and added to the above in quantities ascertained by trial to impart the desired color.

To remove the marks left by the brush, and to impart luster, varnish, after drying, is polished. This is effected by first rubbing with powdered pumice and water, and next with an oiled rag and tripoli until the desired polish is produced. The surface is afterward dried with a soft linen cloth; any greasiness is removed by means of powdered starch, and the process is finished by rubbing with the hand.

Great care must be taken that the surface to which varnish is applied be free from grease or smoke, which prevents all oil-varnishes from drying.

Varnish of excellent quality was made in ancient Egypt, and in some cases has retained its brightness during the lapse of thirty centuries.

They baked their varnish on clay, with a moderate heat, we may suppose. It does not appear that they had any true glaze. That came from China many a long year after. See GLAZE; POTTERY.

The Chinese are said to make varnish by beating together fresh blood with quicklime, which is extensively used as a coating for wooden articles which they wish to make completely water-tight. Von Scherzer, who first introduced this substance to the notice of Europeans, says he has seen in Pekin wooden chests that had been varnished with it, which, after a journey over Siberia to St. Petersburg and back, were still sound and perfectly water-tight. Even baskets of straw used for the transportation of oils are made fit for the purpose by means of this varnish. Pasteboard coated with it becomes, both in appearance and firmness, like wood. Articles requiring to be absolutely impervious are varnished twice, or at the most three times, by the Chinese.

See also LACQUER.

Var'nish-ing. (*Photography.*) The protection of a finished photographic negative by flooding it with a solution of resin in alcohol or benzole, whereby it receives a hard, glossy surface, and is able to stand the wear and tear of printing.

Var'nish-lens. A small lens made by putting a drop of copal on a flat piece of oiled glars. It congeals into a plano-convex lens.

Vase. A large cup or open-mouthed jar, with handles.

The ample variety of Egyptian forms may be understood when it is said that the modern teapot form, the large oil-jar, the China vase, the common pitcher, the water-ewer, the ale and wine glasses, the flower-glasses, the drinking-goblet, the beaker, and the bowl are all to be seen in Egyptian paintings. Analysis and observation prove that the Etruscan and Campanian pottery included most kinds now known, including porcelain, and that they had glazes of glass, lead, and salt. Of the Athenian vases some are fluted, some of a jet black, and others a bright red. The Corinthians had a heavy coarse black ware. That of Athens was the lightest and most elegant, that of Sicyon the brightest and most ancient. The Greeks had also pink vases with black silhouettes.

The Barberini or Portland vase is the largest and best preserved specimen of ancient paste glass. The figures represent the nuptials of Thetis and Peleus.

For a treatise on vases, see Fosbroke's "Encyclopædia of Antiquities," I. 233-243.

See also Rawlinson's "Five Great Empires," Vol. I. 389-391.

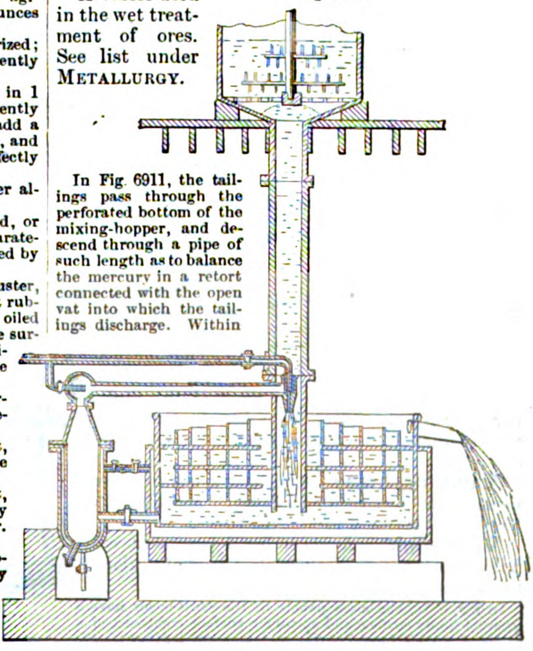
Vat. A wooden tub; used for many purposes, such as for *mash, wash, hop-liquor*, in brewing and distilling. Also known as a *back*.

As a mere storage vessel, it is a CISTERN or TANK (which see).

Also used in many chemical and manufacturing operations in which the substances used are boiled, soaked, steeped, lixiviated, elutriated, etc. See STARCH; TANNING; etc.

A vessel used in the wet treatment of ores. See list under METALLURGY.

Fig. 6911.



In Fig. 6911, the tailings pass through the perforated bottom of the mixing-hopper, and descend through a pipe of such length as to balance the mercury in a retort connected with the open vat into which the tailings discharge. Within

Amalgamating-Vat.

the vat is a series of horizontal and vertical concentric perforated copper partitions, which force the contents to take a devious course. The vat and retort are surrounded by steam-jackets. The fumes of mercury are injected into the descending body of the tailings within the pipe.

Vault. (*Architecture.*) A passage or room with an arched ceiling. An extended arch covering an apartment.

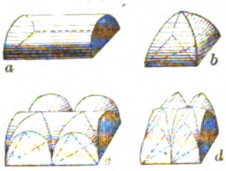
Vaults are *cylindrical*, *coved*, or *groined*.

1. A cylindrical vault has a semicircular arch (*a*).

2. A coved vault has an arch which springs from all sides of its plan (*b*).

3. A *groined* arch is one formed by two intersecting vaults (*c*, *Roman* groined vault; *d*, *Gothic* groined vault).

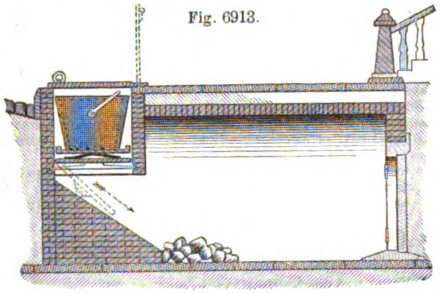
Fig. 6912.



Vaults.

The pavement-sidewalks of cities are, to a large extent, used as coal-cellars. Fig. 6913 shows a garbage-box set within a pit in the sidewalk. The cover of the pit is a lid, and the floor is hinged, so that it may be opened when delivering coals into the vault.

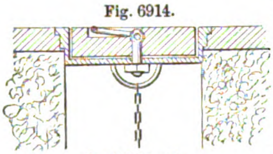
Fig. 6913.



City Vault, with Coal-Chute and Garbage-Box.

Vault-cov'er. A lid over a hole through a pavement. The hole may have a movable cover, to be removed, as in Fig. 6914, when coal is to be emptied into the vault; or it may be for light or ventilation, or both.

Fig. 6914.



Coal-Hole Cover.

Fig. 6915 is a vault-cover with glass bull's-eyes or prisms.

Between the lights of Fig 6916 are congeries of pyramidal elevations, whose intervening depressions drain into gutters in the belly of each corrugation.

Fig. 6915.

Vault-Cover.

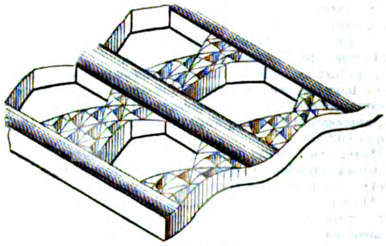
Vault'ing. *Vaultings*, or arched roofs, are *supported* by *ribs* or *groins*, often intersecting each other, meeting in a *boss* in the center, and frequently springing from *corbels*, *brackets*, etc.

Vault'ing-horse. A wooden horse in a gymnasium, for practice in vaulting. Mentioned by Vegetius; common in ancient times.

Vault-light. A cover for a pavement coal-hole, or a section of sidewalk; partially glazed, to illuminate the vault beneath.

In Fig. 6917, the glass panels in the vault-cover have a grooved upper surface and an under surface composed of a series of rounded parallel ridges of unequal depth, with intervening rounded valleys.

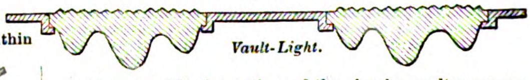
Fig. 6916.



Vault-Cover.

In Fig. 6918, the inverted metallic girders have intervening elongated glasses, the lines of junction being covered with strips to exclude moisture and secure the glasses in place.

Fig 6917.



Vault-Light.

In McCormack's, the sections of the circular vault-cover are alternately open and glazed with lenses. The cover is adjustable above a lower circle, partly glazed and partly open, so as to bring the light sections into coincidence and leave ventilating openings, or close the latter.

V-bob. A form of bell-crank, used to change the direction of motion, as the horizontal motion of the cross-head of a steam-engine to the vertical motion of a pump-rod working in a mine-shaft.

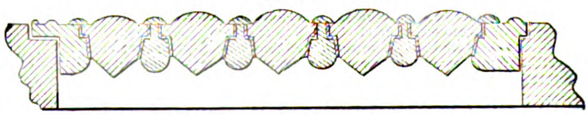
V-croze. (*Coopering.*) One formed for cutting an angular heading-groove.

Vec'tis. (*Surgical.*) An obstetric lever.

Veg'e-ta-ble-chop'per. One for cutting roots, etc., for stock.

Fig. 6920 consists of a row of blades on the under side of a vertically oscillating lever. The knives are bolted to a plate which is secured to the lever, and work into a segmental trough in which the vegetable or meat is placed. A spring beneath the lever raises the knives, which have a length nearly equal to the width of the trough in which they operate.

Fig. 6918.



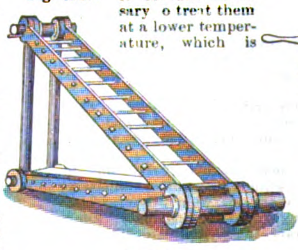
Vault-Light.

Veg'e-ta-ble-cut'ter. One for slicing or chopping roots or leaves, as potatoes, cabbage, etc. See ROOT-CUTTER; etc.

Veg'e-ta-ble-ex'tracts Ap'pa-ra'tus. This apparatus consists of means for partial grinding and then boiling or steaming the materials to extract the juices; followed by presses for separating the liquid from the fibrous and cellular portions of the plant.

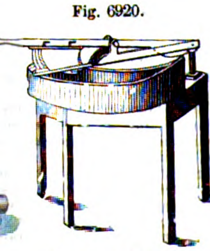
Sometimes a common boiler is used to condense the liquid and bring the extract to the desired consistence; but in order to avoid the destruction or modification of some juices it becomes necessary o treat them at a lower temperature, which is

Fig. 6919.



V-Bob.

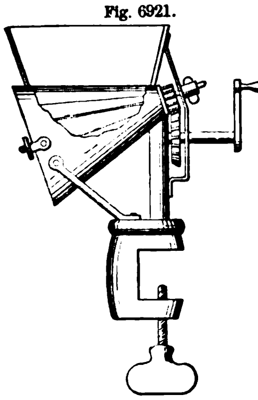
Fig. 6920.



Vegetable-Chopper

done by means of a VACUUM-PAN (which see). This ingenious device has attained its principal celebrity in boiling the juice of the sugar-cane, but is not unknown in the laboratory. Its essential principle consists in withdrawing a portion of the atmospheric pressure, so as to lower the boiling-point.

Fig. 6921.



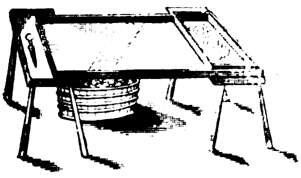
Vegetable Slicer and Grater.

Veg′e-ta-ble-flan′nel. A fabric made of a fine fiber obtained from the leaves of the *Pinus sylvestris*. *Pine-wool.*

Veg′e-ta-ble-grat′er. A machine for pulping roots or leaves.

Fig. 6921 is for cutting or grating. The vegetable in the hopper is exposed to the action of the knives on the inner rotary cone; the knives are adjusted to regulate the thickness of the slices. A grating-cone may be substituted for the cutting-cone. See also ROOT-GRINDER, page 1976.

Fig. 6922.



Sauerkraut-Machine.

Veg′e-ta-ble-i′vo-ry. The nut of a species of South American palm (the *Phytelephus macrocarpa*), much used in turnery. The nuts are known in commerce as *Corosso nuts.*

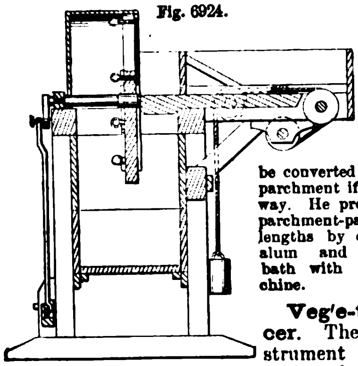
Veg′e-ta-ble-parch′ment. A substance produced by immersing unsized paper in sulphuric acid diluted with about one half its volume of water. Remaining acid is neutralized by an alkali. This closes the pores of the paper, producing apparently a change in its molecular constitution without chemical alteration, and the product closely resembles animal parchment both in its appearance and properties. *Papyrine.* SEE PARCHMENT-PAPER.

Fig. 6923.

Vegetable-Slicer.

Mr. Colin Campbell treats the paper with a strong solution of alum, and dries it thoroughly, before dipping in the acid. The alum prevents the action of the acid from being so rapid as before, and renders the whole operation more manageable. Paper which has been printed on can be converted into vegetable-parchment if treated in this way. He proposes to make parchment-paper in endless lengths by connecting the alum and sulphuric-acid bath with the paper-machine.

Fig. 6924.



Vegetable-Slicer.

Veg′e-ta-ble-sli′cer. The German instrument for cutting cabbage-heads for sauerkraut consists of a table with several blades inserted over oblique slits in the table, and projecting slightly above its general surface. The pith of the stalk having been removed by a scoop or suitable knife, the cabbage-head is pushed back and forth over the knives, the shreds falling through the slits in the table into the tub below. The cut cabbage is salted down and seasoned. See also ROOT-CUTTER.

Fig 6923 is a smaller household implement, for slicing cucumbers, potatoes, apples, etc.

Fig. 6924 is a machine in which the vegetables are advanced by a weighted follower against a series of knives in a wheel which is rotated in a plane at right angles to the root-trough. See also VEGETABLE-CUTTER; ROOT-CUTTER.

Veg′e-ta-ble-wash′er. See ROOT-WASHER, page 1976.

Ve′hi-cle. A car or other conveyance. See under the following heads: —

Varieties of Vehicles.

Accelerator.
Ambulance.
Army-wagon.
Artillery-carriage.
Barouche.
Barrow.
Basket-carriage.
Basterna.
Bath-chair.
Bathing-machine.
Battery-forge.
Battery-wagon.
Berlin.
Bicycle.
Bier.
Boat car.
Bob-sled.
Bob-sleigh.
Booby-hut.
Booby-hutch.
Break.
Brett.
Brick-truck.
Britzska.
Brougham.
Buck-wagon.
Buggy.
Cab.
Cabriolet.
Calash.
Caleche.
Camion.
Car (varieties; see CAR).
Caravan.
Cariole.
Caroche.
Carriage.
Carryall.
Cart.
Casemate-truck.
Chair. Bath
Chaise.
Chaise-cart.
Chariot.
Charlotee.
Child's carriage.
Clarence.
Coach.
Corf.
Coupé.
Curricle.
Cutter.
Dan.
Dearborn.
Dennet.
Diligence.
Dog-cart.
Drag.
Dray.
Droitska.
Drosky.
Dummy-car.
Dumping-car.
Dumping-cart.
Dumping-sled.
Dumping-wagon.
Earth-car.
Fiacre.
Fire-engine.
Float.
Fly.
Fourgon.
Gig.
Gill.
Ginny-carriage.
Gladstone.
Glass-carriage.
Glass-coach.
Go-cart.
Gun-carriage.
Hack.
Hack-barrow.
Hackery.
Hackney-coach.
Hand-barrow.
Hand-car.
Hand-cart.
Hansom.
Hearse.
Horse-litter.
Hose carriage.
Hose-reel.
Ice-boat.
Ice-carriage.
Ice-chair.
Jaunting-car.
Jumper.
Jump-seat.
Kellach.
Kibitka.
Ladder-carriage.
Landau.
Landaulet.
Liquid-manure cart.
Litter.
Locomotive-chair.
Log-sled.
Lorry.
Lumber-wagon.
Mail coach.
Manumotor.
Mortar-wagon.
Night-cart.
Noddy.
Omnibus.
Outside-car.
Palanquin.
Perambulator.
Petroleum-cart.
Phaeton.
Pilentum.
Pony-chaise.
Post-chaise.
Railway-car.
Refrigerating-car.
Revolving car.
Road-locomotive.
Rockaway.
Sailing-carriage.
Sedan.
Sled.
Sledge.
Sleigh.
Sling-cart.
Sociable.
Spring-wagon.
Stage.
Stanhope.
Steam-carriage.
Street-sprinkling cart.
Stretcher.
Sulky.

Vein. (*Mining.*) *a.* A *lead* or *lode* of ore-bearing rock, *alive* or *dead;* that is, containing ore or not.

b. A seam of metalliferous matter filling up a former fissure in rock.

When the vein is straight and uniform, it is called *regular;* when it swells and contracts, it is called a *pipe-vein.* Such enlargements are *bunches.*

Small veins passing off from the ore to the rock are called *strings;* when very small, *threads.*

Veins of ore are classified under specific names, which vary in different localities. The following is a reasonably good scheme: —

1. *Rake-vein;* one commencing at the surface and proceeding downward in a more or less vertical direction. The *slope* is the *hade* or *heading* of the vein. The line of direction is the *bearing.*

2. *Pipe-vein;* an irregular, continuous body of ore, usually conformable to the strata between which it is insinuated. Its working forms an irregular cavern.

3. *Flat or dilated vein;* an extended layer of ore of varying thickness, lying between two strata.

4. *Interlaced vein;* having a lode, with a number of ramifying branches; the latter are known as *side-lodes, feeders, branches.*

Ore in *masses* is known as *nests, concretions, nodules, bunches.*

Nests are friable masses in pockets.

Concretions are kidney-shaped or tuberous.

Nodules are round, and frequently encrusted.

Bunches are masses of ore, surrounded by earthy minerals.

Disseminated metalliferous matter is dispersed in crystals, scales, globules, etc., in a large mass.

Vein'stone. (*Mining.*) The gangue or matrix of the ore. The *veinstone* frequently consists of crystalized silica, fluor spar, or carbonate of lime.

Ve-linche'. Sometimes called a thief-tube. A tube open at both ends, the lower orifice being so contracted that while the finger is closed upon the upper end, liquid will not issue from the lower. It is used in obtaining samples or small quantities of liquids from casks. Also known as a *sampling-tube,* or *sampler.*

Fig. 6925.

Velinche.

The *sucking-tube,* or *monkey-pump,* as sailors call it, is a straw or quill introduced through a gimlet-hole into a barrel, to draw the liquid therefrom. A rye straw applied to a barrel of sweet cider is a familiar and agreeable illustration. It has also the merit — though it needs no extraneous recommendation — of being at least as old as Xenophon, who describes this mode of pilfering from the wine-jars of Armenia.

Vel'lum. A fine parchment made of calf-skin. The skins are limed, shaved, washed, stretched, scraped, and rubbed down with pumice-stone.

Vel'o-cim'e-ter. A measurer of speed. An *odometer* is ordinarily a measurer of distance, but by combining the element of time, it may become a *velocimeter.*

1. (*Nautical.*) The name is usually applied to the marine log, or speed-measurer. There are several different types.

a. Pitot's tube (see Metcalf's patent, No. 92,078, June 29, 1869); Elliott's tachometer, July 28, 1874. See also Fig. 1568, page 661. The principle is similar to the Lind *anemometer,* Fig. 205, page 99; the latter measures the speed, or force rather, of a current of air.

b. The *rotary-pump* principle. Walker, No. 68,265, of 1867.

c. The *log.* A chip on the end of the log-line or

train of wheels to register revolutions and consequent length of line out. Hotchkiss, No. 45,042, November 15, 1864; Lozier, No. 41,932, March 15, 1864; Barnaré, No. 93,513, August 10, 1869. See LOG.

d. Vanes actuated by current. St. John, No. 8,085, May 13, 1851; Pierce, No. 128,324, June 25, 1872.

e. A *flap-valve* opening against the current, and oscillated on its axis with a force proportionate to the speed of the vessel, actuating a rod and a pointer on a dial. Walker, No. 14,328, February 26, 1856; Hinman and Tournier, No. 17,349, May 19, 1857; Thompson, No. 14,035, January 1, 1856.

A velocimeter, Vitruvius says (50 B. C.), was used by the *ancients*, and useful in his own time for indicating the distance traveled by sea and by land. The device for attachment to a land-carriage is described under ODOMETER (which see)

In navigation, an axle was placed athwart the vessel, having at each end a paddle-wheel four feet in diameter, which dipped into the water and was rotated by the motion of the vessel. That part of the axle within the vessel had a wheel with a single tooth standing out beyond its face, at which place a box was fixed with a wheel inside it having 400 teeth corresponding to the single tooth of the before-mentioned wheel. On the side of the spur-wheel was another tooth, which at each revolution acted upon a horizontal wheel provided with balls, which, as they reached a channel, were dropped into a brazen vase, and made a sound, thus indicating by sound and by the number of balls dropped the number of Roman miles traveled. Four hundred revolutions of the paddles, 4 feet in diameter, was considered equal to 5,000 feet, — a Roman mile.

In Walker's apparatus for indicating the speed of vessels, the resistance of the water on the circumferential vanes causes the spindle to rotate, and motion is communicated, by means of a worm-screw and pinion, to a train of wheels and indicator-hands within the cylinder, whereby the number of revolutions of the cylinder is registered, and the speed of the vessel approximately determined.

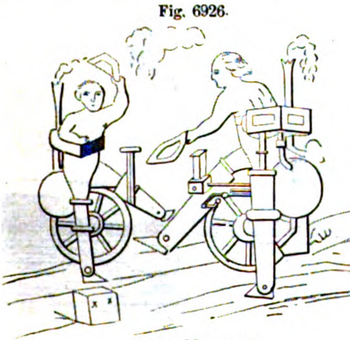
2. (*Machinery.*) Poncelet's velocimeter, for measuring the speed of machinery, etc., consists of a circular disk which is covered with card or paper, and caused to rotate with a uniform velocity by means of clock-work, while a pencil receiving its motion from that of the object whose speed is to be measured describes a curve upon the paper, varying according to the varying velocity of the object. See also SPEED-GAGE; SPEED-MEASURER; SPEED-RECORDER; SPEED-INDICATOR.

3. Apparatus for measuring rate of motion of cannon-balls. See ELECTRO-BALLISTIC APPARATUS; BALLISTIC PENDULUM; CHRONOGRAPH.

Ve-loc'i-pede. A species of carriage impelled by the rider. Blanchard and Magurier's velocipede was described in the "Journal de Paris," 1799. Known as the accelerator, 1819.

At the beginning of the century it was called a "dandy horse"; this was operated by the thrust of the feet on the ground. That of the Baron de Drais, invented at Mannheim, 1817, had but two wheels, and was moved by the thrust of the feet on the ground. Subsequently those driven by a crank movement connected with the wheels and operated by the hands through the medium of cranks or wheels were introduced.

Fig. 6926.



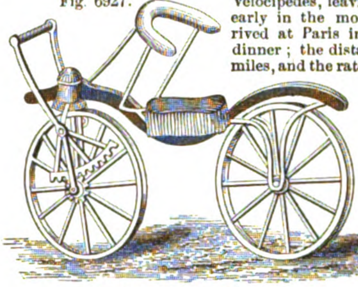
Steam-Monocycle.

The bicycle, patented in England by Johnson, was said to have been invented in Baden. Known in England as a *hobby*.

Subsequently, the bicycle, propelled by treadles operating cranks on the axles of the front wheel, and which created such a furore some six or eight years since, was introduced from France. Propulsion by treadles was applied to a three-wheeled velocipede by McKenzie, as early as 1864; while the French bicycle of Lallemant was patented in this country in 1866. Numerous modifications and improvements followed, forming the subjects of patents, a list of some of which is appended.

The speed attained by the swifter kinds of velocipedes averages from 12 to 13 miles an hour; 50 miles in 5 hours may be attained without the rider alighting from his vehicle; 123 miles within 24 hours has been accomplished. On one occasion, a party of nine, mounted on velocipedes, leaving Rouen early in the morning, arrived at Paris in time for dinner; the distance is 85 miles, and the rate of travel, exclusive of stoppages, was between 10 and 11 miles an hour. Grades exceeding 1 in 25 are said to be impracticable to the velocipede, and the rider in this case must dismount and lead his factitious steed, which, however, displays great docility on such occasions.

Fig. 6927.

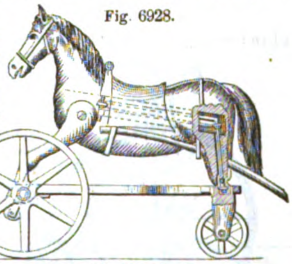


Baron de Drais' Velocipede.

Fig 6926, from Stewart's "Anecdotes of the Steam-Engine," published in 1829, illustrates a sort of steam-monocycle; the mode of propulsion is not very obvious.

Fig. 6927 is the bicycle of the Baron de Drais, as improved in England by Louis Gompertz, shown in the Repertory of Arts in 1821. It is propelled by a segment rack gearing in a pinion on the driving-wheel and operated by a handle in front of the rider's seat or by the feet alternately touching the ground.

Fig. 6928.

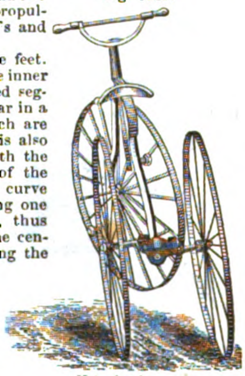


McKenzie's Velocipede.

McKenzie's "cantering propeller" (Fig. 6928), patent, 1864, embraces "a cranked axle, arms and foot rest, so arranged that power applied by the feet of the driver shall give motion to the vehicle." This, of course, had two front wheels, but the mode of propulsion is the same as in Lallemant's and other more recent bicycles.

Fig. 6929 is also driven by the feet. The rear axle is in two parts, the inner ends of each formed into toothed segments which engage a small gear in a box, to which they and the reach are pivoted. The end of the reach is also a toothed segment engaging with the small gear. The inclination of the rider's body when turning a curve partly rotates the gear, elevating one and depressing the other axle, thus inclining the wheels toward the center of the curve and facilitating the turning.

Fig. 6929.

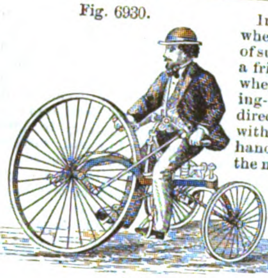


Velocipede.

In Fig. 6930, the driving-wheel is operated by hand-cranks. To the stirrups for the rider's feet are attached cords leading to the two rear wheels, by which the machine is steered.

Pickering's (Fig. 6931) is a bicycle. The tiller is sufficiently elevated to permit a perfectly upright position in riding. The stirrups or crank-pedals are three-sided, and turn on the crank-pins, so that the pressure of the foot always brings one of the three sides into proper position, and are so shaped as to be operated by the fore part of the foot, bringing the ankle-joint into play and relieving the knee.

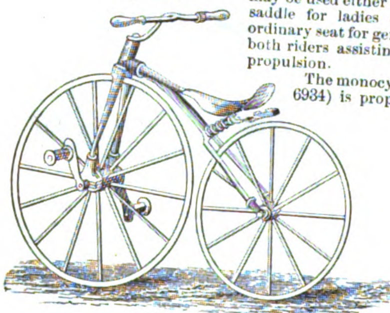
Fig. 6930.



Velocipede.

In Fig. 6932, the small rear wheel is only used as a point of support for the reach and for a friction-wheel. The driving-wheel, which is also the steering-wheel, is worked, not by direct connection of the feet with the treadles, but by the hands and feet, both through the medium of connecting-rods between the cranks and a walking-beam. The reach is so hinged that the wheel may be brought directly under the seat for attaining great speeds on level ground, or thrown forward when descending a slope. A pivotal arrangement permits of guiding the wheels to the right or left.

Fig. 6931.

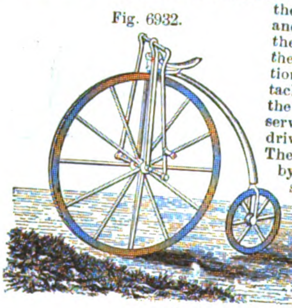


Pickering's Bicycle.

In Fig. 6933, the rear seat may be used either as a side-saddle for ladies or as an ordinary seat for gentlemen, both riders assisting in the propulsion.

The monocycle (Fig. 6934) is propelled by a hand-wheel, from which belts or ropes pass around pulleys on the axis of the main wheel, and thence around the axis of the small wheel, seen beneath the rider, which acts by friction. The small pulleys, attached to arms emanating from the axis of the main wheel, serve as guides to keep the driving-mechanism in place. The steering is effected either by inclining the body to one side or by touching a foot to the ground.

Fig. 6932.



Bicycle.

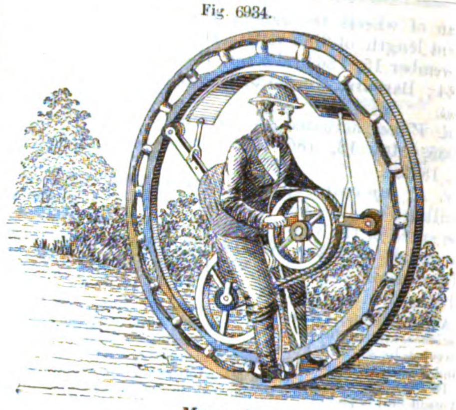
Fig. 6935 represents an ice-velocipede. It has a spiked driving-wheel in front, and two runners attached to the bottom of the reach behind.

Fig. 6936 illustrates a water-velocipede. The main wheel, which the driver bestrides, passing through a casing below, is the means of propulsion. The rudder is operated by two cords passing from the steering-bar beneath pulleys on each side to the rudder-head.

Fig. 6933.

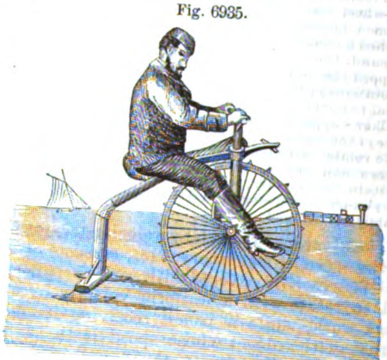
Bicycle.

Fig. 6934.



Monocycle.

Fig. 6935.



Ice-Velocipede.

Patents on Velocipedes from 1819 *to* 1868.

No.	Name.	Date.
	W. K. Clarkson	June 26, 1819.
	G. Parker	November 21, 1825.
19,092.	L. Keiner	January 12, 1858.
30,192.	S. W. Barr	October 2, 1860.
35,583.	H. Boyd	June 17, 1862.
36,160.	A. Longett	August 12, 1862.
41,310	P. W. Mackenzie	January 19, 1864.
44,256.	J. Goodman	September 13, 1864.
46,705.	H. A. Reynolds	March 7, 1865.
47,220	W. Quinn	April 11, 1865.
53,209	J. G. Wilkinson	March 13, 1866.
54,207.	H. A. Reynolds	April 24, 1866.

Fig. 6936.

Water-Velocipede.

No.	Name.	Date.
59,915.	P. Lallemant	November 20, 1866.
64,416.	F. G. Hoeppner	May 7, 1867.
71,531.	C. A. Way	November 26, 1867.
71,532.	C. A. Way	November 26, 1867.
73,029.	M. Newman	January 7, 1868.
74,058.	L. Derovier	February 4, 1868.
75,531.	W. G Crossley	March 17, 1868.
77,478.	O. F. Gleason	May 5, 1868.
79,553.	B. P Crandall	July 7, 1868.
79,554.	Hanlon Brothers	July 7, 1868.
80,425.	H. A. Reynolds	July 28, 1868.
81,603.	A. Christian	September 1, 1868.
82,319.	D Hunt, Jr	September 22, 1868.
83,035	C. K. Bradford	October 13, 1868.
83,395.	C. N. Cutter	November 3, 1868.
84,153.	E. H. W Blake	November 17, 1868.
85,337.	S. M Skidmore	December 29, 1868.
85,591.	S. A Wood	December 29, 1868.

Ve-lour′. A hatter's lustering and smoothing pad of silk or plush; from *vellour*, Fr. Also called *lure*.

Ve-lours′. A fabric for upholstering, carpentry, etc. It is a velvet or plush, partly of linen and partly of double cotton warps with mohair yarn weft.

Vel′vet. (*Fabric.*) A silk fabric in which the warp is passed over wires so as to make a row of loops which project from the backing, and are thus left by withdrawing the wire for an *uncut* or *pile velvet;* but are cut by a knife to make a *cut velvet.*

Mentioned in Joinville and in the will of Richard II. Called, anciently, *vellet.*

"There bought velvett for a coat and camelott for a cloak for myself." — Pepys's *Diary*, 1666.

Vel-vet-een′. (*Fabric.*) A cut-piled fabric of cotton. It differs from velvet only in respect of the material. When it has a twilled back it is called *Genoa*.

Vel′vet-loom. A pile-fabric loom.

Vel′vet-pa′per. Wall-paper printed with glue and dusted with shearings of cloth or flock.

It was invented by Lanyer, who obtained an English patent in 1634. He employed shearings of wool, silk, and other materials upon backings of paper, cloth, silk, cotton, and leather. See Wall-paper.

Vel′vet-pile Car′pet. A carpet made in the same manner as Brussels carpet, except that the wire, over which the loops of the worsted yarn are made, is of a flattened form, and has a grooved upper surface, which acts as a director for the knife by which the series of loops is cut. The carpet is known as *Wilton carpet*. See Brussels Carpet.

Vel′vet-tree. (*Puddling.*) The point where the draft from the neck of the furnace is turned upward into the stack.

Vend. (*Mining.*) The whole quantity of coal sent from a colliery.

Ve-neer′. 1. (*Wood-working.*) A thin slip of wood or ivory glued or cemented to a piece of other material, and forming an ornamental covering therefor.

The practice of veneering is very generally applied to furniture; common woods, such as pine, being thus caused to assume the exterior appearance of rosewood or mahogany.

That this art was practiced by the Egyptians, the tombs of Thebes will verify. Wilkinson identifies it as of the date of Thothmes III., whom he considers the Pharaoh of the Exodus, and who was heavily in the brick business. Bricks with his stamp are more numerous in Egypt than those with any one other pronomen.

In the annexed cut, we see a man fitting a piece of red wood to a plank of yellow wood; at least they are so colored in the original. He has stuck his adze into a block of the same yellow wood, probably sycamore, and in his vicinity are shown his

Fig. 6937.

Veneering in Egypt, 1490 B. C.

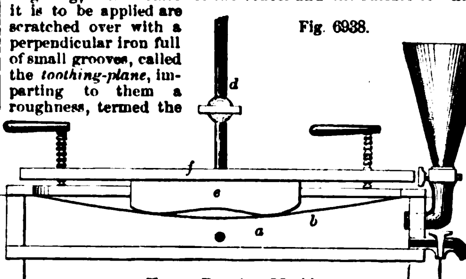
tool-chest and the square. A man is engaged in grinding something on a slab, and another is spreading something on a board, which is thought to be glue, for several reasons: it is kept hot on the fire; it is shown in connection with joining two slabs of wood; and a piece of something is represented just by, which has an irregular edge, supposed to represent the concave fracture of a piece of glue. This was their systematic mode of representing any branch of industry: the material, its shaping, and the tools and articles employed.

Of the flexible beech veneers used in the construction of boxes and desks, Pliny says that the tuberosities and knots which gave the circular figures and wavy lines to the citrus, terebinth, palm, holly, box, maple, etc., gave them value for covering wood whose grain had not these variegations. Covering common wood with thin veneers of a higher priced wood, and subsequently with laminæ of horn, ivory, and tortoise-shell, was also practiced in his day. He speaks with disgust of the "monstrous invention of paint and dyes which were applied to the woods and veneers to imitate other woods or give the appearance of the grain of wood to ivory," etc.

Veneers are attached either by the *hammer* or by the *caul*. The former is more readily and generally applicable to small works. The back of the veneer and the surface to which it is to be applied are coated with a thin glue or a stiff size, the surface is then warmed, and the face of the veneer having been coated with glue and warmed, it is applied to the surface, and the hammer (see Veneering-hammer) is drawn across it with a wriggling motion, forcing the liquid glue out at the edges. Where the two pieces to be united are large, several hands are employed in this operation.

Cauls are plates or molds, adapted to the shape of the surface, either flat or curved, to which the veneer is to be applied. They are held to the work by clamps operated by screws, and, together with the veneer, are heated previous to being applied. Their operation in effecting a perfect union between the two surfaces is more effectual than that of the hammer. Previous to gluing, both surfaces of the veneer and the surface to which it is to be applied are scratched over with a perpendicular iron full of small grooves, called the *toothing-plane*, imparting to them a roughness, termed the *tooth* or *key*, which causes the glue to hold.

Fig. 6938.



Veneer-Bending Machine.

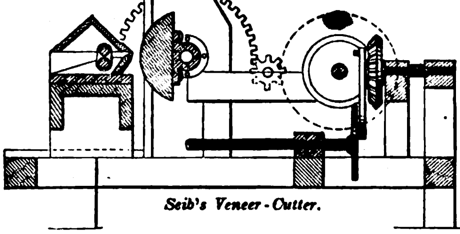
A veneer of ivory, 41 feet long and 14 inches wide, was shown at the London Exhibition, 1851. It was sawn from a rotating block, forming a spiral ribbon, which was then flattened.

This method originated in Russia, and was first applied to wood.

Ve-neer′-bend′ing. Fig. 6938 illustrates a machine for applying veneers with an equal and uniform pressure to curved and other surfaces.

It consists of a trough *a*, provided with a top *b* of flexible and water-proof material. The trough is filled with warm water through the funnel and pipe *c*, provided with a stop-cock, and has a pipe *d* through which hydraulic pressure is applied by a force-pump or otherwise, lifting the flexible top, which, acting against the thin veneer, forces it to conform to the shape of an object *e* to which it is applied; this is prevented from rising by the plate *f*, through which screws pass that secure the flexible cover and prevent its edges from rising. A cock *g* serves to empty the trough.

Fig. 6939.

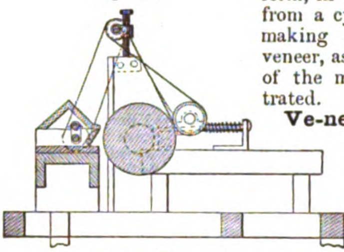


Seib's Veneer-Cutter.

Ve-neer′-cut′ter. Fig. 6939 is the Seib veneer-

cutter; the veneer is cut from a semicylindrical log. Fig. 6940 is another form, in which it is cut from a cylindrical log, making a continuous veneer, as in some other of the machines illustrated.

Fig. 6940.

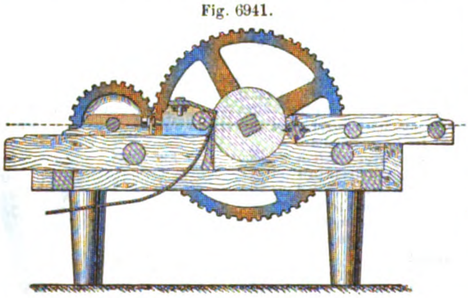


Seib's Veneer-Cutter.

Ve-neer′-cut′ting Ma-chine′. A machine for *cutting* veneers from the log or block; as distinct from *sawing*.

In Humphrey's machine (Fig. 6941), the cutter, a long thin blade the whole width of the veneer to be cut, is slightly inclined from the perpendicular. The block is first turned to a cylindrical form, and is clamped so as to receive a rotary motion. A presser-roller acts against the wood in advance of the knife and removes the veneer. The knife is secured to a carriage, which has a progressive forward motion toward the center of the block, and cuts a continuous veneer. The distance between the roller and knife is adjustable to regulate the thickness of the slip.

Fig. 6941.

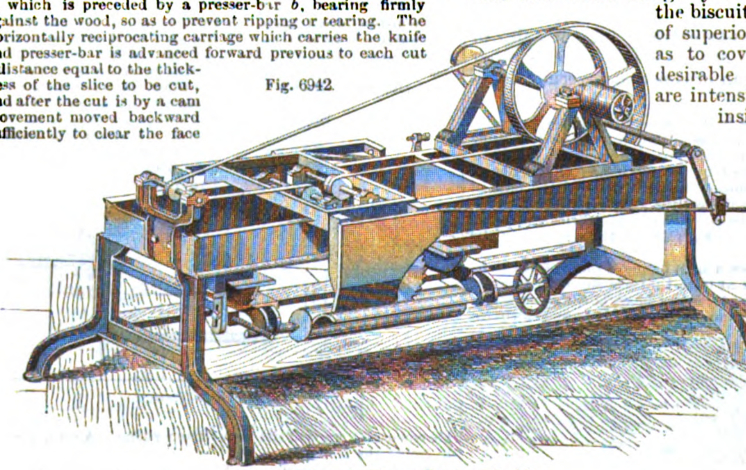


Veneer-Cutting Machine.

Stedman's (Fig. 6942) is designed for cutting a continuous strip from a circular block of wood or ivory, which is held between two revolving mandrels on a carriage, which has an intermittent upward feed previous to each successive cut of the circular saw, which is hung from a carriage having a longitudinal forward and return movement. The saw is accompanied by a guide which facilitates the action of the saw and conducts away the severed strip.

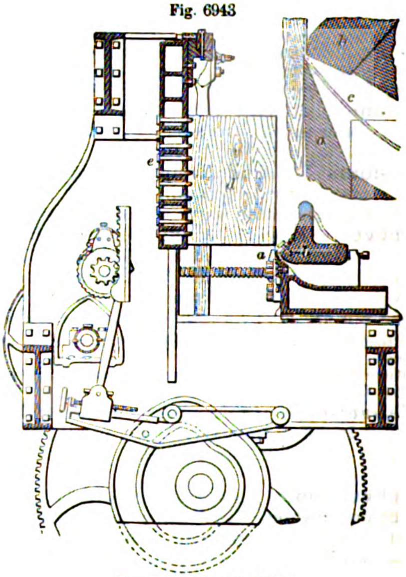
In Parker and Sleeper's machine (Fig 6943), the block *d* is secured by bolts to a vertically reciprocating carriage *e*, and is drawn downward to be presented to the action of the knife *a*, which is preceded by a presser-bar *b*, bearing firmly against the wood, so as to prevent ripping or tearing. The horizontally reciprocating carriage which carries the knife and presser-bar is advanced forward previous to each cut a distance equal to the thickness of the slice to be cut, and after the cut is by a cam movement moved backward sufficiently to clear the face of the ascending block. The severed veneer *c* passes through the throat between the knife and the presser-bar.

Fig. 6942.



Stedman's Veneer-Cutting Machine.

Fig. 6943



Veneer-Cutting Machine.

Ve-neer′ing. 1. The process of covering the surface of an object with a thin sheet or sheets of more ornamental material, in order to improve its appearance.

For the method of veneering wood on wood, etc., see VENEER.

To veneer marble on zinc: take a plate of zinc about 1/10 inch in thickness; make a frame of such a shape as will compose one of the parts of the clock case or other object; over this glue sand-paper rough side out. On the sand-paper place hot tar mastic and apply the veneer of marble previously heated.

2. (*Paper-making.*) The process of covering a sheet of one quality or color of paper by a second sheet of differing quality or texture.

It was invented by Dickinson, England, and as applied by him, the sheets of imperfectly compacted paper were laid together and united by pressure.

3. (*Pottery.*) A process termed *veneering* has been adopted with some kinds of pottery where a strong but coarse and unsightly ware is dipped, while in the biscuit condition, into a paste of superior color and quality, so as to cover the biscuit with a desirable coating, whose colors are intensified by a glaze. The inside and outside may be of different colors.

Ve-neer′ing-ham′mer. An implement for forcing out superfluous glue from between a veneer and the piece to which it is applied. It is either made of iron, with a very thin and wide peen, or more commonly of a piece of wood three or four inches square, with a round handle pro-

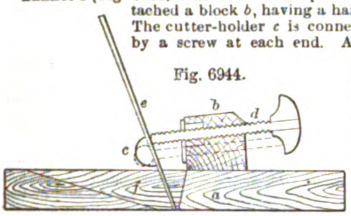
jecting from the center. One edge of the hammer-head is sawn down for the insertion of a piece of sheet iron or steel that projects about $\frac{1}{4}$ of an inch, having a straight, round, smooth edge, and the opposite side of the head is rounded to prevent it from hurting the hand.

Ve-neer′-mill. A saw-mill arranged for cutting veneers. See VENEER-SAW.

Ve-neer′-plan′ing Ma-chine′. An implement for smoothing veneered and other surfaces.

Tanner's (Fig. 6944) consists of a sole-plate *a*, to which is attached a block *b*, having a handle at each end. The cutter-holder *c* is connected to the block by a screw at each end. A central thumb-screw *d* serves to adjust the angle of inclination of the cutter *e*. The shavings ascend through the throat *f*.

Fig. 6944.

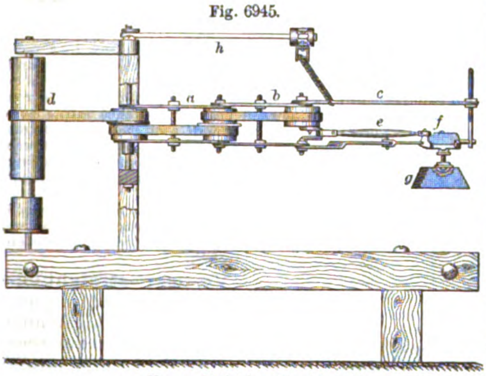


Veneer-Planing Machine.

Ve-neer′-pol′ish-ing Ma-chine′. A machine for giving a fine bright surface to veneer or veneered work.

Spear's machine has three sets of connected arms *a b c*, carrying three pulleys, the first of which receives motion from the drum *d*, and communicates motion to the second, which, in turn, transmits it to the third; the axis of the latter is cranked,

Fig. 6945.

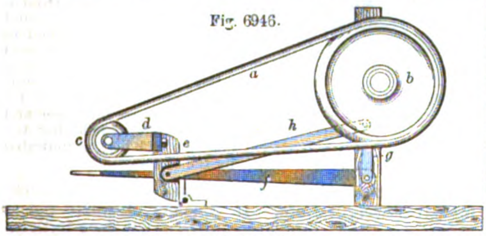


Veneer-Polishing Machine.

and through the pitman *e* reciprocates the carriage *f*, from which the rubber *g* depends. The whole arrangement has sufficient flexibility to permit the rubber to be traversed laterally by the hand, while the polishing is effected in right lines by its reciprocating motion. The arm *c*, from which the rubber depends, is supported by a cord or chain from the stationary arm *h* above.

Smith's machine (Fig. 6946) comprises a band *a* having its exterior surface covered with an abradant, and passing around

Fig. 6946.



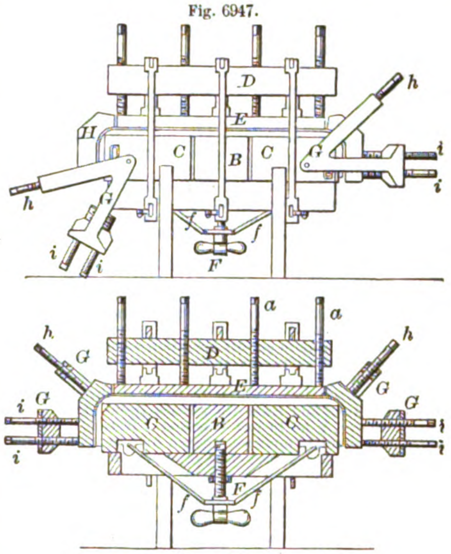
Veneer-Polishing Machine.

two half-round faced pulleys *b c*, the latter of which is adjustable toward or from the former, to vary the tension or to remove the belt when it requires re-sanding. It is journaled in the arm *d* connected to the hinged standard *e*, which is moved when desired by the lever *f* through the intervention of the connecting-pieces *g h*. This apparatus is specially adapted for surfaces of irregular curvature.

Ve-neer′-press. A press for applying veneers to the surfaces to which they are to be attached.

In Fig. 6947, the bed *C B C* is made in three sections, the two outer of which may be separated from or approached to the central one *B* by means of a screw *F* and connecting-rods *f f*.

Fig. 6947.

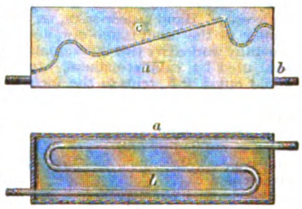


Veneer-Press.

The top *D* is hinged at one side and has hinged clamps at the other. Screws *a a* serve to press the plate *E* against the veneer, while the cauls *H H* bend and hold it against the sides of the work. The cauls are operated by screws *h i i* in the pivoted caul-holders *G*, which, when lifted, are held by catches, and are lowered to release the finished work.

In Fig. 6948, the *caul* *a* is heated by a steam-pipe *b* for the purpose of softening the veneer, to allow it to readily assume the form of a surface *c* to which it is to be applied, and keep the glue in liquid condition until the junction is effected; or the steam may be introduced directly into the caul.

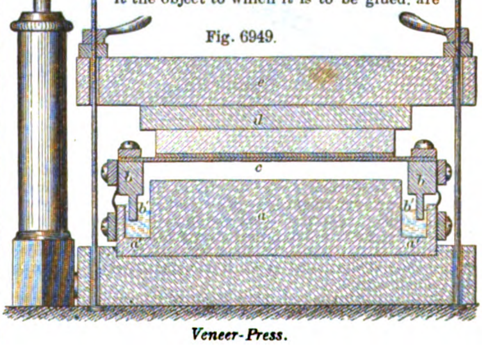
Fig. 6948.



Veneer-Press.

In Fig. 6949, the bed consists of a block *a*, having a groove *a′* running around its margin, and containing water or other liquid; a frame *b*, having a flange *b′* dipping into the water in the groove, and connected with the block *a* by a flexible air and water tight casing of vulcanized rubber; and a top *c* of flexible metal, on which the veneer, and over it the object to which it is to be glued, are

Fig. 6949.



Veneer-Press.

laid. Air is forced by a pump into the space between *a* and *b*, raising the frame and its flexible top, and steam is admitted into the cavity at the same time; the veneer is thus applied equally to the surface, and the glue kept fluid. The slab or plank to be veneered is prevented from rising by the block *d*, which is held down by two cross-heads *e*, adjustable as to hight by screws and hand-nuts.

Ve-neer′-saw. (*Wood-working.*) A circular saw, made thick at the middle, and tapering to a very thin edge at the periphery; used for separating veneers from the solid block.

Veneer-saws for ivory are sometimes made as small as 6 inches in diameter; more generally 15 to 20 inches. They are run at a lower rate of speed than those for wood, and are made to cut as many as 30 leaves to the inch. Those for wood are frequently of much larger size, are run at a higher velocity, and seldom cut more than 15 leaves to the inch. About one third the material is wasted in sawdust.

The veneer-saw was invented by Isambard M. Brunel, 1805-1808, and it was introduced by him into the Chatham Dockyard, and subsequently into his works at Battersea.

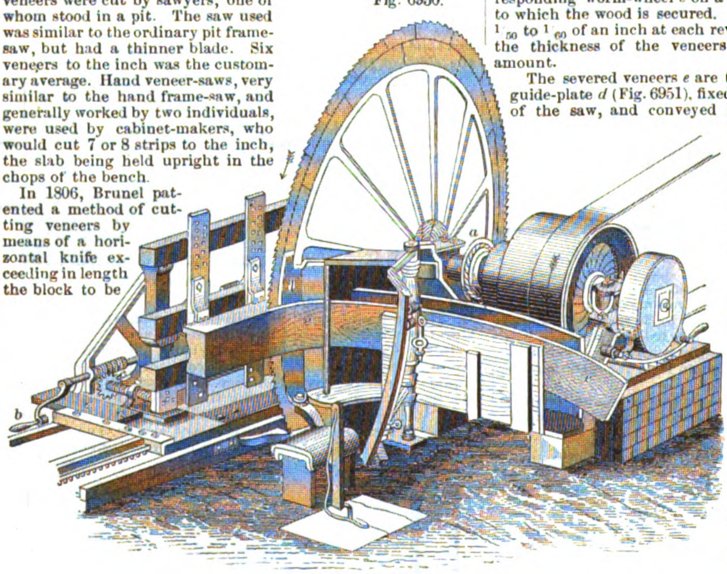
A writer of 50 years since gives the following description of Mr. Brunel's workshop: —

"In a small building I was attracted by the solemn action of a steam-engine of 16 horse or 80 men power, and was ushered into a room, where it turned, by means of bands, four wheels, fringed with fine saws, two of 18 feet in diameter, and two of 9 feet. These circular saws were used for the purpose of separating veneers, and a more perfect operation was never performed. I beheld planks of mahogany and rosewood sawed into veneers $^1/_{14}$ of an inch thick, with a precision and grandeur of action that was really sublime. The same power at once turned these tremendous saws and drew their work from them. A large sheet of veneer, 9 or 10 feet long and 2 feet broad, was thus separated in about 10 minutes, so even and so uniform that it appeared more like a perfect work of nature than one of human art. The force of those saws may be conceived when it is known that the large ones revolve 65 times in a minute; hence $18 \times 3.14 = 56.5 \times 65$ gives 3,672 feet, or two thirds of a mile in a minute; whereas if a pit-saw worked by two men gives 30 strokes of 3 feet in 1 minute, it is but 90 feet, or only the $^1/_{40}$ part of the steady force of Mr. Brunel's saws." — Sir Richard Phillips's *Morning Walk from London to Kew.*

Previous to Brunel's invention, veneers were cut by sawyers, one of whom stood in a pit. The saw used was similar to the ordinary pit frame-saw, but had a thinner blade. Six veneers to the inch was the customary average. Hand veneer-saws, very similar to the hand frame-saw, and generally worked by two individuals, were used by cabinet-makers, who would cut 7 or 8 strips to the inch, the slab being held upright in the chops of the bench.

In 1806, Brunel patented a method of cutting veneers by means of a horizontal knife exceeding in length the block to be operated on. The knife was composed of several pieces of steel, their lower faces being placed exactly in line, slightly rounded, and having a very keen edge. This had a short reciprocating action, while the block of wood was moved sideways against it by means of a screw slide operated by a hand-wheel. The block was raised to the proper distance after each cut by means of four screws at the angles of the frame, simultaneously operated by a single winch.

Fig. 6950.

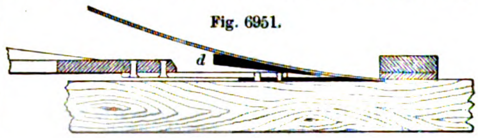


Veneer-Saw.

This apparatus converted the whole of the wood into veneers, without waste, and is said to have been tolerably successful with pliant and straight-grained woods, but did not answer well with irregularly grained and brittle woods, as the veneer in this case had a tendency to curl up and split. See Veneer-cutter.

Fig. 6950 illustrates the *segment-saw*, built up of separate plates of steel screwed to the edge of a metallic disk or chuck. In those exceeding 4 feet in diameter, the guidance of the wood is effected by a device called the drag. The veneer generally

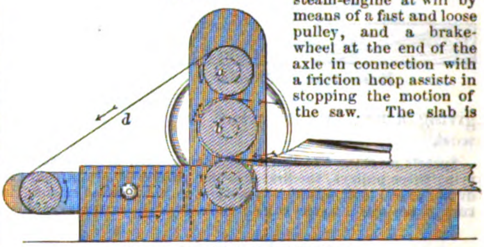
Fig. 6951.



Veneer-Saw.

proceeds from the edge of the saw through a curvilinear trough parallel with its back, but sometimes, as in the present instance, it is conducted away from the saw in front. The axis of the saw is connected to or disconnected from the steam-engine at will by means of a fast and loose pulley, and a brake-wheel at the end of the axle in connection with a friction hoop assists in stopping the motion of the saw. The slab is

Fig. 6952.



Veneer-Straightening Machine.

dogged to the drag, which is carried past the saw by a rack operated by a pinion driven from a band on the pulley *a*, and has devices for producing a quick return motion. A lateral motion is imparted by means of the winch *b*, which turns a rod having a screw-thread at each end, which takes into a corresponding worm-wheel *c* on a screw at each end of the frame to which the wood is secured. The screws advance the frame $^1/_{50}$ to $^1/_{60}$ of an inch at each revolution of the winch, enabling the thickness of the veneers to be graduated within that amount.

The severed veneers *e* are turned aside by a feather-edged guide-plate *d* (Fig. 6951), fixed nearly in contact with the edge of the saw, and conveyed away by a curvilinear wooden trough.

Ve-neer′-straight′en-ing Ma-chine′. A machine for straightening veneers which have been cut in the form of scrolls from a circular log.

That shown (Fig. 6952) is designed to effect this object by a yielding pressure somewhat gradually applied, so as to obviate the danger of splitting. It consists of three rollers *a b c*, arranged one above the other, or the central one, which is the driver, may be placed somewhat in rear of the other two. A belt *d* of canvas passes around in front of the lower roller, behind the central one, and up and in front of the upper roller, and thence around an adjustable roller *e*, by which its tension is regulated. The veneer is inserted between the lower and central rollers, following the course of the belt, as indicated by the arrows.

Ve-ne′tian Ball. An ornamental form of glass for paper-weights, etc. It consists of waste pieces of *filigree glass* conglomerated together in a bulb of clear flint-glass, which is collapsed upon the filigree.

Ve-ne′tian Blind. A *louver* shutter or blind made of slats with spaces between them to admit air. In some cases the slats are fixed at a certain angle in the *shutter;* in other cases they are movable to allow the passage of more or less air and light.

The suspended *blind* has cords for support, and others for changing the positions of the slats.

The blind-wiring machine is the invention of Byron Boardman, in 1857. See Figs. 719, 720.

Ve-ne'tian Car'pet. A carpet whose warp or chain is of worsted, and generally arranged in stripes of different colors. The shoot, which is generally black, is concealed, and the warp exposed on the two surfaces. The weft is sometimes of different colors, and confers a plaid or check pattern. By the suitable arrangement of the heddles, a twill may be given. The ordinary loom suffices, as no figures are raised.

Ve-ne'tian Glass. The *Venetian-glass ball* consists of a number of pieces of filigree glass packed into a pocket of transparent colorless glass, which is adhesively collapsed upon the interior mass by the pressure of the atmosphere as the air is withdrawn by a pump.

The *Venetian filigree* consists of plain and colored enamel laid into a mold and aggregated upon the exterior of a ball of flint-glass. Being enveloped in a film of white glass, the mass is reheated and worked into shape.

Ve-ne'tians. A term applied to doors and shutters having luffer openings.

Ve-ne'tian Win'dow. One with three separate lights.

Vent. 1. (*Ordnance.*) The priming and firing aperture of a gun.

The ventages of ordnance are bushed with copper, a plug of that metal being screwed into the bronze gun and afterward bored for the vent. Copper is less injured by repeated discharges than the bronze (copper, 9; tin, 1), of which the gun is composed. The curved bit of the borer smooths off the end of the plug when making the spherical, parabolical, or other termination to the bore.

The vents of ordnance are $\frac{2}{9}$ inches in diameter.

The hardened steel nipple of a gun, accidentally broken in the barrel, may be drilled out by a diamond drill.

2. The opening in the top of a barrel to allow air to pass in as the liquid is drawn out.

Fig. 6953.

Spring-Vent for Barrels.

3. (*Foundry.*)

The term employed to comprehend the channels and passages by which the *air*, or gases, escape from the mold. The atmospheric air which fills a mold is rapidly expelled by the hot metal, but this forms only a small part of the gaseous matters driven out in all directions. In damp sand steam is rapidly formed, and some of the water present is also decomposed, giving rise to hydrogen, while its oxygen combines with the carbon contained in the sand to form carbonic oxides. The mold and cores also contain more or less organic matters, such as coal, straw, horse-dung, etc., all of which are decomposed, generating inflammable gases.

If the mold has *vent* enough, all these gases, known to the molder as *air*, or foul air, will make their way so rapidly to the outside of the mold that a disturbance or boiling of the metal, due to their presence in the mold, and technically called *blowing*, will be impossible. Vent is first secured by the composition of the sand; if it be too fine, or contain too much clay or too much water, or too finely powdered carbonaceous matter, or be rammed too hard, such faults have to be remedied by suitable treatment, which will facilitate its permeation by the gases. The perviousness of the sand after it has been rammed into the mold is also greatly increased by prodding it all over with a long sharp-pointed steel wire (vent-wire) before the flasks are separated or the pattern withdrawn; each channel left by the wire conveys the gases away, — a fact which is made very evident by the small blue flame issuing from all such openings when the mold is filled with metal, and they are fired by a spark. In taking off the air from large castings which are sunk many feet deep in the floor of the molding-shop, large and long passages leading to the surface are necessary. These are connected very carefully with all cavities below from which a rush of gas is possible, and their construction is indeed a matter requiring great judgment and caution, for, mixed with atmospheric air, the inflammable gases from a mold give rise to an explosive compound, which will, if it ignites prematurely, blow the whole to pieces.

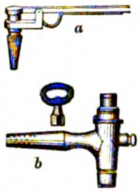
Vent-bit. An auger for clearing the vent of a gun.

Vent-cock. A device for admitting air to a vessel from which liquid is to be drawn, or permit the escape of gas.

The *vent-peg* (*a*, Fig. 6954) consists of a tubular, threaded stem, which may be screwed into a cask, and is provided with an air-tight plunger or stopple, which is lifted by means of a lever.

The *cock* *b* is adapted to be driven, and is furnished with a key by which its valve is opened and closed.

Fig. 6954.

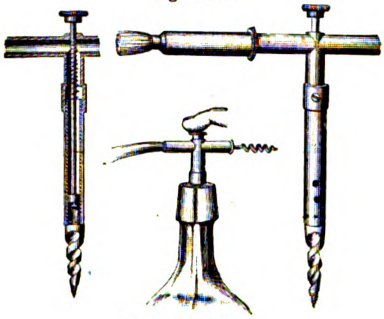


Vent-Peg and Vent-Cock.

Vent-cov'er. A rectangular piece of leather placed over the vent of a cannon to prevent access of moisture to the box. It is secured to the gun by straps and buckles, and has a copper spike in its center, which enters the vent and prevents its being displaced.

Vent-fau'cet. An instrument which may act as a vent-hole, borer or a faucet to draw a portion of liquor from the vessel. As shown, it has the accessories of a corkscrew and brush.

Fig. 6955.



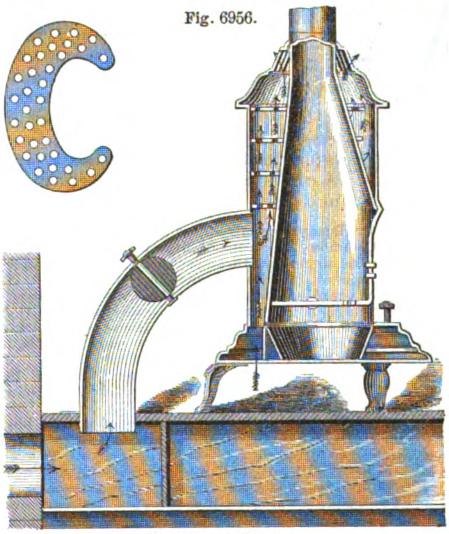
Love's Vent-Faucet.

Vent-field. A flat tablet around the vent of a gun.

Ven'ti-lat'ing-bricks Bricks whose hollows form continuous channels in the walls for purposes of warming, ventilating, and removing moisture from the wall. See BRICK.

Ven'ti-lat'ing-heat'er. A form of stove in which the air is drawn fresh from the outside of the building, warmed in the passages of the stove, and discharged into the room. See STOVE, pages 2410, 2411; also HEATING-STOVE, Fig. 2474, page 1090.

Fig. 6956.



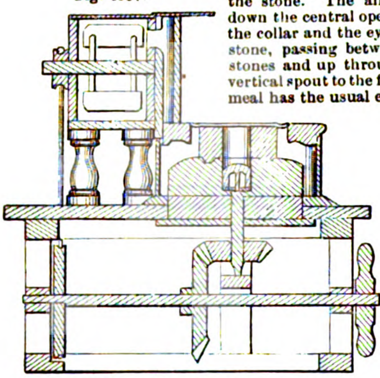
Ventilating-Heater.

Ven'ti-lat'ing Mill-stones. The system of ventilating mill-stones by vacuum or plenum, by a blast of air in the eye or a suction-fan to the case, seems to have been invented about 1844.

See English patents :	Newton, 11,084	A. D. 1846.
	Gordon, 10,163	" 1844.
Belgian patent :	Houyet and Gendebein ..	" 1844.
French patents :	Cabanes	May 29, 1845.
	Cabanes	May 26, 1846.

Fig. 6957 may be taken as an illustration. The collar is connected to the curb by the elastic annular diaphragm, and its lower edge is received in an annular groove in the top of the stone. The air passes down the central opening in the collar and the eye of the stone, passing between the stones and up through the vertical spout to the fan. The meal has the usual exit.

Fig. 6957.



Ventilated Mill-Stone.

Ven'ti-lat'ing-stack. (*Mining.*) A high stack with a partition and air-furnaces, and connected with the ventilating-flue.

Ven'ti-lat'ing Wa'ter-wheel. The water-wheel bucket has an escape for the air toward the interior of the wheel, so as to allow the bucket to fill without confining the air, and to escape freely on reaching the position of discharge.

Fig 6958.

Ventilating Water-Wheel.

It appears to have been first introduced in Scotland, and to have been suggested by the violent eruption of water incident to the confining of the air in the bucket, in some cases forcing a spray to the hight of 6 or 8 feet. The arrows mark the course of the escaping air, from *a* to *b*.

Ven'ti-la'tor. An arrangement for supplying fresh and removing vitiated air from buildings, mines, or other places. This may be effected either by withdrawing the foul air and permitting the fresh air to flow in and supply its place (the *vacuum* process); or by forcing in fresh air (the *plenum* process), which drives the foul air before it to the exit. A combination of both processes is also used in certain cases.

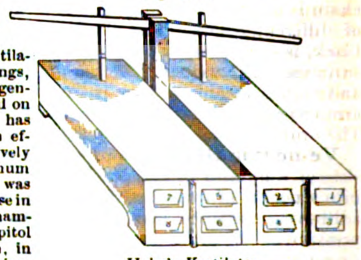
In 1723, Dr. Desaguliers introduced a plan for ventilating the House of Commons by means of fires in upper apartments, which drew the air upward through openings at each angle of the House, whence it was conducted to the chimneys. This plan was not permitted to have a fair trial, and was succeeded by the centrifugal fan, invented by Desaguliers in 1734. One of these was erected over the ceiling of the House, and continued to do duty until 1817, being subsequently superseded by the arrangement contrived by the Marquis de Chabannes.

See "A Course of Experimental Philosophy," by J. F. Desaguliers, LL. D., F. R. S., Chaplain to his Grace the Duke of Chandos London, 1734.

About 1741, or shortly after the invention of the fan-blower by Desaguliers, the Rev. Dr. Hales contrived a ventilator which he endeavored to introduce into the British navy. It worked on the bellows principle, and was composed of two oblong boxes, each of which had a valve moved up and down by rods attached to a lever working on a central pin. Air was drawn into the machine through inwardly opening valves, and expelled by valves opening outwardly. It required the labor of two men, and the inventor claimed that it was capable of discharging 6 tons of air per minute; but it appears to have met with but little success.

About the same period, Sutton proposed to ventilate ships by pipes leading from the well and other parts of the vessel to the galley fire, which was to receive its sole supply of air through these tubes.

Fig. 6959.



Hales's Ventilator.

1. The ventilation of buildings, though more generally conducted on the exhaust, has sometimes been effected exclusively on the plenum principle, as was formerly the case in the Senate Chamber of the Capitol at Washington, in which a combination of both methods is now adopted. General Morin, Director of the Imperial Conservatory of Arts and Trades under the late French Empire, an authority in matters of this kind, gives a decided preference to the vacuum method, for the reasons that the vitiated air is more certainly withdrawn than it can be when expelled by forcing, and on account of the machinery necessarily employed, requiring skilled labor to attend it, which is indispensable in the latter method: while the former, requiring only the same number and arrangement of air-ducts, may be effected simply by the aid of heat.

General Morin indorses the following table, by some considered excessive, of the proper hourly supply of air required for each person in various situations: —

	CUBIC FEET.
Schools, each child, per hour	400 to 500.
Schools, each adult, per hour	800 to 1,000.
Meeting halls, for each person, per hour...	1,000 to 2,000.
Theaters, for each person, per hour........	1,400 to 1,700.
Prisons, for each person, per hour..... ...	1,700
Workshops, ordinary trades, for each person, per hour..........................	2,000
Workshops, unhealthy trades, for each person, per hour..........................	3,500
Ordinary hospitals	2,000 to 2,400.
Hospitals for epidemic cases...............	5,000

The temperature in general should not exceed, for

Workshops	59° Fah.
Hospitals	61° to 64° Fah.
Schools	66° to 68° Fah.
Meeting-rooms	66° to 72° Fah.
Theaters	68° to 73° Fah.

The air may be maintained at a higher temperature in well-ventilated apartments than in those where it is not frequently renewed.

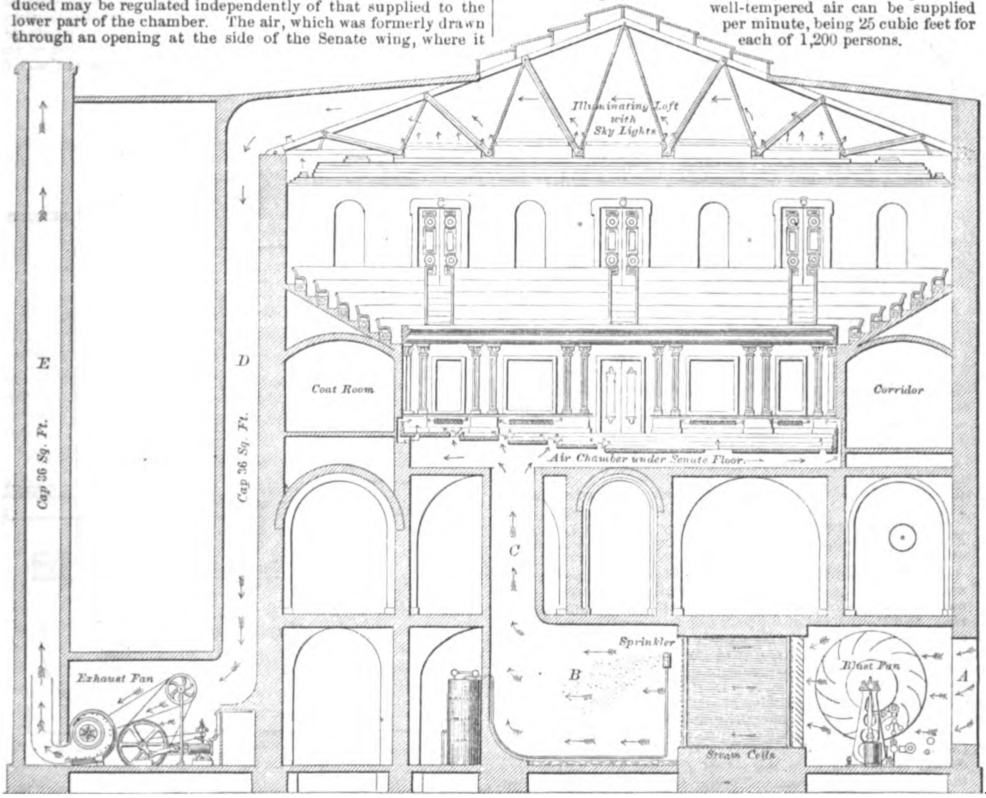
Ordinarily, the fires by which the building is heated are wholly or principally relied on to effect the required renewal of the air. Dr. Arnott's plan, 1838, consists in cutting an opening in the chimney above the grate or fireplace, and providing this opening with a valve which opens inwardly to the flue, so as to draw off the foul air from the upper part of the apartment while preventing the entrance of smoke.

The plan of the Marquis de Chabannes, employed at the Covent Garden Theater, 1819, consisted in using the large central chandelier as the principal ventilating-agent. This was surmounted by an inverted wrought-iron funnel which conducted the hot air into a wooden shaft surmounted by a cowl. Air-passages leading from various parts of the house conducted the foul air into this shaft. A furnace in one of the galleries, and another over the stage, were employed as auxiliaries.

Previous to November, 1870, the Senate Chamber in the Capitol at Washington was ventilated upon the plenum principle exclusively, no exhaust being employed. The fan used for forcing is 14 feet in diameter, moved by an engine of 16 horse-power, delivers 500 cubic feet of air per revolution, and is capable of being run at a speed of 80 revolutions per minute, which is the maximum required for summer ventilation. The upper doorways and the openings in the ceiling were relied on to discharge the vitiated air. The fresh air was introduced through openings at the lower part of the chamber. Owing to defects and contractions in the main induction channel and the distribution passages, however, the requisite quantity of air could not be supplied without causing a strong current on the floor. The speed of the fan had accordingly to be reduced so as to give only about $\frac{1}{4}$ the quantity of air required. To remedy this defect, two large exhaust-fans driven by a 25 horse-power engine were erected; these draw the air through perforations in the ceiling into the illuminating loft above, thence downward through two descending shafts having a sectional area of 33 square feet into the exhaust-chamber, whence it is discharged through a single upcast shaft having a sectional area equal to

that of the other two combined. A second air-shaft was constructed, leading from the chamber in which the air is either heated or cooled, according to the season, to an air space under the seats of the galleries, into which it is distributed through numerous perforations. The temperature of the air thus introduced may be regulated independently of that supplied to the lower part of the chamber. The air, which was formerly drawn through an opening at the side of the Senate wing, where it was liable to be contaminated by smoke and gas from the neighboring flues, now passes through a tunnel 220 feet long, the mouth of which is located in a position free from these contaminating influences. By these means, 30,000 cubic feet of pure and well-tempered air can be supplied per minute, being 25 cubic feet for each of 1,200 persons.

Fig. 6960.



Sectional View of the Senate Wing, United States Capitol, showing the Pressure and Exhaust Ventilating Apparatus.

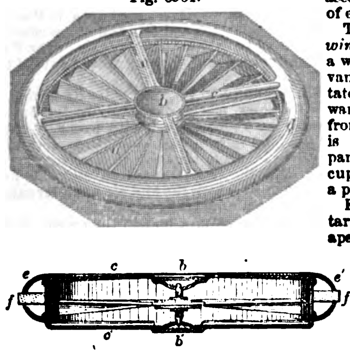
Fig. 6960 is a transverse section of the Senate wing, United States Capitol, illustrating the mode of warming and ventilating the Senate Chamber.

Fresh air is drawn in through an opening *A* in the basement wall by means of two powerful steam-driven blast fans, which force it through a series of steam-coils into a chamber *B*, where it is charged with aqueous vapor by a sprinkler. It thence ascends through an upcast *C* into an air-chamber beneath the Senate floor, and is admitted into the apartment through registers in the floor and at the sides. Rising to the upper part of the hall, it passes through apertures between the skylights into the illuminating loft, whence it is drawn downward through a descending shaft *D*, having a sectional area of 36 square feet, by steam-driven exhaust-fans, and finally discharged into the open air through an ascending shaft *E* of equal capacity.

The *ventilator for windows* consists of a wheel with spiral vanes, which is rotated by the outward passage of air from the room. It is usually set in a pane of glass, or occupies the site of a pane

Fig. 6961 is a rotary ventilator for apartments. The wheel *a*, which has a number of radial vanes, is stamped out of sheet-metal, and is journaled in bearings upon disks *b b′* attached to the arms *c c′* of the case *d*. A hole of sufficient size is cut in a window-pane, the case inserted and held by the flanges *e e′* and tongues *f f′*, which are turned up for the purpose.

Fig. 6961.



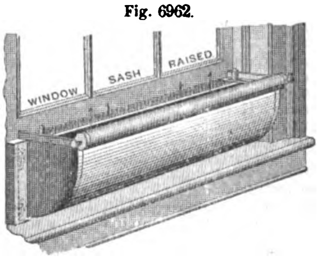
Ventilator.

Or a curved chute placed at the opening formed by a raised sash to direct the air upward into a room.

Or a louver arrangement in a pane of glass, or occupying the place of one.

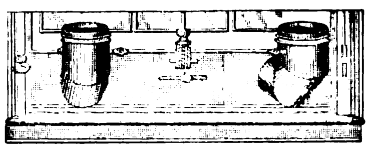
The ventilator, Fig. 6963, consists of a frame which is held between the lower bar of the sash and the sill of the window-frame, and has two elbowed pipes, whose inner ends are vertical, so as to direct the cool air from out doors upwardly into the apartment. The pipes are provided with valves for regulating the quantity of air admitted, or shutting it off altogether.

Fig. 6962.



Window - Ventilator.

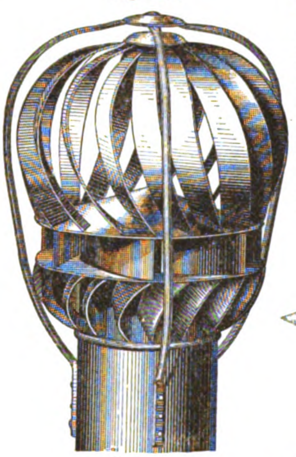
Fig. 6963



Ventilator.

The *chimney-ventilator*, or cowl, assumes many forms. The vanes or plates are inclined, so that the hood is rotated by the action of the wind or of the heated air passing outward.

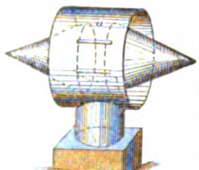
Fig. 6964.



Cowl.

In the chimney-ventilator, Fig 6965, two cones, base to base, are secured to the top of the chimney-pipe and are surrounded by a ring *a*, the object being to create a partial vacuum in the space between the cones and the ring and promote an ascending draft, whichever may be the direction of the wind. See also CHIMNEY; COWL; MULGÛF-PUNKAH; etc.

Fig. 6965.



Double-Cone Ventilator.

The *barn*, *brewery*, or *stable ventilator* is a louver, story, or cupola, whose lapping but separated slats admit the passage of air.

In the *ventilation of mines*, a series of shafts, termed *winzes*, are sunk from one level to another, permitting the ascent of the more highly heated air from below, causing an ascending current; and the descent of the cooler air from outside, which traverses the various galleries, is usually found sufficient. In coal or other mines where large quantities of dangerous gases are generated, this method is inadequate, and artificial means are resorted to to produce a more powerful ascending current, and cause a more rapid circulation of air. The most simple means of doing this, and that generally employed in coal-mines, is by means of two shafts, in one of which a fire is kept up, rarefying the air and producing a strong draft, which causes the withdrawal of the air from the set of galleries with which this, the upcast shaft, is connected. The downcast shaft communicates with another set of galleries, between which and the first a communication is established at or near the extreme end of the mine, so that the air which descends through it to replace that which is being carried off by the upcast shaft flows through the whole extent of the mine before arriving at the latter. Where a fire is inadequate to produce sufficient ventilation, other exhaust apparatus, generally the fan, is resorted to. In some cases but a single shaft is used, which is divided by a vertical partition, termed a *brattice*, one portion serving for the *upcast*, and the other for the *downcast*. The air-pump is also employed for ventilating mines as well as buildings; one of these, near Liege, is described as consisting of two wooden cylinders 11 feet 7 inches in diameter, open at top, and having valved bottoms. The pistons which were attached to the opposite ends of a beam were fitted with upwardly opening valves, were reciprocated by connection with the piston-rod of a 13-inch steam-cylinder fixed over one end of the beam, had a stroke of 6 feet 2 inches, and with a boiler pressure of 41 pounds per square inch discharged 17,000 cubic feet of air per minute.

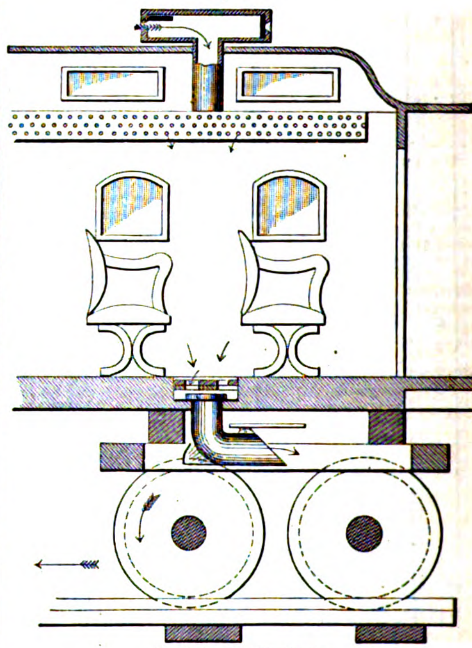
The form of air-pump in which a vacuum is produced by the alternate partial submersion of a cylinder or cylinders into water, and partial withdrawal therefrom; the "plunging bells" of the Hartz, the "duck machine" of Cornwall, and the air-holder of Belgium are of this class, and have long been employed in mines. More modern varieties are the double-acting airometer of De Vaux and Struve's mine-ventilator. These each consist essentially of two air-holders, similar to gas-holders, which alternately dip into water and produce the exhaust. The air-holders are, of course, of large size; one of a pair of Struve's producing an exhaust of 60,000 cubic feet of air per minute, being 20 feet in diameter, stroke not stated.

In the Belgian mines centrifugal ventilators of very large size, from 18 to 27 feet diameter, have come into general use. The principal kinds noticed are Rittinger's, Gallez's, Lambert's, and Guibal's, the two former having curved and the two latter straight wings; their minor details also differ. The most effective of these are stated to utilize from 30 to 40 per cent of the total power of the engine.

In some of the deep mines in France the miners work in air maintained at a density of three atmospheres. This pressure is obtained by means of pumps driven by a steam-engine, and is apparently very beneficial to the men. When about to descend, they enter a closed anteroom, into which air from the shaft is admitted to establish an equilibrium. The manhole is then uncovered for their descent.

Various patents have been granted for devices for *ventilating railway-cars*. These generally embrace the following essential features: 1, a mouth adjustable toward the direction in which the train is proceeding, and having an inclined top which deflects downward the current produced by the motion of the train; 2, an arrangement to catch the dust and sparks; and, 3,

Fig. 6966.



Godley's Car-Ventilator.

a downwardly descending pipe to direct the purified air into the car. The principle is essentially that of the wind-sail employed on shipboard.

In Clement's patent, November 22, 1853, sponge or other porous material, kept constantly moist by water from a suitably arranged chamber, is used as an air-filter.

Godley's car-ventilator acts by *vacuum* process. It has swiveled elbow-pipes, placed underneath the floor of the car, connecting with the interior of the latter by means of registers, and so arranged that the exit-openings are toward the rear of the train, the suction of the atmosphere having the effect of drawing the air out of the car through the elbow-pipes.

See also Figs. 95 to 99, page 46.

The *ventilator for ships* is commonly a wind-sail; a large tube of canvas having an expanded mouth, which is turned in the direction of the wind while the tube is directed down the hatchway, conveying the air to the lower deck. The contrivances of Hale and Sutton have been mentioned. Dr. Thiers, of New York, has patented (November 29, 1870) an apparatus in which the oscillating motion of mercury contained in a horizontal tube or tubes running athwartships and fore and aft, producing a partial vacuum, is caused to exhaust the foul air. The fluid is kept in motion by the rolling and pitching movements of the vessel.

Perkins, about 1820, proposed to ventilate ships by using two barrels half filled with water, placed diagonally to the line of the keel, and connected by a pipe. Pipes with inwardly opening valves led from the hold to each cask, and other pipes with outwardly opening valves led from the casks to discharge-ports. The rolling and pitching of the vessel caused an alternate flow from one cask to the other, by which the foul air was alternately drawn into and expelled from each cask.

The *ventilator for hats* consists of a hole in the crown, and a head-band supported at a certain distance from the sweat-lining, so as to allow upward passage of air around the head.

The *ventilator for boots* consists of a double upper with holes; the motion of the foot being relied upon for causing circulation of air.

The *ventilator for stacks*, *mows*, and *granaries* consists of a perforated air-duct which allows the heated air and moisture to pass off.

Ven-tose′. A cupping-glass.

Vent-piece. (*Ordnance.*) *a.* A plug of copper containing the vent, and screwed into its position in the gun.

b. The block which closes the rear of the bore in a breech-loader.

Vent-pipe. An air or steam-escape pipe.

Vent-plug. A stopper for the vent of a gun.

Vent-punch. It is made of steel, slightly less in diameter than the vent, and is used for clearing the vent when it has become foul or scaly.

Vent-stop′per. A plug or cap to close the vent-hole.

Vent-wire. (*Founding.*) A long steel wire, one end of which terminates in a bow and the other in a sharp point. It is used, as described above, for giving vent to green and dry sand-molds.

Ve-ran′da. An open portico attached to a house.

Verge. The spindle or arbor of a watch-balance. The term is commonly applied to that of the old vertical movement, whose *balance-arbor* has two *pallets*, which alternately engage with teeth on the opposite sides of a *crown-wheel*, whose axis is at right angles to that of the *verge*. See VERTICAL ESCAPEMENT.

Verge-es-cape′ment. See VERTICAL ESCAPEMENT.

Verge-file. A fine file with one *safe* side, formerly used in working on the verge of the old vertical escapement.

Ver′meil. 1. Silver gilt; gilt bronze.

2. (*Gilding.*) A liquid applied to a gilded surface to give luster and fire to the gold, making it resemble ormolu. It is composed of

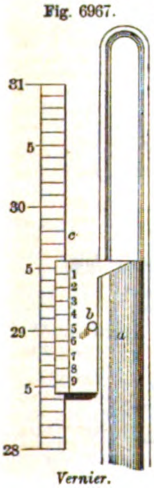
	Annotto	2 ounces.
	Gamboge	1 ounce.
	Vermilion	1 ounce.
	Dragon's blood	½ ounce.
	Salt of Tartar	2 ounces.
	Saffron	18 grains.
Boiled in..	Water	2 pints.

Steam, and apply with a soft brush.

Ver-mil′ion. A brilliant red color originally derived from cinnabar, — a native sulphide of mercury, — but generally prepared artificially. It is made in large quantities in Europe and elsewhere, the processes varying somewhat in different places. The Chinese is the most esteemed and most expensive.

Ver′ni-er. A divided sliding scale used for measuring any portions of the space between two of the smallest divisions of a graduated instrument. It derives its name from Peter Vernier, a gentleman of Franche-Compté, who described it in a tract printed at Brussels in 1631. Also called *nonius*, from Peter Nunnez or Nonius, a Portuguese mathematician, born 1497, to whom its invention has been ascribed.

Fig. 6967.



Vernier.

The vernier is attached to astronomical and surveying instruments, to the barometer, and to the beam-compass and other scales for rectilinear measurements.

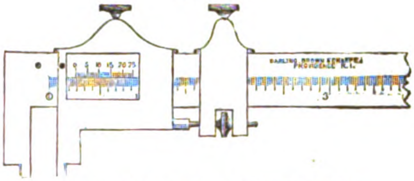
That applied to the barometer, Fig. 6967, will illustrate its principle, *a* representing the mercurial column, *b* the vernier, and *c* the barometer-scale, divided into inches and tenths. The vernier-scale is $1^{1}/_{10}$ inches in length, and is divided into 10 equal parts, each embracing $^{11}/_{100}$ of an inch, and therefore exceeding each division of the scale by $^{1}/_{100}$ of an inch. If therefore any division of the vernier coincide with a division on the scale, that division, counting downward, when the 0 of the vernier coincides with the top of the mercurial column, indicates the number of hundredths of an inch to be added to the tenths division on the scale next above which the 0 of the vernier stands.

In the mountain-barometer and scales for nice measurements, the vernier is constructed to read to thousandths of an inch by the aid of a microscope.

In circular instruments, graduated to degrees and half-degrees, a space on the vernier equal to 30 divisions of the limb is divided into 29 parts, thus allowing measurements to be made to minutes.

By further subdividing and the use of the microscope, readings down to 10″, 5″, or even single seconds are effected, as in the case of high-class astronomical instruments.

Fig. 6968.



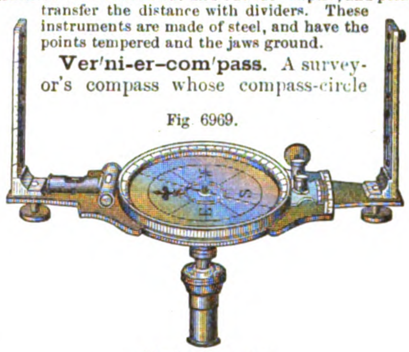
Brown, Shape, and Co.'s Vernier-Caliper.

Ver′ni-er-cal′i-per. A caliper with vernier-graduations.

One side of the vernier-caliper reads to thousandths of inches; on the other side are 64ths of inches, to read without a vernier. Instead of 64ths of inches, some are divided with verniers, reading to 20ths of millimetres, French measure. This instrument is furnished with both inside and outside calipers, and points to transfer the distance with dividers. These instruments are made of steel, and have the points tempered and the jaws ground.

Ver′ni-er-com′pass. A surveyor's compass whose compass-circle with a vernier attachment is movable about a common center by turning a tangent-screw at the south end of the instrument. It is adapted to retrace the lines of old surveys where the variation of the compass has changed, and to surveys of public lands where the lines are based on a true meridian.

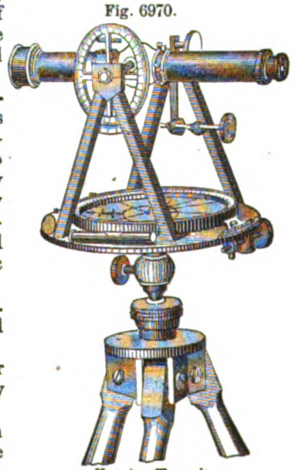
Fig. 6969.



Vernier-Compass.

Ver′ni-er-tran′-sit. A surveyor's transit having a vernier-attachment to the compass, by which the latter may be adjusted to indicate the *true* instead of the magnetic bearings.

Fig. 6970.



Vernier-Transit.

Ve-ro′na-serge. A thin worsted and cotton fabric.

A fabric of mohair and cotton variously colored.

Versed Sine. In mechanics, the rise of an arch.

Ver'ti-cal Bor'ing-ma-chine'. A drill or boring-machine having a vertical spindle. See Figs. 814, 815, 816.

Ver'ti-cal Buhr-mill. One in which the buhrs rotate in a vertical plane. See Fig. 2316, page 1021.

Ver'ti-cal Dial. A dial having a plane fixed to a wall, tower, or house. The angle formed by the gnomon is the complement of the latitude, the style preserving its parallelism with the earth's axis. See DIAL.

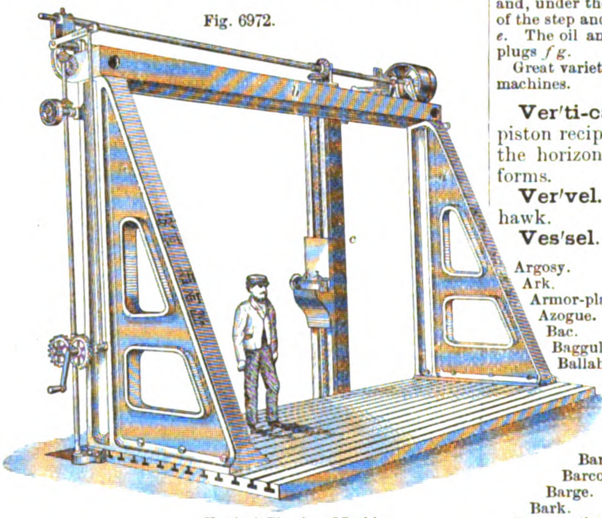
Fig. 6971.

Vertical Escapement.

Ver'ti-cal Drill. One with a vertical spindle. See Fig. 1770, page 751.

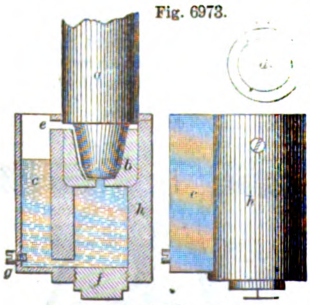
Ver'ti-cal Es-cape'-ment. The *vertical* or *verge escapement* is old-fashioned, and has been superseded by more lasting contrivances which admit of a flatter movement.

Fig. 6972.



Vertical Planing-Machine.

Fig. 6973.



Dunklee's Self-Oiling Step for Vertical Spindles.

Its inventor is not known. The teeth of the *scape-wheel* are detained by the *pallets* on the *verge*, the upper and lower ones acting alternately. The *scape-wheel* is a *crown-wheel*, and its axis is at right angles to that of the verge. This makes its plane of revolution *vertical*, the plane of oscillation of the balance being assumed to be horizontal. The construction necessitates a certain thickness of watch, which is so familiar in old time-keepers. To reduce the thickness, the planes of revolution were brought into parallelism, which brings us to the next device, called by its then distinguishing characteristic, — the *horizontal*.

Ver'ti-cal Mill. See GRINDING-MILL, Fig. 2316.

Ver'ti-cal Plan. The ground-plan, or *orthography*.

Ver'ti-cal Plan'ing-ma-chine'. A planing-machine in which the cutting action of the tool is performed in a vertical plane. The cut illustrates a machine of this class, built by Messrs. John Bourne and Company for the Chinese government.

The base-plate is of cast-iron, grooved longitudinally to receive T-bolts for securing the work. Two standards *a* support the longitudinal beam *b*, which carries the shafting and bevel-gear by which the cutter-head screw is rotated. The screw and tool-holder are carried by the upright bar *c*, which has a longitudinal motion in guides at the top and base of the machine, and is advanced the proper distance after each cut by screws above and below. The cutter-holder is caused to move twice as fast upward as it does downward, and three tools may be employed if desired. The example can cut 16 feet horizontally and 12 vertically.

Ver'ti-cal Pump. One in which the plunger or bucket moves vertically, — the more common form.

Ver'ti-cal Spin'dle-step.

Fig. 6973 shows Dunklee's self-oiling step. *a* is the spindle; *b*, the step resting in the socket *h*, which has a chamber beneath, communicating with the oil-chamber *c*, which is filled with the lubricant to a higher level than the foot of the spindle. The lubricant ascends through an aperture in the bottom of the step and through vertical grooves on its interior, shown at *d*, and, under the influence of centrifugal force, flows over the top of the step and back into the oil-chamber through the aperture *e*. The oil and sediment may be removed by unscrewing the plugs *f g*.

Great variety is shown in the steps for spindles of spinning-machines.

Ver'ti-cal Steam-en'gine. One in which the piston reciprocates vertically, as distinguished from the horizontal, inclined, or rotary, — all common forms.

Ver'vel. A silver name-ring around the leg of a hawk.

Ves'sel. See under the following heads: —

Argosy.
Ark.
Armor-plated vessel.
Azogue.
Bac.
Baggula.
Ballahore.
Ballast-lighter.
Ballon.
Balsa.
Banker.
Barangay.
Barca.
Barcon.
Barge.
Bark.
Barquantine.
Barque.
Batardates.
Bateau.
Becasse.
Bilalo.
Bilander.
Bireme.
Bir-lin.
Boat.
Bomb-ketch.
Brig.
Brigantine.
Broad-horn.
Bucentaur.
Budgero.
Buggalow.
Buggy-boat.
Bumboat.
Bunder-boat.
Bungo.
Buss.
Cable.
Caique.
Canal-boat.
Canoe.
Caper.
Carack.
Caracore
Caravel.
Carvel built.
Catamaran.
Chain-boat.
Chebec.
Chop-boat.
Cigar-steamer.
Clipper.
Coaster.
Cock.
Collier
Coracle.
Corvette.
Cowan.
Crane.
Cray.
Cutter.
Dandy.
Dhoney.
Dhow.
Dingy.
Dispatch-boat.
Dogger.
Doney.
Dory.
Dow (dhow).
Dredge-boat.
Drogher.
Dug-out.
Dummy.
Dwang.
Farcost.
Felucca.
Ferry-boat.
Fire-ship.
Flat-boat.
Floating-battery.
Floating-light.
Fly-boat.
Fourth-rate.
Frigate.
Frigatoon.
Funny.
Galeas.
Galiot.
Galleon.
Galley.
Gallivat.
Garkookah.
Gaydiang.
Gig
Gondola.
Grab.
Gunboat.
Hawker.
Hermaphrodite brig.
Hooker.
Horse-boat.
House-boat.
Howker.
Hoy.
Hulk.
Ice-boat.
Iron-clad.
Iron-vessel.
Jigger.
Jolly-boat.
Junk.
Kajak.

Keel-boat.
Ketch.
Koff.
Launch.
Life boat.
Lighter.
Light-ship.
Liner.
Long-boat.
Lorcha.
Lugger.
Man-of-war.
Marine car.
Massoulah boat.
Monger.
Monitor.
Monkey-boat.
Mortar-vessel.
Mud-boat.
Mulette.
Oil-carrying vessel.
Outrigger.
Packet.
Paddle-box boat.
Periaugua.
Pink.
Pinnace.
Pirogue.
Polacca.
Ponton.
Portable boat.
Praam.
Prahu.
Privateer.
Proa.
Pungy.
Punt.
Raft.
Raising sunken vessels.
Ram.
Razee.
Remberge.
Scamparia.
Schooner.
Scow.
Sectional boat.
Settee.
Shallop.
Sheer-hulk.
Shield-ship.
Ship.
Skiff.
Skute.
Sloop.
Smack.
Snag-boat.
Snow.
Steamboat.
Steam-ram.
Steam-vessel.
Stone-vessel.
Submarine battery.
Submarine boat.
Tank-vessel.
Tartan.
Team-boat.
Tender.
Topsail-schooner.
Torpedo-boat.
Tow-boat.
Track-boat.
Trow.
Tug.
Turret-ship.
Twin-boat.
Two-topsail schooner.
Vakka.
Whale-boat.
Wherry.
Xebec.
Yacht.
Yawl.

Ves'sets. A kind of cloth.

Ves'ta. A kind of wax-match.

Ves'ti-bule. An ante-hall, lobby, or porch.

Vet'er-i-na-ry In'stru-ment. See SURGICAL INSTRUMENTS.

Fig. 6974 shows the practice of the veterinary art in ancient Egypt. Oxen and sheep and goats were kept in vast herds, and, besides these, the oryx, antelope, and other animals of the desert, were tamed and bred in the farm-yard. In the figure are shown a man feeding a sick goose; a herdsman feeding an oryx; treatment of goats, — one has its fore-leg tied up; giving a medicated ball to a sick ox, which is lying down.

Fig. 6974.

Treating Sick Animals (Beni Hassan, Egypt).

Fig. 6975.

V-Gearing.

V-gear Wheel. A duplex arrangement of skew-gearing in which each tooth is of the shape of the letter V.

Vi'a-duct. An elevated road for the passage of vehicles. Bridges are viaducts; but the latter term is especially applied to arched or truss structures which cross valleys or gorges where the width of water-course is but a fraction of the distance traversed. Viaducts are constructed where the depth renders embankments infeasible.

One of the longest viaducts is that of the London and Greenwich Railway, which is 3 miles 60 chains long, laid on more than 1,000 arches of yellow brick, 18 feet span, 22 feet high, 25 feet wide. Opened in 1838. Cost, $1,300,000 per mile. Extinguishing title to property swallowed a large portion, and extinguished some of the owners at the same time.

The London and Blackwall Railway is built in the same manner upon a continuous series of brick arches. Its length is 3 miles 38 chains, and its cost £1,083,951.

Remarkable viaducts are shown in the railway-bridges (so to call them) over the Susquehanna and many Southern rivers; the Ohio, at Louisville. In England: over the Avon, on the line of the London and Northwestern Railway; the Victoria Bridge, over the valley of the Wear; the Crumlin Viaduct, in Wales. In France: over the Monie, near Nantes. In Holland: over rivers and *dieps*. In India: over the Ganges.

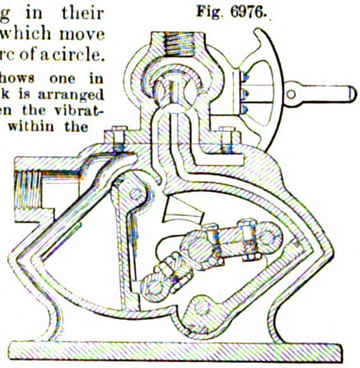
See BRIDGE; TRESTLE; TRUSS; WOODEN BRIDGE; etc.

Vi'al. A small, long bottle.

Vi-a-tom'e-ter. A way-measurer, as its name indicates. See ODOMETER; PEDOMETER.

Vi'brat-ing-pis'ton Steam-en'gine. One in which the power is communicated to the crank through pistons which are vibrating in their motion, and which move through an arc of a circle.

Fig. 6976.



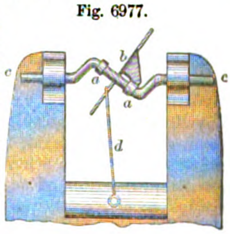
Vibrating-Piston Engine.

Fig. 6976 shows one in which the crank is arranged directly between the vibrating-piston and within the cylinder, the connections between the pistons and the cranks being so arranged that each piston, though being only single-acting, may act upon the crank during more than half of each revolution of the latter, thereby avoiding the occurrence of any dead point in the revolution of the engine. The connection of the side-packing strips of the piston with the end strips is accomplished by means of pins and slots, in combination with the mortise and tenon joints in the same.

Vi'brat-ing-pro-pel'ler. A propeller which operates by a sculling movement.

In that illustrated, the two arms *a a* of the blade *b* are sleeved upon an inclined crank on the shaft *c*, having its bearings in two sternward projections from the hull of the vessel. A link *d* is loosely jointed to the blade *b* and to the vessel, to maintain the blade in a fore-and-aft position, while a laterally reciprocating motion, reversed at each revolution, is imparted by the rotation of the propeller.

Fig. 6977.



Vibrating-Propeller.

Vi'brat-ing-roll'er. (*Printing.*) A roller having a reciprocating end motion, to equalize the ink on the sub-plate or surface.

Vi'brat-ing Steam-en'gine. A steam-engine which vibrates on a center. See OSCILLATING STEAM-ENGINE.

Vi'bro-scope. 1. An instrument invented by Duhamel for counting the vibrations of a tuning-fork.

The tuning-fork is fixed in a horizontal position, and has a light style, attached to one of its prongs by wax. To receive the trace, a piece of smoked paper is gummed around a cylinder, which can be turned by a handle, a screw cut on the axis causing it at the same time to travel endwise. The style barely touches the blackened surface. The fork is made to vibrate, and the cylinder turned, the style making a mark whose waves

correspond to the number of vibrations, and the number of these by count in a second of time is the number of vibrations of the fork. By plunging the paper in ether, the trace may be fixed and the number counted at leisure.

2. An instrument invented by Mr. Wesselhoft of Riga, designed to enable an observer to make direct observation of the motion of a vibrating object.

It is founded on the principle of the phenakistoscope or the zootrope, and consists of a rapidly rotating disk having equidistant sight-holes. The vibrating object is viewed through these by means of a telescope, and, owing to the persistency of vision, appears constantly in view, though its change of position, as it is seen successively through each aperture of the revolving disk, is distinctly perceptible, and its vibrations, which are in reality rapid, will appear comparatively slow, enabling the observer to readily trace its path.

Vic-to'ri-a. A park-carriage having a low seat for two persons, a calash top, and an elevated driver's seat in front.

Vign-ette'. The term was formerly applied to ornaments consisting of tendrils and *vines* upon silver, and hence the name. Rastoldt, in 1471, is credited with the introduction of this mode of portraying initials, flowers, etc. Pynson was the first English printer to introduce borders and vignettes in his books.

Vign-et'ter. (*Fine Arts.*) The photographer's instrument for giving a vignette appearance to a portrait or print, the edges fading away insensibly into the background.

Vi'na. A fretted instrument of the guitar kind, used by the Hindus; it usually has seven strings or wires, and a large gourd at each end of the finger-board. Its extent is two octaves.

It is of great antiquity. It has movable frets fastened by wax, so as to be regulated to suit the scale of the piece to be played. The usual musical scale has 22 intervals, called *scruti*, in the compass of an octave.

Vi'ne-fi-ca'teur. A French apparatus for collecting the alcoholic vapors that escape from liquids during the process of vinous fermentation. It is a conical vessel or cap, covering a hole in the top of the fermenting-tun, which is in other respects closed air-tight. The conical vessel is surrounded by a reservoir of cold water, so that the spirituous vapors, rising from the liquid, will be condensed on the side of the reservoir, and, running down its sides, be returned to the tun. A tube carries off uncondensed vapors.

Vin'e-gar. Ordinary vinegar may be defined as a dilute acetic acid, mixed with other acidifying and flavoring ingredients, varying with the material employed in its production. Wine-vinegar contains, besides the acetic acid, tartaric acid and a minute proportion of acetic ether. Alcohol-vinegar also has a small proportion of acetic ether. Cider-vinegar, besides acetic, contains malic acid. Malt-vinegar, which is the kind principally used in England, contains, in addition to acetic acid, most of the constituents of beer.

The vinegar of Sphettus was celebrated by Aristophanes and Athenæus as remarkably pungent.

Vinegar may be derived from any saccharine solution capable of undergoing alcoholic fermentation, the alcohol being converted into acetic acid by the subtraction of two atoms of hydrogen and the addition of two atoms of oxygen.

Wine-vinegar is made — principally in France, Orleans being a chief seat of the manufacture — from inferior wines and grape refuse. The liquid is clarified by straining through a tun filled with beechwood chips, and is then placed in casks, which are filled about two thirds full, and kept in a room where a constant temperature of 86° is maintained. The process occupies several weeks. The process of making cider-vinegar is entirely analogous, all that is required being that the liquid should have sufficient time and heat to pass to the alcoholic, and from that to the acetous fermentation.

Malt-vinegar is prepared by making a wort, as in brewing; a ferment is added, and the wash or *gyle*, as it is then called, being placed in casks, is acetified either by *stoving* or by *fielding*. By the first method this is effected in close rooms heated by stoves or steam pipes to a temperature of 70° to 80°, or upward.

In the second method the casks are exposed to the open air, arranged in parallel rows with walks between, the whole arrangement being termed a *field*. The bung-holes are left open in fine weather, but covered by a tile during rains. When completely acetified, — a process which usually requires several months, — the vinegar is drawn off by a siphon, and is afterward clarified by being passed several times through the *rape*, a large vat containing a compact heap of the skins and stalks of raisins.

The quick method, invented originally by Boerhaave, consists in causing the liquid to be acetified to percolate through a vessel, in which it is finely divided, so as to expose a large surface to the air. By this the time required is very much reduced. Various methods and apparatus have been employed for this purpose.

Vin'e-gar-ap'pa-ra'tus. A tub in which cider, malt-wort, or other fermented wash is allowed to trickle through shavings, exposed to the action of the air. An *acetifier*. See GRADUATOR.

Fig. 6978.

Vine-Rake.

Vine-rake. An implement for pulling sweet-potato or other vines off from the ridges preparatory to the digging of the ground.

The beam carries a fork or rake made with two forwardly curved teeth. The rake is drawn by a pair of animals, one walking on each side of the ridge, and as the team advances the teeth pass under the vines and tear them loose from the ground, carrying them along until the rake becomes full.

Vi'ol. 1. (*Nautical.*) A large messenger used in weighing an anchor by the capstan. *Voyol.*

2. (*Music.*) A typical instrument of the violin class. See VIOLIN.

Fig. 6979.

Viol.

Fig. 6979 shows an ancient form of instrument, known at a later period as the *monochord*, from its single string. It was played with a plectrum. The whole series of stringed instruments may be reasonably assumed to have grown from the lyre, for which, to follow the myth or the history, whichever it may be, the dried tendons in the shell of a tortoise gave the first suggestion. The corn-stalk fiddle of the Southern negro is, to some of us, a familiar illustration of a rustic instrument with but slight capability for expression, but at the same time suggestive of better things. (See LYRE.) See also, for various antique forms of lyre, Plate LII. +, Bonanni's "Instrumens Harmoniques," Rome, 1776.

Vi'ol-block. (*Nautical.*) A large *snatch-block.* See SNATCH-BLOCK.

Vi'o-la. (*Music.*) The second instrument of the viol class, having four strings, tuned a fifth below those of the violin; the C and G strings are covered with silver wire. Its ordinary compass is 3 octaves. It is written on the G clef, 3d line, and on the G clef when it extends high.

Vi-ole' d'A-mour'. (*Music.*) A bow instrument of the viol class, rather larger than the *viola*. It has 7 catgut strings, the three lowest of which, like the C and G strings of the viola, are covered with silver wire. Below the neck of the instrument, and passing beneath the bridge, are seven metallic strings tuned in unison with the others, so as to vibrate sympathetically with them. Its compass is 3½ octaves, and is written on two clefs.

Vi'o-lin'. (*Music.*) A stringed instrument played by a bow, the highest in its range of its class. It has 4 strings tuned by fifths, and all capable of be-

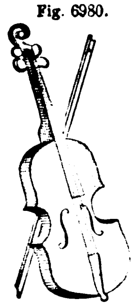
ing shortened by the left hand. Its compass is 3½ octaves, written on the G clef.

Of its class are the

Violin	Viola d'amour.
Viol	Violone.
Viol de gamba.	Violoncello.
Viola.	Contra-basso.

The four strings of the violin are supported at their respective ends by the *pins* in the *head* and by the *tail-piece*. The neck has no frets, unlike the guitar.

Fig. 6980.



Violin.

The *violoncello*, *viola*, the obsolete *viol*, the violone (contra-basso or double-bass), are allied to the violin, are or were played with the bow, and differ in the number of strings (the viol had a fretted neck and six strings) and in the compass of the instruments.

The viola was a fifth lower in compass than the violin. The violoncello, or bass-viol, is an octave below the violin; and the violone, or double bass-viol, is an octave below the violoncello.

As the tones of strings depend upon the number of vibrations in equal times, the strings in the instruments of lower compass are larger. In a piano tuned to an ordinary pitch for the parlor, the middle A of the treble clef will be produced by 420 vibrations per second.

The range audible to an ordinary ear as a distinct musical tone is about from the 4th descending C below this A to the 4th ascending C above it, and the vibrations are stated as follows, putting the said A in its place in the series: —

C^4	4 032 vibrations per second.
C^3	2,016 vibrations per second.
C^2	1,008 vibrations per second.
C^1	504 vibrations per second.
A	420 vibrations per second.
C	252 vibrations per second.
C_1	126 vibrations per second.
C_2	63 vibrations per second.
C_3	31½ vibrations per second.

See Siren.

It has been proposed to apply keys to the finger-board of the violin, by pressing which the strings may be shortened by a definite amount, so as to produce the proper note without depending upon the skill or judgment of the former in applying his fingers directly to the strings.

The chirping and singing of the cricket and grasshopper are frequently spoken of; but they do not sing, — they *fiddle*. By rubbing wings and legs together — each in the manner peculiar to the species — these insects produce the sounds which characterize them.

Stringed instruments with a finger-board, and played with a bow, are found among the Chinese, Japanese, Hindus, Persians, and Arabs, besides the European nations, and their descendants in other countries.

The original of the piano-forte is the *harp*, which, laid prostrate, becomes the *dulcimer*, known to the Arabs and Persians as *santir*, and to European nations of some centuries since as the *cimbal*, the *cymbaly* of the Poles, and the *cimbalom* of the Magyars of the present day. The instrument assumed many forms; beaten like the modern *dulcimer*, shown in Fig. *i*, Plate XL., from a work published in 1535; or twanged by the fingers or plectra, as in Fig. *j*, same plate, a *citole* from a drawing in the British Museum. The *citole*, or finger-played dulcimer, was the *psalterium* of the fourteenth century; Italian, *salterio*; English, *psaltery*.

The addition of the key, *clavis*, made the *cembalo* or *cithara*, a *clavicembalo* or *clavicetherium* respectively, *l* and *k*, of Plate XL.

The Hindus claim to have invented the violin-bow, their *ravanastron* or ancient violin being cited in ancient Sanscrit writings.

In the "Edda" we read of the intestines of a cat being made into a cord for Lok, the evil one of the Scandinavian myths. The lyre-strings, said to have been invented by Lynus as a substitute for thongs of leather or twisted strings of flax, were made of sheep's intestines, οιων χορδας of Homer. *Catgut* is the *nervictus* of the Middle Ages.

A representation of the Anglo-Saxon *fithele* is given in a MS. of the eleventh century in the British Museum. (Cotton, Tiberius, c. 6.) The instrument is pear-shaped, had four strings, and has no apparent bridge. A German fiddle of the ninth century is also shown, copied by Gerbert from the MS. of St. Blasius; it has only one string. German fiddles of the twelfth and thirteenth centuries are also shown.

The "Nibelungenlied" Volker is described as wielding the fiddle-bow as dexterously as the sword.

Paintings of a fiddle on the interior of the roof of Peterborough (England) Cathedral date from the twelfth century. One has the incurved sides and S-shaped sound-holes.

The upper group in Fig. 6981 is from a MS. of the fourteenth century (MS. Reg. 2, B. vii., British Museum), of the angelic host at the creation. The original represents angels playing upon the fiddle, cittern, shalm, harp, and trumpet. The portion represented in our cut has but the first two instruments.

Fig. 6981.

Violin.

The lower group is also from a MS. of the same century (Brit. Mus. MS. Addit. No. 10,293), where a performer on the fiddle is accompanied by others on the dulcimer and bagpipe.

Pepys, in his Diary (1661), states that he "took a great deal of pleasure [at the coronation of Charles II.] to go up and down, and look upon the ladies, and to hear the musique of all sorts, but, above all, the 24 violins." His devotion to music and to the ladies was remarkable, and occasionally got him into trouble.

He elsewhere refers to his own practice on the "viallin," and to an abominable "base viall" at Hempson's, which, with his fiddle, made the "worst music I ever heard."

"He [Templer] is a great traveller, and says all the harvest long the fiddlers go up and down the harvest fields [in Italy?] everywhere, in expectation of being hired by those that are stung [by the tarantulas]." — Pepys. 1662.

"We into the house and there fell to dancing, having extraordinary musick, two viollins, and a base viollin and theorbo, four hands, the Duke of Buckingham's musick, the best in towne. . . . . I paid the fiddlers £3 among the four, and so to bed." — Pepys's *Diary*, 1668.

A mention of the fiddle in England occurs in the legendary tale of St. Christopher, written early in the thirteenth century: —

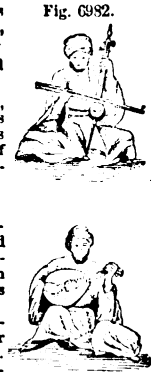
"The king loved the melody of fithele and of song."

The instrument was noticed by Chaucer, but was not common till the time of Charles II., who, in imitation of Louis XIV. and his band of performers under the leadership of Beltazarini, established a band of twenty-four fiddlers; hence the old refrain, —

"Four-and-twenty fiddlers all of a row."

The *rebec* was an instrument having successively 2, 3, and 4 strings, and was played by a bow. It was introduced by the Saracens or Moors into Europe, and was known in Italy in the twelfth century. It and its name are derived from Arabia.

Fig. 6982.



Syrian Kermanjek, and 'ood.

The modern Arabian fiddle, the *kermanjek*, is supported on the ground like our violoncello, and has two or three strings. The neck is like that used among us, having no *frets*. In Thompson's illustration, which we copy, the body is made like that of their *derbekkeh*, or drum. A calabash, or bowl, with a parchment cover, upon which the bridge-piece is supported. In the mode of covering, it resembles our banjo, but, unlike the banjo, the body of the *kermanjek* is closed at the rear.

Away in Chinese Tartary the Abbé Huc records, "A boy took down a sort of violin with 3 strings, that hung on a goat's horn, and presented it to the head of the family." He was glad to escape from the tent during a lull in the "bawling" of "the terrible virtuoso," "taking advantage of a moment when he stopped to swallow a bowl of tea."

The art of violin-making, naturalized in Italy in the fifteenth century, appears to have reached its culminating point in the productions of the Cremonese school, about the close of the seventeenth. Antonio Stradivarius, who flourished at this period, stands, by common consent, at the head of all violin-makers. The instruments of Guarnerius are scarcely less renowned, both commanding almost fabulous prices, while those of other makers of the same school and period enjoy a reputation far above that of more modern instruments. This is no doubt due in part to age, which imparts a mellowness of tone to stringed instruments, but is believed also to be largely attributable to the correct adjustment of their proportions and skill in arranging their minor details, as well perhaps as to a choice of the materials from which they were made. To determine the fact as far as possible, and with a view of throwing historical light on the development of Italian violin-making, the directors of the Austrian Exposition of 1873 in Vienna invited the exhibition of instruments of this class, dating from the earliest periods down to the close of the eighteenth century.

See Sandy and Forster's "History of the Violin." See also

an article in "Lippincott's Magazine," September, 1874, pp. 352-360.

Vi'o-lin'-pi-a'no. (*Music.*) A form of the piano-forte patented some thirty years since in England by Todd. It is intended to give the violin tone to the piano-strings by the pressure upon the string of an endless band covered with powdered resin like the bow of a fiddle.

This is effected by the pressure of the foot of the player upon a pedal, which puts the endless band in motion, and the band is caused to rub against the particular wire, as the key appertaining thereto is depressed by the finger of the player.

This violin attachment was in addition to the usual hammer action; and was brought in as an auxiliary at pleasure.

An instrument on this principle, termed the tetrachordion, was exhibited at the Paris Exposition of 1867 by its inventor, M. Baudet. In this each string consists of a single wire, and is surrounded by a tuft of fiber, the upwardly projecting ends of which are, by the action of the keys, brought in contact with the rosined surface of a roller covered with parchment or leather, and revolved by the alternate action of two treadles.

Vi'o-lon-cel'lo. (*Music.*) A bow instrument of the viol class, having 4 strings tuned in fifths an octave below the *viola*. Its compass is 3½ octaves.

Vi'o-lo'ne. (*Music.*) A large bass-viol, one octave lower than the *violoncello*, and 2 octaves below the violin. A *double-bass*.

Vir'gi-nal. (*Music.*) An instrument consisting of a number of strings stretched in a frame like that of a harp, and played by means of *hammers* and *keys*. It was one of the precursors of the piano-forte, and was well known to the musical profession and the cultivated classes of society in the sixteenth and seventeenth centuries; how much earlier we do not know. See *n*, Plate XL.

A book of exercises for the virginal, written for Queen Elizabeth, is still extant.

The *pit-a-pat* motion of the fingers, so different to the clawing action of the hands in playing upon the harp, gave occasion to Shakespeare to compare to it the love-taps of his heroine, —

"Still *virginating*
Upon his palm."

This man, whom nothing escaped, made words as he wanted them.

A century later Gabriel Platte describes a dibbling-machine as formed of iron pins

"Made to play up and down like *virginal jacks*."

After many essays and various changes in movement and application, after the *virginals*, *manichords*, *clavichords*, *harpsichords*, and *spinets* had had their day, the piano came forth, "beyond all question the first of musical instruments." — THALBERG.

The "virginall" and printed "virginall-book" are several times mentioned by Pepys, 1660-63.

"Took Aldgate Street on my way, and there called upon one Hayward that makes Virginalls, and there did like of a little espinettes [spinet] and will have him finish them for me; for I had a mind to a small harpsichon, but this takes up less room." — PEPYS's *Diary*, 1668.

It is commonly said that "the idea of making the hammer of the harpsichord *strike* the string instead of *pulling* it gave rise to the piano-forte." The substitution of the *hammer* for the *plectrum* was, however, made in the *virginal* a century before the introduction of the *harpsichord*. The *clavichord* was also a well-known instrument, and operated by keys and wires, which acted as hammers. The *virginal* had a padded hammer, consisting of a leather button on the top of the hammer-wire. With the exception that the harpsichord had two strings and the virginal but one, it is easier to see the original of the piano-forte in the *virginal* than in the *harpsichord*, in construction as well as date.

These instruments, with hammers and quills in various forms and combinations, having been in use for nearly three centuries at the time the piano-forte was introduced, it is hardly worth while to give credit to any particular person at that late date for the invention of an instrument in which the *strings of a prostrate harp were struck by hammers*. The improvements on that well-known device were, however, great, and the piano may be said to date from that of B. Christofori of Florence, 1711. See *A*, Fig. 3586, and accompanying description, page 1691.

Vis-à-vis. A dress-carriage for town use.

Vise. 1. An instrument with two jaws, between which an object may be clamped securely, leaving both hands free for work. The hand-vise is not a vise proper, but has a tang which is grasped by one hand, while the other holds the tool to work upon the object held.

A better definition could hardly be given than that of the "Autocrat of the Breakfast-Table," when vice-president at a feast where the presiding officer was too voluble and gave him not half a chance: —

"A vise is something with a screw that 's made to hold its jaw
Till some old file has played away upon an ancient saw."
O. W. HOLMES.

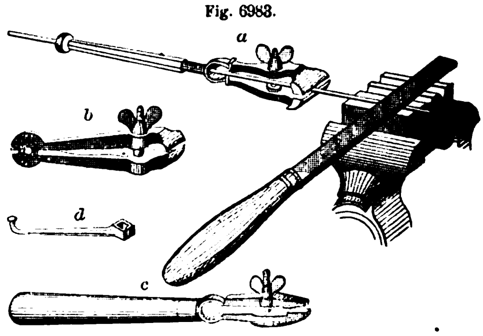
It is said to have been invented by a disciple of Pythagoras, one Archytas of Tarentum, about 516 B. C. Pliny must always find an inventor for an object.

Vises are known by purpose or construction: —

Barrel-vise.	Hand-vise.
Bench-vise.	Pipe-vise.
Calking-vise	Saw-vise.
Foot-vise.	Screw-vise.
Glaziers' vise.	

In Fig. 6983, *a* is a *pin-vise*, used by watch-makers in filing small pins and other cylindrical objects. The jaws are not united by a joint, but are formed in one piece with the stem of the vise. The screw and stem are perforated so that long wires may be inserted through them; and the latter is octangular, so that the whole may be twisted around with the left hand while the right is operating the file. *b c* are hand-vises, also used for holding work while being filed; the latter has a wooden handle. The screws of hand-vises usually have thumb-nuts, but in those of the very largest size square nuts, turned by a key or spanner *d*, are employed.

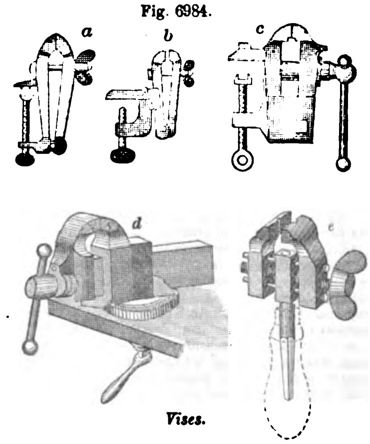
Fig. 6983.



Hand-Vises.

In Fig. 6984, *a b c* represent table-vises; these are provided with a fixed projecting jaw and a screw, usually toothed at the upper end for holding them on the edge of the work-table. *d* is a swivel-vise; *e*, a parallel-jaw hand-vise.

Fig. 6984.



Vises.

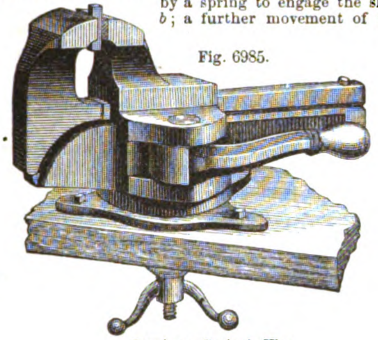
Fig. 6985 illustrates the Stephens vise, being a perspective view of the vise and swivel.

B (Fig. 6986) shows a swivel attachment.

C, plan of the vise, part of the top being removed to show the working parts. The movable jaw *a* is opened and closed by the

toothed sliding-bar *b*. The lever *c* operates a toggle *d* connected to a toothed piece, which, as the lever is swung round, is forced by a spring to engage the sliding-bar *b*; a further movement of the lever

Fig. 6985.

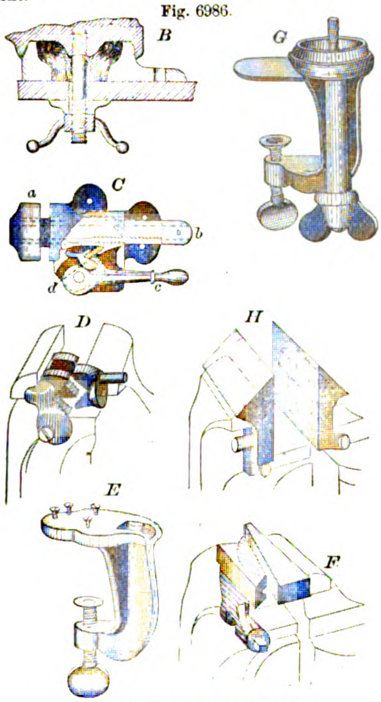


Stephens Swivel-Vise.

brings its end in contact with a cam projection of the toggle, closing the jaw *a* upon the object held by the vise.

D, pipe attachment.
E, flat table-clamp for jewelers.
F, taper attachment for irregular work.
G, jewelers' swivel table-clamp.
H, coach-makers', wood-workers', and harness-makers' attachment.

Fig. 6986.



Stephens Vise and Attachments.

In the parallel vise (Fig. 6987), the lower end of the movable jaw slides along a guide, and is moved by a screw and hand-wheel as its upper part is opened and closed by the screw which passes through the fixed jaw.

Fig. 6988 is a portable wrought-iron table-vise. The base and table are of cast and the legs of wrought iron.

Fig. 6989 is a handy form of vise for pattern-makers' and saw-filers' use. The jaws are closed by a lever cam and opened by a spring.

2. (*Carpentry.*) A spiral staircase, the steps of which wind around a perpendicular shaft or pillar called a *newel*.

3. (*Plumbing.*) A tool used by plumbers for drawing lead into flat grooved rods, called *cames*, for lattice-windows.

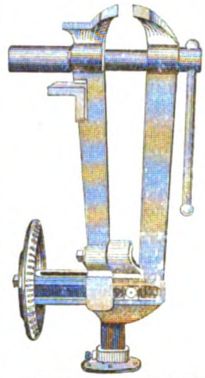
Vise-clamp. A supplementary jaw — or, perhaps, we might say, *alveolar process* — to hold pieces of peculiar shape or tender material in the jaws of a vise. See *H*, Fig. 6986.

Vise-press. The screw-press — called a vice-press formerly in England — occurs upon the coins of Bostra, in Arabia, and in an illuminated Bible of the fifteenth century. (FOSBROKE.) See SCREW-PRESS.

Vit′re-o-graph. A photograph on glass.

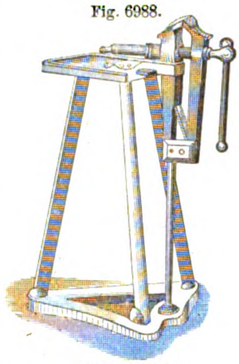
Vit′rics. This term includes the fused compounds in which silex predominates, such as glass and some of the enamels; in contradistinction to the *ce-*

Fig. 6987.



Machinist's Parallel Vise.

Fig. 6988.

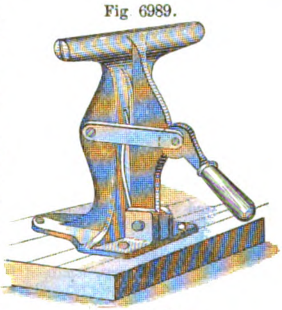


Wrought Vise.

ramics, in which alumina predominates, such as brick, tiles, pottery, and certain of the enamels.

Vit-ri-fac′tion. The act of changing into glass. Said of the melting of silex by heat, — a process which is assisted by the addition of alkalies. *Vitrification.* See GLASS.

Fig. 6989.



Saw-Filer's Vise.

Vi′tro de′ Tri′no. (*Glass.*) A kind of Venetian filigree-glass, made of an inner and outer shell, each containing filigree canes, a bubble of air being inclosed at each crossing of the canes. See RETICULATED GLASS; FILIGREE-GLASS.

Vit′ro-type. (*Photography.*) A name given to the processes which involve the production of collodion film pictures on glass.

Vit′ry. A light canvas. *Vittory.*

Voic′ing. (*Music.*) In the construction of organ-pipes, paring away the upper edge of the block in a *wooden mouth-pipe*, opposite to the lip which imparts the vibration to the air issuing from the *plate of wind*. The upper edge is obliquely serrated, to divide the issuing stream of air, the result of which is to prevent a chirping at the commencement of the note.

The voicing of the metallic mouth-pipe is by making parallel notches on the beveled surface of the lip at an angle with the axis of the pipe.

Vol-can′ic En′gine. The name applied by its inventor, Oliver Evans, to the aëro-steam engine, in which the heated gases from the furnace are combined with the steam and are unitedly carried to the cylinder. Whether the idea of Mr. Evans proceeded

beyond a mere project is not known to the writer. The distinguished inventor had a very original and practical turn of mind, qualities not always united in the same individual.

An engine of this character was patented in the United States by Bennett in 1838, and was also secured by English patent. The furnace was inclosed in the boiler, and the fuel was burnt under pressure. The smoke and heated gases passed through the water, so as to prevent the passage of grit to the cylinder. See AËRO-STEAM ENGINE.

Vol-i-cim'e-ter. A *sea-way measurer*, or self-registering log, was invented by Smeaton. See VELOCIMETER.

Vol'ta-e-lec-trom'e-ter. An instrument for indicating the degree of electrical excitation. See ELECTROMETER; GALVANOMETER; VOLTAMETER.

Vol-ta'ic Bat'ter-y. An apparatus consisting of pairs of dissimilar metals arranged in a saline or acid solution so as to develop an electric excitation at the expense of the relatively electro-positive metal. See GALVANIC BATTERY.

Volta's first arrangement, invented 1800, was the "pile," consisting of alternate plates of zinc and silver placed one above the other, separated from each other by thicknesses of moistened cloth. To this succeeded the "trough," in which the plates were placed on their edges and liquid substituted for the cloth. Afterward copper was substituted for the silver. Zinc was, and still is, generally used as the positive metal. The negative metal varies in different batteries. Different exciting fluids are also used, as nitric acid or dilute sulphuric acid; the former is employed with the Bunsen and Grove batteries; the latter with most others, bichromate of potash being generally added. A number of formulas are given for the liquid, leading to the conclusion that the proportions may be indefinitely varied within certain limits without material variation in efficiency.

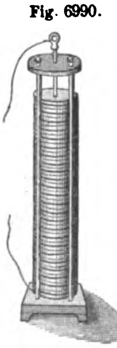
Poggendorff's is 3 pounds bichromate of potash, 4 pounds concentrated sulphuric acid. McCracken's: 1 pound bichromate potash, 3 sulphuric acid, 1 gallon water. Ogden's: 9 bichromate of potash, 40 sulphuric acid, 7 water. Newton: 1 bichromate of potash, 1 sulphuric acid, 12 water. United States Telegraph Company: 6 pounds bichromate of potash, 1 gallon sulphuric acid, 5 gallons water. Western Union Telegraph: 1 saturated solution bichromate of potash, 1 sulphuric acid, 18 water. Prevost's, patent: 800 water, 50 bichromate of potash, 50 sulphuric acid, 2 chromic acid.

Vol-ta'ic Light. A light of great intensity, obtained by passing a current of voltaic electricity through two carbon points which are caused to closely approach each other. In practice, a magneto-electric battery is usually employed instead of the voltaic battery. See ELECTRIC LIGHT.

Vol-ta'ic Pile. One of the earliest means employed in the production of voltaic electricity.

It consisted of a number of disks of silver or copper, wet cloth, and zinc, in the order named, and this accumulation of positive and negative surfaces produced results much more powerful than had been hitherto attained by any appliances of the new science. It was invented by Volta in 1800.

Fig. 6990.



Voltaic Pile.

Zamboni's pile consists of alternate disks of gilded paper and sheet-zinc packed in a glass tube and pressed at each end by metallic plates, which are respectively positive and negative. The disks being dry, the effect is feeble. Two of these piles have been made to oscillate continually a pendulous clapper, which, striking against two bells on the piles, simulated perpetual motion.

Sulzer, in 1767, had noticed that when two pieces of different metals, as copper and zinc, were placed one above and the other below the tongue, an itching sensation, accompanied by a metallic taste similar to that of copperas, was produced.

Vol-tam'e-ter. An instrument for measuring the strength of a voltaic current.

In Faraday's (*A*, Fig. 6991), two tubes with closed ends, and containing water acidulated with sulphuric acid, are inverted in a vessel containing the same fluid. In each tube is a slip of platinum connected with one of the poles of a voltaic battery. The current decomposes the water into its elements, which form in bubbles, oxygen upon the positive, and hydrogen upon the negative slip, and thence ascend the tubes. The quantity of gases developed in a given time determines the force of the current. *B* is an enlarged view; *a* being the vessel, and *b* the index-tube. See also GALVANOMETER.

Vol'ta-plast. A voltaic battery specifically adapted for the electroplating process.

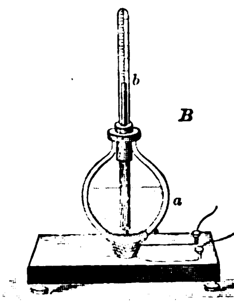
Vol'ta-type. A cast of an object obtained by the gradual deposition of a metal from a metallic solution, through the agency of electric action. See ELECTROTYPE.

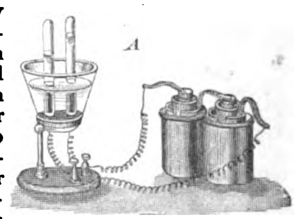
Vol'ume Now, one book of a series or of a collection: as, "a work in three volumes"; "a library containing 2,000 volumes."

Formerly, *volumen*, a scroll of bark, papyrus, waxed linen, skin, parchment, silk, and, lastly, paper, wound around a stick known as an *umbilicus*, the extremities of which were called the *cornua*, and were tipped in some cases with silver, gold, ivory, or even gems. The author's name was written on a *label* and tied to the *cornua*. The whole was placed in an envelope. They were tinged with oil of cedar-wood, to preserve them from insects.

The specifications of patents at Rolls Court, London, are on very long strips of paper, examined and read by unrolling.

Fig. 6991.





Voltameter.

Vol'u-ta-ry Press. A transferring-press in which a hardened steel roller or plate, with a design in *cameo* or *intaglio*, is made to deliver an impression upon a plate or roller of a softer material. The harder member forms the *die*, the softer one the *mill*. See TRANSFERRING-MACHINE.

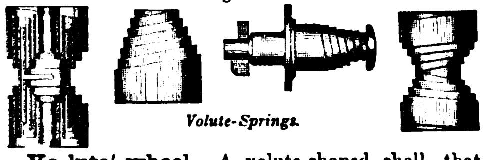
Vo-lute'. An ornamental architectural scroll.

Vo-lute'-com'pass-es. A draftsman's compasses in which the legs are gradually expanded, so as to trace a spiral.

Vo-lute'-spring. A spring of metal coiled in a helix, and extended or extensible in the line of its axis, in which direction its resiliency is utilized.

Fig. 6992 shows several forms, single and double, used in the running-gears of cars and for bumpers.

Fig. 6992.



Volute-Springs.

Vo-lute'-wheel. A volute-shaped shell, that in revolving presents its open mouth to the air, which is thus gathered into the tube and discharged through the hollow axis. It is a common and effective form of blower.

The term *volute*-wheel is sometimes applied to a water-wheel with radial or curved buckets, in which the periphery of the wheel is surrounded by a volute-shaped casing or scroll, which confines the water against the wheel, gradually decreasing in capacity as it encircles the wheel.

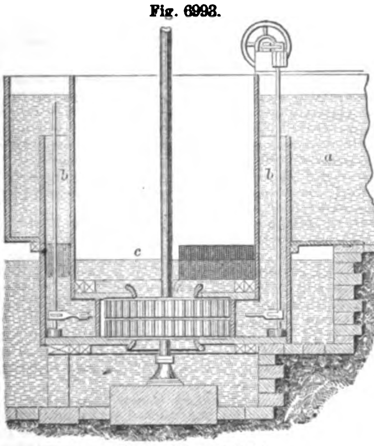
Vol'velle. A contrivance of revolving graduated circles for making calculations.

Vor'tex Wa'ter-wheel. A kind of turbine in

which the water enters tangentially at the surface and is discharged at the center.

In that illustrated (Fig. 6993), the water from the race *a* flows downward into the chamber *b*, and is conducted centripetally by a series of curved guide-blades to the wheel, whence it

Fig. 6993.



Vortex Water-Wheel.

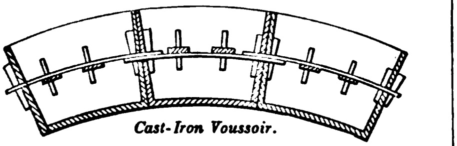
is discharged by two central orifices, one opening upward and the other downward. The portion discharged downward is at once conducted away by the tail-race, while that passing upward into the space *c* is conveyed by suitable channels into the tail-race. The wheel is always completely submerged below the level of the water in the tail-race.

Vote-re-cord'er. An apparatus in which, by an impulse given by each member of a body at his desk, upon the "aye" or "no" lever or button, the indication is made at the clerk's or president's desk, and the record counted or sum shown.

In one of the many forms, the members vote simultaneously. There is a dial like a large face of a clock to indicate the *yeas*, and another to indicate the *nays*. These dials contain the numbers of all the members, and each pulls a knob, communicating by a wire, as the bells do in a hotel. with the dial; his number flies out as he pulls, and he sees that his vote is recorded.

By turning a little crank, the hand on the dial is made to point out the number of votes that have been cast both for and against the bill; and by another simple process, the names of those voting both in the affirmative and negative are printed for the use of the clerk on a slip of paper. The whole process of taking the vote, recording it, and printing the name, does not require more than half a minute.

Fig. 6994.



Cast-Iron Voussoir.

Vous'soir. (*Architecture.*) One of the truncated wedges forming the members of an arch.

Fig. 6994 shows one made of cast-iron.

Vox Hu-ma'na. (*Music.*) A reed-pipe stop in an organ, tuned in unison with *open diapason*, and depending for the peculiar quality of its tone, *timbre*, upon the shape of the tube through which the sound of the reed is transmitted. The stop is named from its supposed resemblance to the human voice. See STOP.

Voy'ol. (*Nautical.*) A large rope used as a purchase for raising the anchor when more power is required than can be obtained by the use of the messenger. Also written *viol* and *voyal*.

Voy'ol-block. A large single-sheaved block for the messenger, which brings the power of the capstan upon the cable.

Vugh. A large cavity in a mine.

Vul'can-ite. A hard and non-elastic variety of vulcanized rubber, used for making combs, dental plates, and numerous other objects. It contains more sulphur and is subjected to a higher and more prolonged heat in curing than ordinary vulcanized rubber. The invention of Charles Goodyear. (See VULCANIZING.) For special purposes, metals which do not readily combine with sulphur, as gold, platinum, and aluminium, have been combined in a fine state of division with the compound. For instance, see Fowler's patent, 1865, for the combination of vulcanite with aluminium for dental and other purposes.

See also EBONITE, page 771; IVORY, ARTIFICIAL, page 1207; HARD RUBBER, page 1061; CAOUTCHOUC, page 454.

Lamb's patents, November 18, 1873, refer to the vulcanization of other gums and drying vegetable oils, such as those from linseed and cotton-seed. The gums ballata, checkley, and gutta-percha are mentioned. The oil of the *asclepias* is also used.

Vulcanizing Processes. See patents: —

No.	Name and Date.	No.	Name and Date.
144,998.	Mayall, Nov. 25, '73.	11,897	Marcy, Nov. 7, '54.
85,945.	Marquard, Jan 19 '69.	17,037	Herring, Ap. 14, '67.
144,622.	Lamb, Nov. 18, '73.	7,816.	Trotter, Dec 8, '50.
144,623.	Lamb, Nov. 18, '73.	10,586.	Meyer, Feb. 28, '54.
10,738.	Goodyear, Ap. 4, '54.	56,670.	Cutler, July 24, '66.
24,996.	De Wolfe, Aug. 9, '59.	37,523.	Roberts, Jan. 27, '63.
23,151.	Beins, March 8, '59.	24,695.	Eaton, July 5, '59
23,773.	Mayall, April 26, '59.	125,707.	Walker *et al.*, Ap. 16, '72.
27,706.	Eaton, April 3, '60.	26,172.	Eaton, Nov 22, '59.
30,807.	Falke *et al.*, Dec. 4, '60.	153,447.	Meyer, July 28, '74.
27,798.	Harris, April 10, '60.	153,448.	Meyer, July 28, '74.
23,855.	Parmelee, May 3, '59	153,449.	Meyer, July 28, '74.
24,401.	Parmelee, June 14, '59.	153,450.	Meyer, July 28, '74.
10,339.	Meyer, Dec. 20, '53.		
33 303.	Gately, Sept. 17, '61.		

Coloring Vulcanite.

99,956. Schlesinger, Feb. 15, '70. | 99,885. Halliday, Feb. 15, '70.

Vulcanite Articles. See patents: —

No.	Name and Date.	Purpose.
103,416.	Bird *et al.*, May 24, 1870	Wringer-rolls, etc.
62,106.	Albright, February 12, 1867	Harness-trimmings.
77,952.	Beins, May 19, 1868	Car-springs.
140,519	Mayall, July 1, 1873	Belting.

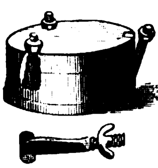
Restoring Waste Rubber. See patents: —

No	Name and Date.	No.	Name and Date.
15,998.	Forstrick, Oct. 28, '56	30,181.	Parmalee, Sep. 25, '60.
122,289.	Smyser, Dec 26, '71.	92,764.	Tuttle, July 20, '69.
23,740	Bachnagel, Ap 19, '59.	17,295.	Popenhausen *et al.*, May 12, '57.
25,160.	Hall, August 16, '59.		

Vul'can-ite-flask. An iron box for holding a denture while being exposed to the heat of a vulcanizer.

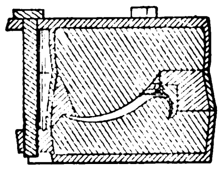
The flask is formed in three parts. The teeth are set in the central part, and the others contain the dies for pressing the rubber into shape. The parts are attached together by bolts.

Fig. 6995.



Vulcanizing Flask.

Fig. 6996.



Flask for Dental Vulcanite-Mold.

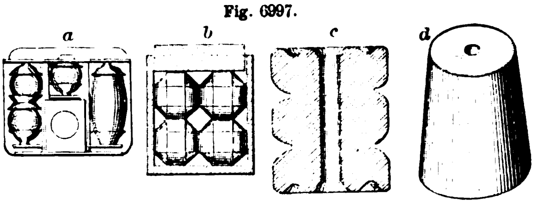
Vulcanizing Flasks and Molds.

No.	Name and Date.	No.	Name and Date.
39,481.	Howells, Aug. 11, '63.	73,326.	Hayes, Jan. 14, '68.
30,787.	Hayward, Nov. 27, '60.	36,146.	Franklin, Aug 12, '62.
84,209	Moulton, Nov. 17, '68.	97,266.	Banigan, Nov. 30, '69.
105,971.	Osgood, Aug 2, '70.	33,523.	Falke, Oct. 22, '61.
139,579.	Hopkins, June 3, '73.	28,668	Hayes, June 12, '60.
115,207.	Hotchkiss *et al.*, May 23, '71.	23,948.	Roberts *et al.*, May 10, '59.
91,134.	Hurd, June 8, '69.	112,755.	Weicker, Mar. 14, '71.
140,494	Gately, July 1, '73.	41,347.	Alden, Jan. 19, '64.
22,976.	Putnam, Feb. 15, '59.	53,034.	Parmelee, Mar 6, '66.
28,428.	Warren, May 2, '60.	151,779.	Hopkins, June 9, '74.
53,667.	Peer, April 3, '66.	157,647.	Starr, Dec. 8, '74.
52,107.	Wood, Jan. 16, '66.	154,082.	Ransom, Aug. 11, '74.
79,816.	Edson, July 14, '68.	161,656.	Birdsall, April 6, '75.
85,821.	Hayes, July 8, '62.	170,731.	Heigs, Dec. 7, '75.

Vul'can-ite Spring. Fig. 6997 shows several applications of vulcanite to car-springs.

a has metallic cups with vulcanite cushions.
b has polyhedral blocks of vulcanite.
c has annular corrugations.
d. The block is a frustum of a cone.
See also Figs. 1142 - 1144, pages 482, 483.

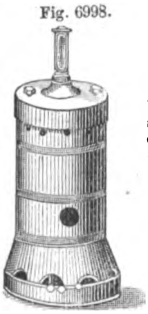
Fig. 6997.



Vulcanite Car-Springs.

Vul'can-iz-er. A furnace in which the flasks containing the dentures are exposed to a heat sufficient to combine the sulphur and caoutchouc, and produce the compound called *vulcanite*.

Fig. 6998.



S. S. White's Vulcanizer.

In Hoffstadt's self-regulating vulcanizer, the flame is regulated and the degree of heat indicated by the tap of a bell when it has reached the desired point. The gas stopcock is actuated by a thermostat, which comes into effective action at a prescribed degree of temperature.

Vul-can-iz'ing. The process of combining sulphur with india-rubber to render the rubber insensible to atmospheric changes, increase its durability, and adapt it for various purposes in the arts.

This was originally effected by dipping the rubber in melted sulphur and heating it to nearly 300°. See CAOUTCHOUC.

Several other methods have been employed. In one, the vapor of sulphur, with superheated steam, is brought in contact with the rubber in the mixing apparatus. In Parkes's cold method, the rubber articles when finished are cleaned, dried, and immersed for one minute in a bath composed of 1 part bichloride of sulphur and 40 parts sulphide of carbon, after which they are quickly dried in a warm draft. The most usual and probably the best method for general purposes consists in mechanically mixing the gum at a moderate heat with flowers of sulphur, and subsequently "curing" it in superheated steam at from 250° to 300° Fah. Other ingredients, as litharge, white-lead, zinc-white, and whiting, are added to the sulphur to give color, body, and softness to the rubber. See INDIA-RUBBER.

The crude rubber is first placed in large tubs and softened by jets of steam, then passed repeatedly between a pair of smooth steel rollers, which mash and further soften it, while water, trickling from above, washes out the dirt; it is then passed through a masticating-machine between a pair of spirally corrugated rollers, water being supplied as before to complete the cleansing, and, coming out in the form of sheets, is hung in a steam-heated apartment to dry, the longer the better. From the drying-room it passes to the grinding-mill, also a pair of steel rollers, heated within by steam, but kept dry on the outside. It is passed repeatedly between these rollers, until it becomes of a uniform doughy consistency, and is finally delivered in square sheets. The vulcanizing compound is next applied in the mixing-mill, which is very similar to the grinding-mill, the rollers being heated within by steam. The rubber is passed repeatedly between these rollers, while the compound is applied with a trowel or puddling-stick, and becomes equally distributed through the mass. The final heating to complete the process is not usually done until the rubber is attached to the cloth which is to receive it, and the article of which it forms a part is complete. This is effected in cylindrical chambers, the ends of which are tightly closed after the articles are introduced. Live steam is admitted to the interior of the cylinder, which is provided with a system of steam-pipes at the bottom to prevent the free steam around the goods from condensing.

Car-springs are *cured*, as the process of vulcanizing is technically called, by placing the crude springs in which the caoutchouc is mechanically combined with the sulphur, white-lead, whiting, and whatever other material the consistency and weight may require, in iron molds, the parts of which are keyed together; and these molds are placed in a boiler, to which live steam is then admitted, the heat being adjusted to the character of result required; from 250° to 300° Fah.

In the curing of material for shoes, a dry heat is usually employed, but steam heat is sometimes used. They are made on lasts, and placed in racks on a carriage, which is then wheeled into an oven heated by a hard-coal fire. The heat is gradually increased, from say 160° at the commencement to 275° at the conclusion, — the process occupying about 10 hours of oven heat.

The history of the discovery of vulcanization is a romance, and has its tragical features, if a life of hard work, brilliant discovery, base piracy, and defeated hopes may constitute the elements of a tragedy.

Charles Goodyear, who added a new material to the substances before available for the uses of mankind, was born at New Haven, Conn., in 1800, and died in New York in 1860. His first discovery in relation to the mode of making india-rubber non-adhesive consisted in dipping the article — a shoe, for instance — in nitric acid. The effect of this was good, but was only surface-deep. This he patented in 1836, and articles were thus treated at Providence, R. I., for some years, till the discovery and introduction of *vulcanization*. 1839 was the date of his discovery, and 1844 that of his French patent, which was the first publication of his discovery.

Not satisfied with the nitric-acid process, he appears to have devoted his time and money to experiments of a hypothetical and empirical kind; allying the raw caoutchouc with this, that, and the other ingredient, grinding, macerating in various solvents and acids. At last, it appears, a piece of india-rubber combined with sulphur was accidentally dropped on to a hot stove, and the process was revealed. Where it had been slightly warmed, the effect was but slight; and from this were all the grades of soft and hard rubber, up to the charring of the materials. The remainder of the invention was but a pursuit of various suggestions growing out of the discovery. Materials of many kinds were added to give character, weight, cheapness, color; the latter constituting artificial ivory or wood, such as *ebonite*. Colored with cinnabar, it formed material for artificial gums and dentures. Innumerable uses occurred, and an enumeration of the number of articles now made of vulcanite would fill a pamphlet.

Goodyear's patent in France was voided by a technicality, it being held that he had not fully put his invention in public use within the prescribed time. His confidence was abused in England, and a patent obtained in that country a few days prior to that of Goodyear. His patents in this country, 60 in number, have been the cause of interminable litigation, and the inventor died about the time the title was quieted.

His name will ever be remembered as that of a brilliant inventor. So far as personal recognition is concerned, he has his due, but he was much pressed in pecuniary matters. Among the well-deserved personal recognitions may be mentioned the Great Council Medal at London, 1851; the Grand Medal of Honor at Paris, 1855; and the Cross of the Legion of Honor from Louis Napoleon.

Vyce. (*Coopering.*) A gimlet-pointed hand-screw employed to hold up the head while the staves are closed around it.

W.

Wab'bler. An elliptical cutter-head placed at such obliquity on the shaft as to revolve in a circular path. Sometimes called a *drunken cutter*.

Wab'ble-saw. A circular saw hung *out of true* on its arbor. Used in cutting dovetail slots, mortises, etc.

Fig. 6999.

Wabble-Saw.

Wad. 1. (*Fire-arms.*) The wad of a gun is intended to hold the charge in position at the rear of the chamber, or to prevent windage. In small-arms it is usually a disk of felt, punched by a circular wad-cutter. An old felt hat furnishes excellent wads. Plugs of paper, oakum, or cardboard are also used.

2. (*Ordnance.*) Wads for ordnance are of four kinds.

Junk wads; made of old rope.

Grommet wads; made of cordage, in the form of a ring.

Papier-maché wads; small disks for closing the fuse-holes of common shells and the loading-holes of diaphragm shells.

Coal-dust wads: serge bags filled with coal-dust, placed inside the 5-pound cartridges for 8-inch guns, to fill up the chamber.

3. (*Mining.*) *a.* Graphite.

b. An earthy oxide of manganese.

Wad'ding. 1. A spongy bat of cotton wool, made by the carding-machine, and attached by a coat of size to tissue-paper, or treated on one side with a film of glue or gelatine. The name is derived from *ouate* or *wat*, the down of the asclepias, which was formerly imported from Asia Minor for stuffing cushions.

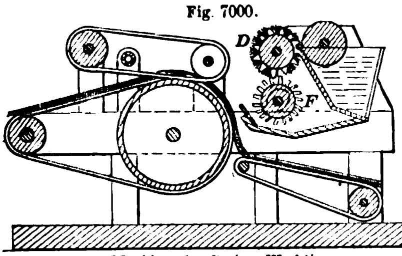
2. (*Fabric.*) Loosely woven stuff used by tailors.

3. Tow for common wads.

Wad'ding-siz'er. A machine for giving a coating of size to the surface of a bat of cotton.

The upper reticulated metallic apron is so situated as to exert a pressure upon the sized bat as it passes over the cylinder for the purpose of producing the adhesion of the fibers by means of

Fig. 7000.



Machine for Sizing Wadding.

the sizing. The blast-pipe is for the purpose of detaching the bat from the apron.

The rotary cylinder *F* has pin-points or other rigid projections on its periphery, which receive the size from the rotary brush *D*, and sprinkle it upon the bat or web by centrifugal force.

Wad-hook. A spiral tool for withdrawing wads. A *worm.*

Wad'mal. A heavy, coarse, woolen stuff for sailors' jackets. Made in the Orkneys. *Wadmeil; wadmill; wadmarel.*

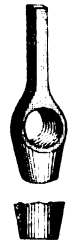
Wad'mill-tilt. (*Weapon.*) A covering for a field-gun and carriage used in the British service, equivalent to our *paulin.* Length, 14 feet 6 inches; breadth, 11 feet 6 inches; weight, 50 pounds.

Wad-punch. A tubular steel punch used for cutting gun-wads, etc. A similar punch is used by leather-workers and others.

Wa'fer. A thin adhesive disk used for sealing letters, etc.

Their employment for this purpose is of comparatively modern origin. They are said to have been made in Venice in the sixteenth century. The term is derived from the thin small pieces of bread used in the Eucharist. The Emperor Henry VII. was poisoned by a monk with the mass wafer at Beneventum, 1318.

Fig. 7001.



Wad-Punch.

The ordinary kind is made by diffusing fine flour into pure water, forming a thin batter free from clotty particles; this is not allowed to ferment, but is placed between two iron plates, previously greased with butter, which come together like a pair of tongs, leaving a small space between them; and is exposed for a short time to the heat. The plates are then allowed to cool, and, on being opened, the contained sheet is found to be dry, solid, and brittle, and about as thick as a playing card. The wafers are cut from it by annular sharp-edged punches.

Transparent wafers are made by dissolving fine glue or isinglass with such quantity of water that the solution, when cold, shall be of proper consistency: it is poured, while hot, upon a plate of mirror glass, warmed by steam and slightly greased, surrounded by a metallic frame rising just as high above the plate as the wafers are to be thick; on this a second plate of glass, heated and greased, is laid. When the two plates become cool, the gelatine has become solidified, and is cut into wafers with a punch.

Waf'fle-ir'on. A cooking-utensil having two hinged portions to contain batter, which is quickly cooked by the relatively large surface of heated iron, owing to square projections which make cavities in the batter-cake.

Waft. (*Nautical.*) A flag stopped at the head and middle portions, hoisted as a signal. The meaning of the signal varies according to the place where it is hoisted; at the main, peak, etc. *Wheft.*

Wag'on. 1. A four-wheeled vehicle used for goods, freight, and produce, rather than passengers.

The first forms of wheeled vehicles were CARTS and CHARIOTS (which see); the four-wheeled vehicle was much later. It is probable that the word translated *wagon* in our version of the Bible referred to a two-wheeled cart.

The children of Jacob were directed to take "wagons out of Egypt" (Genesis xlv. 19), and many years later (1490 B. C.), in the departure of the Israelites from Egypt, the prince of the tribes offered six covered wagons and twelve oxen, two oxen to a wagon, for the use of the Levites: "two wagons and four oxen he gave unto the sons of Gershom," "and four wagons and eight oxen he gave unto the sons of Merari." — Numbers vii. 3, 7.

Camels are not shown in the Egyptian paintings, and could not have been in common use in that country in Pharaonic times. Their use had long been known in Persia, and some were probably introduced by the immigrating Israelites.

Cambyses failed to reach the oasis and temple of Ammon, probably from want of camels.

Herodotus refers to the carts and wagons of the Scythians (see CART). Æschylus, in his "Prometheus Bound," speaks of the

"Wandering Scyths who dwell
In latticed huts high poised on easy wheels."

One of their wagons, measured by Rubruquis, had a distance of 20 feet between the wheels; the axle was like the mast of a sloop, and it was hauled by 22 oxen, 11 abreast (Fig. 7002).

Marco Polo, who traveled through this country 1275-1295, states that their houses "are circular, and are made of wands covered with felts. These are carried along with them whithersoever they go. They also have wagons covered with black felt so efficaciously that no rain can get in. These are drawn by oxen and camels, and the women and children travel in them. They eat all kinds of flesh, including that of horses and dogs and Pharaoh's rats. Their drink is mare's milk."

Strabo calls the inhabitants of the Don, Mæotis, and Dnieper, *Hamaxæci*, or dwellers in wagons. And Hesiod: —

"To the land of the Galactophagi, who have their dwellings
in wagons."

The cut (Fig. 1149) represents modern Tartar vehicles, which probably differ but little from those used on the same steppes twenty-five centuries ago. See CART.

Fig. 7002.

Scythian Wagon.

The four-wheeled wagons in the triumphal procession of Ptolemy Philadelphus were of large size; that bearing the image of Bacchus was 14 cubits long and 8 wide, drawn by 180 men. Then followed a wine-press mounted on a four-wheeled wagon 20 cubits long and 16 in width, and drawn by 300 men. The press was full of grapes, and tramped by 60 satyrs, with Silenus as president. Then followed a wagon 25 cubits long and 14 wide, supporting a sack containing 3,000 measures of wine, and consisting of leopards' skins sewed together. This was drawn by 600 men. This wonderful procession is described in the fifth book of the "Deipnosophists," by Athenæus.

The *plaustrum* or Roman wagon is shown upon the column of Trajan. The Scythian, as described by Herodotus, is pictured on page 485. The *plaustrum* had wheels of the same size and a pole. The high-wheeled wagon was derived from the barbarians. It is the *heh hwiolad wæn* of our Anglo-Saxon ancestors. The perch or coupling between the fore and hind axles was added in the Middle Ages.

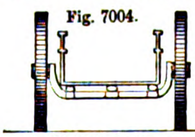
The cumbrous *char* of the fourteenth century was the state-carriage of the time, and was but a wagon. The shafts were fastened to the wagon-body, and the two axles fastened to the bed. Such a carriage must have turned with difficulty, as the fore-carriage was not swiveled. The illustration is from the "Luttrell Psalter," a manuscript of the fourteenth century.

Fig. 7003.

A Lady's Char of the Fourteenth Century.

A vehicle on four wheels of equal diameter is of lighter draft than one in which the fore wheels are smaller than the hind-wheels, unless the load is distributed on the wheels in proportion to their diameter. In Baddeley's wagon, constructed in reference to this point, the hind wheels are unusually large, and bear four fifths of the weight when the body is fully loaded. The axle is bent, and the body is supported thereon by three springs, two being used under the fore part.

Fig. 7004.



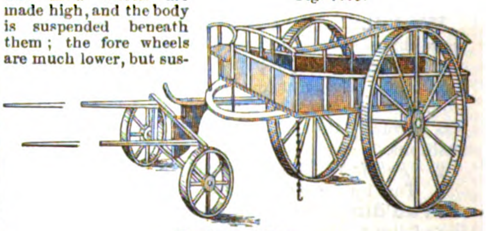
Baddeley's Wagon.

Baddeley contributed a number of papers to the early volumes of the London "Mechanics' Magazine" upon this subject, and is one of those to whom we are indebted for much that is sensible in modern vehicles

A mongrel contrivance, partaking of the features of cart and wagon, has been suggested. The forward end of a two-wheeled cart is supported upon a fore-carriage, to which the horse is attached The device needs no lengthy description, as the illustration (Fig. 7005) shows it plainly.

Fig. 7006 is a wagon made with the rear part of its body offset and depending downward below the bottom of the front part. It has also a bent hinder axle placed directly under the rear part of the body. See also TRUCK, Fig. 6676.

Fig. 7005.



Gordon's Wagon.

Fig. 7007 illustrates a Belgian dray, *a* being a side, *b* a front, and *c* a rear elevation. The hind wheels are made high, and the body is suspended beneath them; the fore wheels are much lower, but sustain comparatively little of the weight. This construction enables very heavy loads to be carried, two horses drawing as much as ten tons. In some cases the body of the dray is more elevated, and casks or cases are slung beneath it by chains, while a heavy load is carried on top.

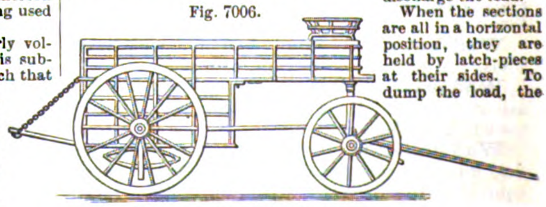
A number of devices have been introduced for dumping the load of a wagon. The Baltimore brick-wagons are made to travel back on rollers over the hind axle until they upset and discharge the load.

Other wagons have trap-doors in the bottom.

Others are made in sections so pivoted as to careen singly or simultaneously.

Robinson's dumping-wagon has a body composed of separate sections arranged in line with each other and pivoted to the bed-pieces of the wagon-frame, so as to be placed in a horizontal position to hold the materials, or tilted, rear end downward, to discharge the load.

Fig. 7006.



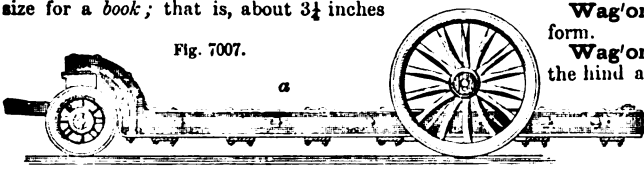
Express-Wagon.

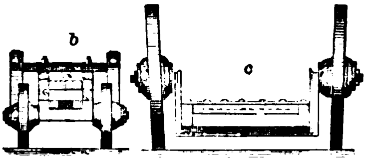
When the sections are all in a horizontal position, they are held by latch-pieces at their sides. To dump the load, the

sections are disconnected and tilted, as indicated in the figure.

2. A tool having four edges of cane mounted in a frame, and used to trim the edges of gold-leaf to a size for a *book;* that is, about 3½ inches

Fig. 7007.





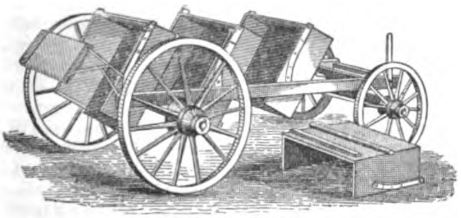
Belgian Dray.

on a side. A *book* consists of 25 leaves of gold interposed between paper leaves. The cane is used in preference to steel, as the gold does not adhere to it.

Wag'on-boil'er. (*Steam-engine.*) A boiler having a semicircular top and flat or concave bottom; so called from the resemblance of its shape to that of a wagon covered with its tilt. See *A*, Plate LXI.

It is always set up with a *wheel-draft;* that is, the current of flame and smoke after passing under the boiler-bottom is made to rise up at the back, whence, returning along one side by a brick flue to the front, it crosses the front end, and thence passes along the other side to the back, where it enters the main flue, which conducts it to the chimney. Wagon-boilers were formerly very generally used in the manufacturing districts of Yorkshire and Lancashire. The usual sizes were 16 to 24 feet long, 6 feet 8 inches deep, and 5 feet wide; each foot in length was considered as capable of supplying steam for 1 horse-power of the engine, a 20 horse-power boiler being 20 feet in length. In one of this size, the fire-grate is 5 feet long and 4 feet wide, the grate bars usually having a fall of 3 or 6 inches from front to back.

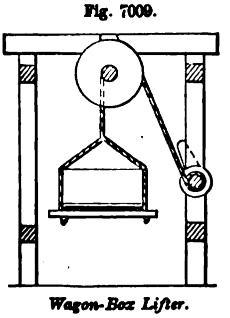
Fig. 7008.



Dumping-Wagon.

Wag'on-bow. An arched-shaped slat with its ends planted in staples on the wagon-bed sides. Used to elevate the tilt or cover.

Fig. 7009.



Wagon-Box Lifter.

Wag'on-box Lift'er. A hoisting device to elevate the wagon-bed from the running gears when the latter are required to hold the hay-frame, or are to be used without any bed, for hauling rails, etc.

Wag'on-brake. A carriage-brake is a frictional device applied to the wheels of a vehicle in order to retard its motion when descending a hill. It is usually called a *wagon-lock* in the United States; and though the term *brake* is eminently appropriate, to avoid repetition the subject will be considered under WAGON-LOCK (which see).

Wag'on-ceil'ing. One of a cylindrical form.

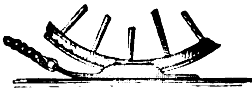
Wag'on-coup'ling. One for attaching the hind axle to the fore. Known also as a *reach* or *perch* in carriages.

Wag'on-drag. A shoe secured by a chain to the bed or coupling of the vehicle, and forming a temporary runner which receives the weight of the wheel, and by friction on the ground arrests the speed of the vehicle in going down hill.

In the United States, a *lock* is preferred. See WAGON-LOCK.

In its simple form, it is a cast-iron shoe to receive the wheel, being secured by a chain to some part of the vehicle, so as to *drag* thereby. It is suspended to a hook on the carriage when not in use.

Fig. 7010.



Drag.

Kneebone's drag (English) is curved to the contour of the wheel, and is anchored to the carriage by a chain of such a length as to allow the wheel to run up on to it when detached from its suspensory hook on the carriage for that purpose. It has a roller in front, which diminishes its friction on the ground and throws the wear on the rear part of the shoe.

Fig. 7011.

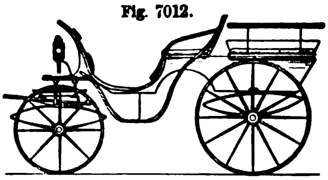
Kneebone's Drag.

Wag'on-ette'. (*Vehicle.*) A kind of four-wheeled pleasure-vehicle of very light construction.

Wag'on-ham'mer. The vertical bolt which connects the *double-tree* to the tongue, and upon which the *double-tree* swings.

It is made in the form of a hammer for the sake of convenience, being withdrawn from its place in the double-tree when required for any purpose. The end of the shank is tapered off, and is used in lifting the linch-pin to remove a wheel.

Fig. 7012.



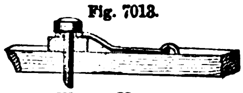
Wagonette.

With thimble-skein wagons (see AXLE-SKEIN), in the place of the hammer-head is a wrench for removing the nut from the end of the spindle.

Wag'on-head'ed Ceil'ing. One having a cylindrical form.

Wag'on-hoist. An elevator used in carriage-factories, depots, and livery-stables to raise or lower vehicles to or from floors in the building. The platform is balanced by weights from pulleys over the respective corners, and is operated by hand-rope, drum, and spur gear.

Fig. 7013.



Wagon-Hammer.

Wag'on-jack. One for lifting the wheels of a wagon clear of the ground, that the wheels may be removed and the spindle greased. The varieties are numerous. See CARRIAGE-JACK; LIFTING-JACK; etc. See list under JACK, page 1208.

Wag'on-lock. A device to bring a friction on the wheels of a wagon to retard its motion in descending hills.

In Fig. 7014, the rubber *H* is brought, by means of lever, cord, and crank-shaft, to bear upon the wheel.

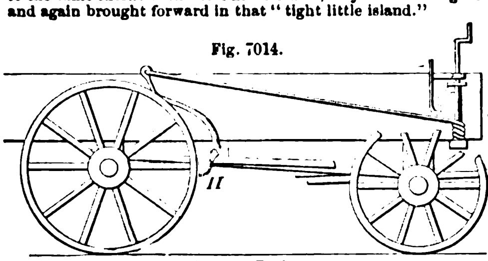
In Fig. 7015, the self-locking lever engages the guide-segment by friction, being impelled thereto by the spring upon the op-

erating lever. The friction is relieved by drawing toward the main lever.

In Fig. 7016, the holding back of the horses in descending a hill pulls upon levers at the end of the tongue and operates the rubber levers. There are very many different methods.

Though the friction-lock has never been adopted in Britain to the same extent as in the United States, they have been again and again brought forward in that "tight little island."

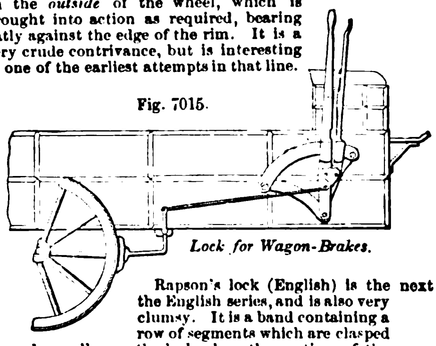
Fig. 7014.



Wagon-Brake.

Lord Somerville's friction-lock (called a drag) consists of a bar on the *outside* of the wheel, which is brought into action as required, bearing flatly against the edge of the rim. It is a very crude contrivance, but is interesting as one of the earliest attempts in that line.

Fig. 7015.

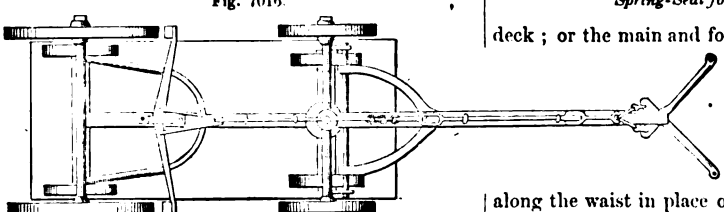


Lock for Wagon-Brakes.

Rapson's lock (English) is the next in the English series, and is also very clumsy. It is a band containing a row of segments which are clasped around a collar on the hub when the motion of the wheel is to be impeded or arrested. Several modes of bringing the affair into action are suggested. In one, the breeching-straps of the horse pass through staples on the shafts and thence back to the brake-band, so as to pull on the latter when the horse holds back.

Wag'on-seat. One perched on the wagon-bed, as in Fig. 7020, or supported from the standards, as in Fig. 7019.

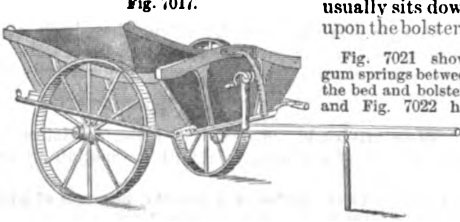
Fig. 7016.



Wagon-Brake.

Wag'on-spring. Excepting in that kind of driving-buggy known as a *wagon*, or the *wagonette*, the wagon-bed usually sits down upon the bolsters.

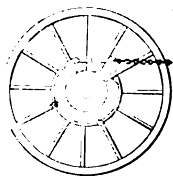
Fig. 7017.



Somerville's Lock.

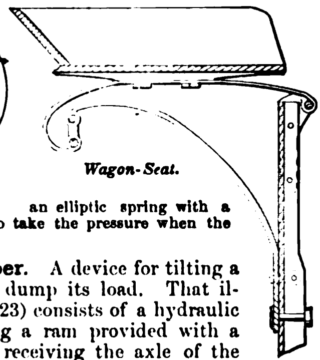
Fig. 7021 shows gum springs between the bed and bolster; and Fig. 7022 has

Fig. 7018.



Rapson's Lock.

Fig. 7019.



Wagon-Seat.

an elliptic spring with a caoutchouc sphere to take the pressure when the load is extreme.

Wag'on-tip'per. A device for tilting a wagon in order to dump its load. That illustrated (Fig. 7023) consists of a hydraulic lifting-jack having a ram provided with a head suitable for receiving the axle of the car, which is run over it, and that end lifted by operating the pump.

Wag'on-tongue Sup-port'er. See TONGUE-SUPPORT.

Wain. A wagon.

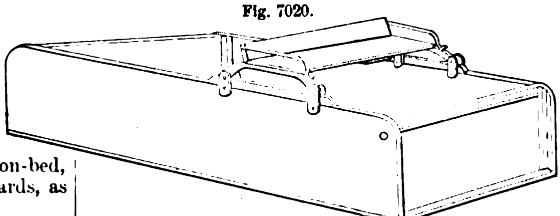
Wain'scot. (*Carpentry.*) A paneled facing to interior walls. It was common formerly, but other modes of finishing interiors have superseded it. *Wainscoting.* It is again coming into use.

So called from a foreign species of oak called *wainscot* having been formerly applied for the purpose.

Waist. 1. A narrow portion of an object, as the contracted part of a Smeaton lighthouse.

2. (*Nautical.*) The middle portion of an object, as the midship part between the forecastle and quarter-

Fig. 7020.



Spring-Seat for Wagons.

deck; or the main and fore hatchways; or the half-deck and galley.

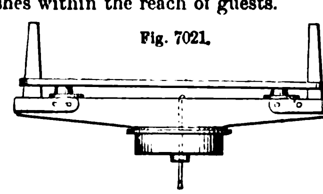
Waist-block. A bulwark sheave in the waist of the vessel.

Waist-tree. (*Nautical.*) Another name for a *rough-tree* or spar placed along the waist in place of bulwarks.

Wait'er. 1. A tray on which to carry plates, etc., or offer food to guests.

2. A revolving or traveling table or tray to bring the dishes within the reach of guests.

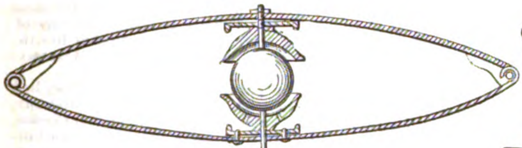
Fig. 7021.



Wagon-Spring.

3. An elevator. See DUMB-WAITER; ELEVATOR; HYDRAULIC ELEVATOR; ROPE-ELEVATOR; WATER-ELEVATOR. See also list under HOISTING.

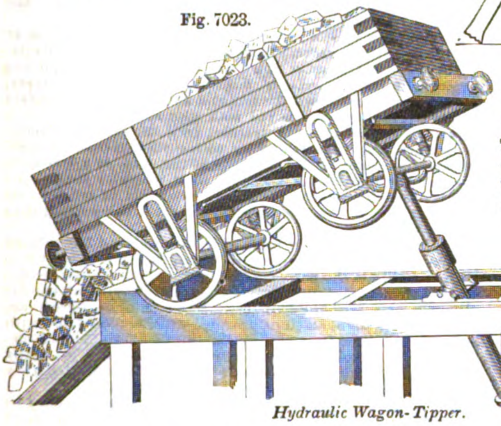
Fig 7022.



Wagon-Spring.

Wale. 1. (*Shipwrighting.*) A wide plank at certain portions of a ship's side, extending from stem to stern and describing the curve of the

Fig. 7023.



Hydraulic Wagon-Tipper.

strakes. The wales are known as the *main-wale*, *gunwale*, *channel-wale*, etc.

The *channel*-wale of a man-of-war is below the lower deck-ports, and the *main*-wale between the ports of the respective decks.

2. A timber bolted to a row of piles to secure them together and in position.

Wale-piece. A horizontal timber of a quay or jetty, bolted to the vertical timbers or secured by anchor-rods to the masonry to receive the impact of vessels coming or lying alongside.

Walk'er-bit. (*Saddlery.*) A milder type of Mexican bit, but yet retaining its leading characteristics.

Walk'ing-cul'ti-vat'or. One in which the operator walks behind, as distinguished from the *riding* or *sulky* cultivator.

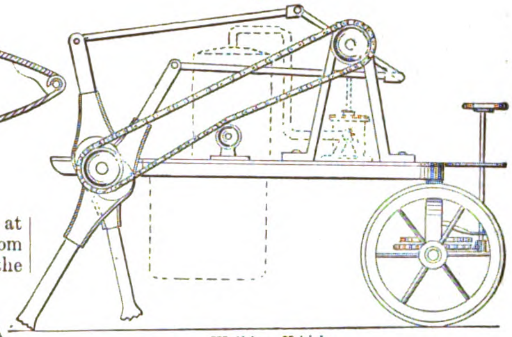
Fig. 7024.

Walking-Cultivator.

Walk'ing-ve'hi-cle. One in which the progression is made by the recurrent action of oscillating rods which step upon the floor or ground.

The legs are operated by cranks turning on eccentrics, by which they are raised during their forward movement and depressed during their effective stroke.

Fig 7025.



Walking-Vehicle.

Walk'ing-wheel. A PEDOMETER (which see).

Wall. 1. A structure of stone or brick.

The following terms are employed: —

Face; the front of a wall.

Back; the rear.

Core; the filling-in.

Course; a layer of stone or brick. See COURSE.

Bond; the system of laying. See BOND.

Batter; the slope of the face (if any).

Party-wall; one common to two houses.

Flank-wall; a *return* or side wall.

Fire-proof walls are made of stone, brick, or metal, but the resisting power of brick is greatest Granite splits and flies, sandstone scales, limestones and marble crumble into lime, iron warps and melts. This subject has been considered, briefly, under FIRE-PROOF BUILDING, and here there is but room for a few examples of the uses of iron in forming, strengthening, or facing walls.

A is for an inside wall, having studs *a* of corrugated sheet-metal for supporting a lath surface *b*, whose inturned edges occupy slots in the edges of the stud-plate.

B has studding and frame of angle-iron *c*, with panels of iron lattice-work *d*, which is covered in entirely by concrete material *e*.

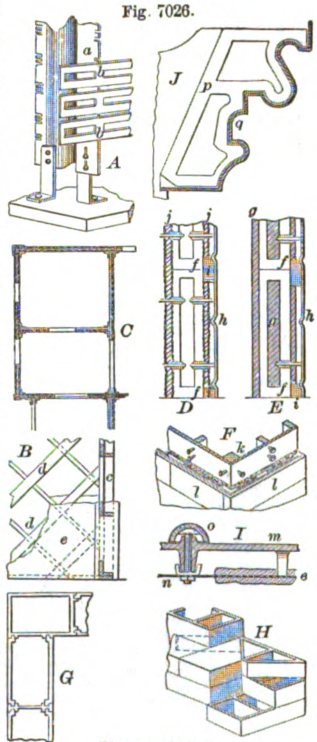
C represents on a small scale one or two rooms of a house constructed on Seely's plan, with corrugated sheet-metal and angle-iron.

D has an open framework of metallic sections *f*, with sides of double wire gauze *j*, inclosing plaster of Paris, and with an outer sheathing of metal *h*, in imitation of masonry, isolated from the frame by soapstone blocks *i*.

E has a filling of concrete *g* around the frame *f* and the sheathing *h* and blocks *i*, just described.

F has a wooden frame *k* with a con-

Fig. 7026.



Fire-proof Walls.

crete outside the sheathing, and an outside wall of artificial stone *l* made with dovetails at the rear, which form locks in the concrete.

G has cast-iron hollow boxes, made with tongues, grooves, lugs, and locking-plates. These are built together in their courses, and the courses fastened together in a similar manner.

H uses cast-iron, hollow, rectangular, or triangular blocks, and builds them up in the manner of bricks.

I is specially intended for mansard roofs; it has an outer iron plate *m* and inner wire-gauze *n*, on which the plaster *e* is spread. *o* is an outer break-joint plate to cover the junction of the plates, and its bolt locks all the parts together.

J shows a sheet-metal cover *q* to a cast-iron bracketing *p*, the whole forming a cornice.

The "formacean" walls, described by Pliny, were "molded rather than built," as he says, "by ramming earth within a frame of boards, constructed on either side." He declares them very lasting, and refers to the earthen watch-towers erected by Hannibal on the summits of the mountains in Spain. "The earth so rammed, I can assure you, does continue for years in an imperishable state, and is neither affected by rain, by wind, nor by fire, and neither mortar nor cement is used in them." These must have been what are now termed PISÉ-WORK (which see).

Ransome's process (English) for rendering walls impervious to moisture is as follows: —

The external surfaces of the walls to be protected are first washed with a silicate of soda or solution of flint, which is applied again and again, until the bricks are saturated, and the silicate ceases to be absorbed. The strength of the solution is regulated by the character of the bricks upon which it is to be applied, a heavier mixture being used upon porous walls, and a lighter one of those of denser texture. After the silicate has become thoroughly absorbed, and none is visible upon the surface, a solution of chloride of calcium is applied, which, immediately combining with the silicate of soda, forms a perfectly insoluble compound, which completely fills up all the interstices in the brick or stone, without in any way altering its original appearance. By this operation the wall is rendered perfectly water-tight, and, as the pores of the bricks are thoroughly filled for a considerable depth from the surface with the insoluble compound, which is entirely unaffected by atmospheric influences, no subsequent process is necessary.

Cob walls, still used in some rural districts of Britain, are made of clay and chopped straw, based upon brick or stone foundations, and having a thickness of about two feet. They are built in the manner of PISÉ-WORK (which see). In some cases, however, the work is not confined within boards, but is built up by the shovel, being well incorporated before applying and after placing it on the wall. The lintels and sills of the doors and windows are built in, but the openings are cut subsequently. As each layer dries its surface is shaved and trimmed, receiving a final coat of plaster.

Straw houses are made in England by an inventor who proceeds as follows: —

He compresses straw into slabs, soaks them in a solution of flint, to render them fire-proof, coats the two sides with a kind of cement or concrete; and of these slabs the cottages are built. By ingenious contrivances, the quantity of joiner's work is much reduced, and the chimney is so constructed as to secure warmth with the smallest consumption of fuel, and at the same time to heat a drying closet. The cost of a single cottage of this description, combining "all the requirements of health, decency, and comfort," is $425. See also list under MASONRY.

The walls of Babylon were possibly 75 feet high. They had been gradually decreasing in height since the time of Herodotus, who reported them 200 royal cubits = 337 feet (English); Ctesias, 300 feet; Xenophon, 100. It is probable that the reputed dimensions decreased as more reliable estimates were transmitted.

The Chinese wall was built by Chi-hwang-ti, 220 B. C. The feudal system was about that time in course of demolition in China, and was accomplished by the Han dynasty. The process is now being repeated in Japan.

This great wall is 1,200 miles long, from 20 to 25 feet high, and from 15 to 20 feet broad.

It was built as a barrier against the hordes of Tartar cavalry, and was everywhere constructed of the materials found in the immediate neighborhood.

Fig. 7027 is a view of a portion of the Great Chinese Wall, at a point three days' journey from Pekin, on the route to Siberia.

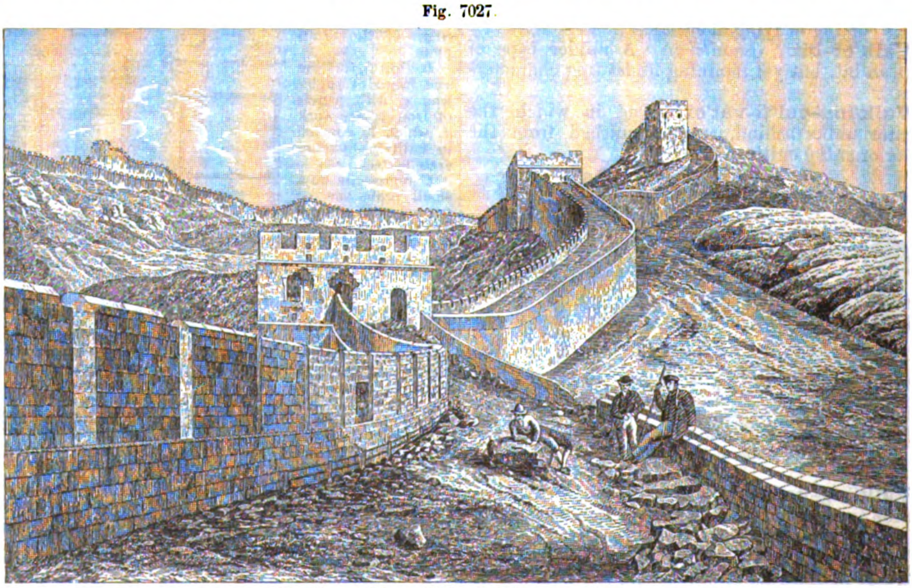
On plains and terraces which afforded clay and loam, it was formed with an earthen core, built up in well-pounded layers, growing narrower toward the top, and faced with large tiles laid flat. The top was also paved with tiles and defended with a parapet. On mountains of stratified rock the facing was made of masonry, and the interior filled with earth and cobble-stones. On the mountain of Kal-gan, where the rock is a trachytic porphyry, which breaks only into most irregular shapes, the wall is of solid masonry, the stones being laid in cement; its section is here an isosceles triangle, the crest being brought to a sharp edge.

In other localities it is built of hewn rock, and has a brick parapet. Where it ascends a mountain the top is built into steps to facilitate the passage of soldiers. Throughout its entire length it is defended by towers, which rise from it at regular distances of a few hundred feet. Many of these towers are several stories high, and are provided with loopholes and with arched windows. In many places the northern side was defended with ditches and embankments, which may originally have existed throughout the whole length of the wall, or they may have been constructed to resist local attacks.

Every mountain pass and every weak point was defended by a fortified town. The wall is now in very different states of preservation, according to the material used. In the valleys, the points where it was originally most needed, it has crumbled into a mere line of rubbish, which is being rapidly graded down by the plow.

The Abbé Huc says of the Chinese wall, that one of the embassy of Lord Macartney in 1793 estimated the cubic masonry of the great wall was greater than that of all the houses in England and Scotland. "But it is evident that he has taken for the basis of his calculation the part of the wall immediately to the north of Pekin, which is really fine and imposing, but it must not be supposed that this barrier is equally large and solid throughout its whole extent. We have had occasion to cross

Fig. 7027.



The Great Chinese Wall: the Nang-Kao Pass.

it at more than fifteen different points, and have often traveled for days together without ever losing sight of it; and, instead of the double-battlemented stone-wall which is seen at Pekin, it is sometimes a very humble-looking wall of clay; and we have even seen it reduced to its simplest expression, and composed only of stones piled up together."

It appears that it suffered the fate so common to contract work; well done at special points, and "the mere pretense of a wall on those distant points, which had besides little to fear from the Tartars, — such, for instance, as the frontiers of Ortons and the Alechan Mountains." — Huc.

For information of the construction of Roman walls see "Murus"; "Paries," in Smith's "Dictionary of Greek and Roman Antiquities."

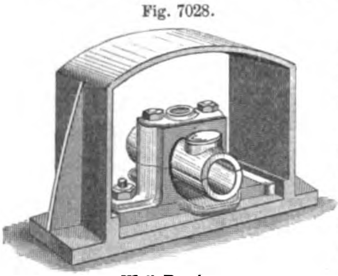
2. (*Mining.*) The rock inclosing a vein. The upper and lower portions are known as the *roof* and *floor* respectively.

Where the *dip* is considerable, the upper boundary is the *hanging-wall*, and the lower the *foot-wall*.

3. (*Nautical.*) A large knot worked on the end of a rope; as of a man-rope, for instance.

Wall-bear'ing. (*Machinery.*) A bearing for receiving a shaft when entering or passing through a wall. It is protected by a cast-iron casing, built into the wall, the bottom of which serves as a bed-plate for the plummer-block, the upper part supporting the masonry above. A *wall-box*.

Fig. 7028.

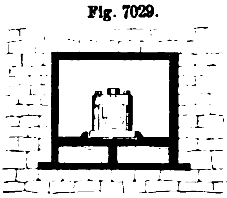


Wall-Bearing.

Wall-box. (*Machinery.*) A device for supporting a plummer-block in which a shaft rests in passing through a wall.

It consists of a rectangular cast-iron frame, having arrangements for receiving and holding the box in fixed position.

Fig. 7029.



Wall-Box.

Wall-clamp. A brace or tie to hold walls together, or the two parts of a double-wall, to prevent spreading.

Wall-desk. A sort of bracket-desk attached to a wall.

Walled A'rea. (*Metallurgy.*) *a.* An ore-roasting space inclosed by three walls, or by four, with the exception of a doorway.

b. A *patio.* See Fig. 138.

Wall-knot. (*Nautical.*) A large crowning-knot worked upon the end of a rope.

Wal'low-er. A lantern-wheel. A wheel made with two end disks attached to the shaft, and a series of rounds or trundles connecting the disks and acting as cogs. A trundle-wheel.

Fig. 7030.

Wall-Desk.

Wall-pa'per. Paper prepared for hanging upon walls to render them more sightly; or merely for the purpose of coloring them, as in photographic studios; the rooms in hospitals devoted to eye-diseases, etc. Great improvements have been made of late both in the quality of the material and its ornamentation.

Paper-hangings were first attached in the stead of silk or tapestry, about A. D. 1555. They were made by the Spanish and Dutch, and ornamented by stamping, or stenciling *velvet* or *flock* paper in which the surface was ornamented with silk or floss, by Lanyer, who obtained a patent therefor in the reign of Charles I., about 1634. He called the product *Londrindina*, and states that he had "found out an art for affixing wool, silk, and other materials upon linen, cotton, leather, and other substances, with oil, size, and cements, so as to make them serviceable for hangings and other purposes."

His claim to priority was disputed, and it was stated to have been invented in 1620 by François of Rouen, where the business was carried on by father and son till the death of the latter, in 1748. Wooden blocks for printing the patterns in size were exhibited during the dispute.

Nemetz describes the manufacture of "wax-cloth hangings with wool chopped and beat fine" to one Andrau, a Frenchman, early in the eighteenth century. This artist was inspector of the palace of Luxembourg, was celebrated for his arabesque and grotesque paintings, and had a manufactory of hangings in the palace.

Savary, in his "Dictionary of Commerce," states that flock-hangings were first made at Rouen, but they do not appear to have had a paper backing. In the early part of the eighteenth century paper-hanging was of such poor quality as only to be used in houses of inferior class, but toward the end of that century the manufacture had attained excellence, and the best mansions were decorated with it. In 1786 the art is declared by Temple to have culminated in point of excellence in design.

The mode of making the paper-hanging in continuous lengths was subsequently introduced.

Breitkopf, of Leipsic, Germany, introduced the imitations of marble, porphyry, and other masonry.

The addition of a metallic dust to give brilliancy to the design on the paper seems to have originated some two centuries since. Hautsch, of Nuremberg, invented the mode of preparing the metallic dust, which was soon adopted by the wall-paper manufacturers. (See METALLIC DUST.) Eccard is also credited with being the first to make tinsel-paper with the "metallic dust."

Black and white mica (*Glimmer*) were also used in Germany for this purpose in the seventeenth century.

In *block-printing*, wooden blocks are prepared by cutting away the portions which are not designed to print, or pieces of metal, forming the pattern, are inserted. These are dipped in the color and laid on the paper, which has been previously covered with a thin coating of color serving as a ground. In the cheaper kinds a colored paper is used to print on.

The greater proportion of wall-papers are now printed in a manner entirely analogous to calico-printing by being passed through a series of engraved cylinders heated and rotated by steam-power, which dry the color very rapidly, and perform the whole work with such expedition that the plain paper, as it comes from the mill, may be printed and reeled ready for use in half an hour.

Paper-hangings, printed from cylinders, were exhibited by Zuber of Mulhausen, at the eighth French Exposition of Industry, 1834.

By using a sufficient number of cylinders, from 12 to 20 colors are applied to the paper during its passage through the machine.

Of late years thin veneers of wood have been introduced to some extent in lieu of wall-papers.

Wall-papers are sometimes printed with varnish or size, and gilt or copper leaf applied; or pulverized bisulphide of tin is dusted over so as to adhere to the pattern. In flock-papers finely comminuted wool dyed of the desired color is similarly used. Powdered steatite or French chalk is used as the ground for satin papers, the gloss being produced by polishing. Stripes are sometimes produced by passing the paper rapidly under a trough having parallel slits in its bottom. Previous to the introduction of machinery, the size of the sheets of wall-paper was necessarily limited to that of the old hand-mold. At present they are made in lengths of 12 yards, having a width of 20 inches when hung, and covering 60 superficial feet. The number of pieces therefore required to cover a surface is ascertained by dividing the number of superficial feet which it contains by 60.

Wall-pa'per Cut'ter. A machine for trimming the edges of wall-paper.

The paper is laid with its margin projecting over the edge of the table. A wheel running on the paper communicates its motion to a pair of cutting-wheels, between which the paper is passed.

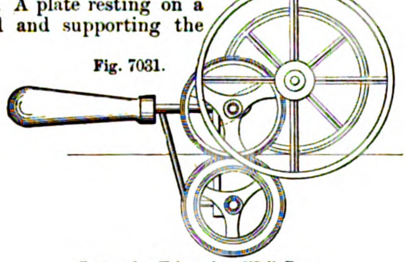
Wall-pa'per Hang'er. A device for hanging wall-papers.

The end of the sheet is carried around a roller, and is held by a clamping-bar maintained in closed position by a spring acting on arms; when the paper is applied its end is released by pulling a trigger, and the roller is then employed for pressing the surface of the paper in order to cause its adherence to the wall.

Wall-plate. 1. (*Building.*) *a.* A piece of timber let into a wall to serve as a bearing for the ends of the joists.

b. A plate resting on a wall and supporting the

Fig. 7031.



Cutter for Trimming Wall-Paper.

frame of the roof. See KING-POST TRUSS. Called also *raising-plates.*

2. (*Machinery.*) The vertical back plate of a plummer-block bracket, for attachment to the wall or post. See BRACKET.

Fig. 7032.

Wall-Plate.

Wall-sid'ed. (*Nautical.*) Said of a ship with upright sides above the water-line; in contradistinction to the term *tumbling home*, in which the ship bulges below, and has less beam at the upper deck than at the water-line.

Wall-wash'er. A large plate at the end of a tie-rod to extend the external bearing. They are known as *bonnets, stars, S's,* according to shape.

Fig. 7033.

Wall-Washers.

Wa'ney. The feather-edge or acute angular edge of a slab-board, cut from a round log without previous squaring, or obtained in the process of squaring.

The *edges* remove the *bark* and *waney* from a board.

Want'y. (Dan. *Want*, cordage.) A rope or strap to bind a load on the back of a horse. Used in hilly countries, and by cavalry when foraging. A *surcingle.* A *wagon-rope.*

Wapp. (*Nautical.*) A leader on the end of a pendant, acting as a fair-leader.

Ward. (*Locksmithing.*) *a.* A curved ridge of metal inside a lock which opposes an obstacle to the passage of a key which is not correspondingly notched.

Warded locks were used by the Romans, as the keys found at Herculaneum and Pompeii sufficiently testify. The character of the ward frequently gives the name to the lock, as, —

One-ward or *two-ward lock.* The wards, being usually of sheet-metal bent into a round form, are sometimes called wheels; hence the names *one-wheel, two-wheel* locks, etc. When the wards are cast solid, instead of being made of bent strips, the lock is a *solid ward.*

The shape of the ward sometimes gives the name, as L-*ward*, T-*ward*, Z-*ward*, etc.

A lock without *wards* is a *plain lock.*

Fig. 7034.

Lock-Wards.

b. The notches or slots in a key are also called key-*wards*, somewhat in violation of the meaning of the term: *ward*, a guard.

Ward'ing-file. A flat file having a constant thickness, and only cut upon the edges. Used in filing the ward-notches in keys.

Ward-room. (*Nautical.*) A cabin, on board large ships-of-war, for the accommodation of officers ranking as lieutenants.

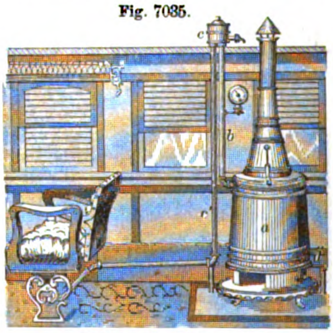
Ward's Case. An air-tight inclosure with glass sides and top for preserving or transporting plants, etc.; named from the inventor.

Mr. Hooker, the naturalist, records that in 1850 the superintendent of the Calcutta Botanic Gardens received 391 plants from North America, packed and transported in ice, in excellent order. They consisted of varieties of trees, bushes, and plants, fruit and ornamental, and were packed in Ward's cases for transportation to the English settlements in the Himalaya Mountains.

Warm'er. A heating device. See list of STOVES and HEATING APPLIANCES, pages 2409, 2410.

Fig. 7035 is an apparatus for warming railway-cars by means of hot water, which is heated in an annular boiler *a* surrounding the stove, passes through an upwardly ascending pipe *b* into the small tank *c*, whence it descends through the pipe *c'*, and is conveyed by a horizontal pipe beneath the seats of the car, and is finally returned to the lower part of the boiler by the pipe *d*.

Fig. 7035.



Baker's Car-Warmer.

Warm'ing-pan. A brazier with hot coals for airing and warming a bed.

"January 1st. Presented from Captain Beckford with a noble silver warming pan." — PEPYS'S *Diary*, 1669.

"Never mind the warming-pan." — PICKWICK.

Warn'ing-piece. (*Horology.*) An oscillating piece in the striking parts of a clock which is actuated by a pin on the hour-wheel, so as to release the *fly* which regulates the speed of striking ready for the lifting of the *hawk's-bill* detent in the *rack*. The *warning-piece*, by starting the fly, causes a rustling noise, which is the precursor of the *striking*, and is called the *warning*.

Warn'ing-wheel. That wheel in a clock which produces an audible sound at a certain distance of time before striking.

Warp. 1. (*Nautical.*) *a.* A tow-line smaller than a cable.

b. A rope or cable used in towing, or in moving a ship by attachment to an anchor or post.

2. (*Weaving.*) The threads running the long way of a fabric. They are wound on the *warp-beam*. The threads of the *warp* are carried up and down by the *heddles* of the harness, forming a track called the *shed*, along which the *shuttle* flies, leaving the *weft*, *woof*, or *filling*, as it is variously called.

The number of threads in a woolen warp is calculated by *biers* of 40 threads each. Thus an ordinary broadcloth having 3,600 threads in the warp is said to consist of 90 *biers*. The threads would be set in a *sley* or *reed* 3 3/16 yards wide, 2 *ends* or threads passing between every *dent* or *reed* of the *sley*. Fulling will reduce the width of the goods to 1¾ yards.

A Venetian cloth having 5,880 threads in the warp would be set in a sley of 1 15/16 yards wide, with 4 ends in a reed; and the cloth, when fulled, would be about 58 inches wide.

The *warp* is known also as the *twist*, or the *chain*; and in silk as *organzine*.

The *weft* is also known as the *woof*, the *shoot*, the *filling*; and in silk as the *tram*.

3. An irrigating process to cover the land with alluvial sediment.

4. The twist of wood in drying.

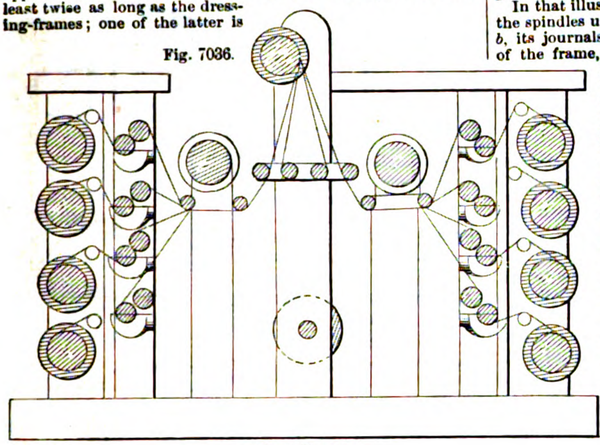
Warp-beam. (*Weaving.*) The roller on which the warp is wound, and from which it is payed off as the weaving proceeds. See WARPING-MACHINE.

The woven fabric is wound on to the *cloth-beam.*

Warp-dress'er. A machine for sizing yarns for the loom.

In the machine (Fig. 7036), dressing-frames are placed on opposite sides of the center-frame and yarn-beam, which are at least twise as long as the dressing-frames; one of the latter is placed opposite one half the length of the center-frame, and another opposite the other half By this means the operator can easily reach to any part of either section of yarn, and a yarn-beam of any length can be filled by employing a sufficient number of dressing-frames, while the tension of all the yarns is nearly equal.

Fig. 7036.



Warp-Dresser.

See also Bullough's SLASHER, Fig. 5145, page 2199.

Warp-dye'ing Ma-chine'. An apparatus for drawing warp-threads, laid out in sets, through the dye-beck. Each warp is separated from the others by a pin, and is conducted under each lower and over each upper roller in succession until delivered to the squeezing cylinders where the superfluous color is pressed out. Weighted levers regulate the amount of pressure on the upper cylinder.

The whole apparatus stands in the dye-beck.

Warp'er. See WARPING-MACHINE.

Warp-frame, or **Warp-net Frame.** 1. A lace-making machine which has as many threads as needles, the threads being *warped,* or wound on a beam or roller, the same as in a loom. It differs from the *point-net frame* in this, among other things, that the latter has but a single thread, which is made to form the succession of loops, as in the *stocking-frame.*

2. (*Weaving.*) See WARP-MACHINE.

Warp'ing-block. One used in the rigging-loft in warping off yarn.

Warp'ing-hook. The brace for twisting yarn in the ropewalk.

Warp'ing-jack. The contrivance suspended between the *travers* and the revolving *warp-frame,* and whose duty it is to separate the warp-threads into the *leas* or two alternate sets, one set for each *heald* or *heddle.* Also called the *heck-box.* See WARPING-MACHINE.

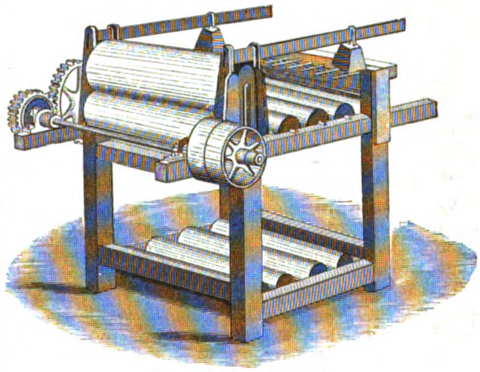
Warp'ing-ma-chine'. (*Weaving.*) A machine for *beaming,* that is, laying flat and parallel on the *yarn-beam* the threads of which the warp is composed.

In that illustrated, the yarns, having been first wound from the spindles upon a cylinder *a*, this is transferred to the frame *b*, its journals resting in bearings on the upright standards of the frame, and the mass of warp-threads pressing on the surfaces of two large anti-friction rollers beneath. The yarns divided into sets are passed between the teeth of the separator or *ravel c*, and each thread is separately conducted between two adjacent teeth of a second *ravel d*, and finally secured to the roller or *yarn-beam e*. This rests upon two rollers, caused to rotate in the same direction by gear-wheels engaged by an intermediate pinion on the shaft of the pulley *f*; these carry round the yarn-beam, which withdraws the threads from the roller *a*, winding them upon itself; it is held down and its longitudinal motion prevented by two narrow rollers *g g'*, which bear against a circular projection at each of its ends, and rotate on a common axis journaled in standards upon the pivoted levers *h h'*, which are weighted so that any requisite pressure may be given to the yarn-beam. These contrivances give the minimum amount of friction, equalize the strain, and lessen the danger of rupturing any threads. See also next article.

Warp'ing-mill. (*Weaving.*) An apparatus for laying out the threads of a warp and dividing them into two sets.

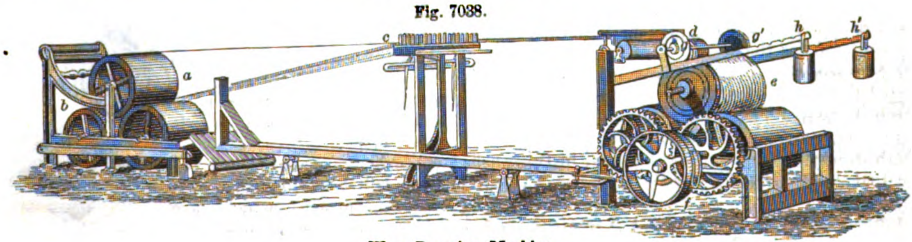
It comprises a large wooden reel *a* of 12 or more sides mounted on a vertical axis and rotated by an endless band passing around a horizontal wheel at its base, and a second wheel turned by a winch. One sixth of the whole number of threads, on their bobbins, are mounted on a frame *b*, called the *travers*, the bobbins being set loosely upon spindles, so as to revolve freely. The yarns are passed through the eyes of pins on the *jack* or *heck-box c*, which has a rising and falling motion by reason of its being connected by a cord passing over a pulley to the axis of the mill *a*. The pins in the heck-box are arranged in two sets by each alternate pin being connected to one of two

Fig 7037.



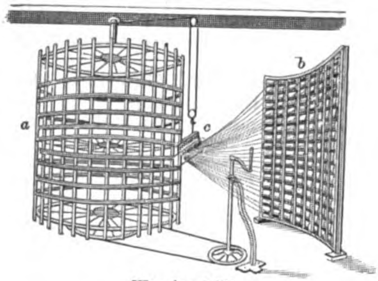
Warp-Dyeing Machine.

Fig. 7038.



Warp-Beaming Machine.

Fig. 7039.



Warping-Mill.

movable bars in the *heck-box*, so that by pushing up one set of pins, after the yarns are passed through, the warp is divided into two *leas*, one for each of the heddles of the loom. The ends of these are knotted together, and they are passed over two pins on the mill, which is then turned by means of the winch. The heck-box rises, and the yarns are wound spirally on the reel; the movement is then reversed, and the box descending by its own weight, a spiral layer is laid on in the opposite direction, and so on until the yarns are all wound off the bobbins. See also previous article.

Warp-lace. Lace having a warp which is crossed obliquely by two weft-threads. See also BOBBINET.

The oldest lace has a knit ground, and the ornament worked by the needle. The oldest machine, made in 1764, was a modification of the stocking-frame, and was called the *frame-looped net* machine; six-sided meshes could be made, which held their form when starched, but shrunk like crape when damp.

To this succeeded the *warp-frame*, which had looped stitches, but had so much more solidity that it could be cut and stitched like cloth. In 1810, there were 400 warp-looms at work making Mechlin net.

Heathcote patented his first *twist-net* machine in 1805, and Lord Lyndhurst pronounced it "the most wonderful machine ever invented." It was to make a net like the *bobbin-net* made on the *pillow*. As he observed: "Cushion-made net had half the threads proceeding in wavy lines from end to end of the piece, and may be represented by warp-threads. The other threads, lying between the former, pass from side to side by an oblique course to the right and left, and may be called weft-threads. If the warp-threads could move relatively to the weft-threads so as to effect the twisting and crossing, but without deviating to the right or left hand, and if the weft-threads could be placed so that all of them should effect the twisting at the same time, and one half of them should proceed at each operation to the left and the other half to the right (a substitute being also provided for the cushion-pins), lace would be made exactly as on the cushions." See "Popular Science Monthly," March, 1874, Vol. XLVII., pages 540-542.

Warp-ma-chine'. A lace-making machine having a thread for each needle employed; in contradistinction to the stocking-frame, which has but a single thread.

This machine was invented about 1775; it was improved by Dawson in 1784, by the application of the rotary motion and the cam-wheels to move the guide-bars. Warp-machines were the first to produce ornamental patterns on lace, such as spots, bullet-holes, etc.

The Jacquard apparatus was applied to the warp-machine by Draper in 1839.

Warp-roll'er Reel. (*Knitting-machine.*) A spool which holds the supply of yarn.

Wash. The fermented wort of the distiller. The grain is ground and infused, forming a *mash*; the decanted liquor is a *wort*, which, by fermentation, becomes *wash* for the still.

Wash-back. A tun or vat in which *wort* is fermented to form *wash* for distillation.

Wash-ba'sin. The *hand-thweale* of the Anglo-Saxons; the *louterion* of the Greeks.

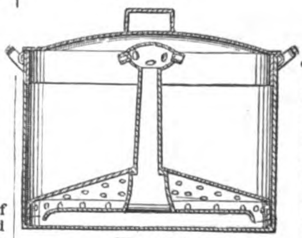
Wash-bee'tle. The pounder used in tub-washing; called *battledores* and *batlets* in the sixteenth century.

Wash'board. 1. (*Carpentry.*) A skirting around the lower part of the wall of an apartment.

2. (*Nautical.*) A board above the gunwale of a boat to keep the water from washing over.

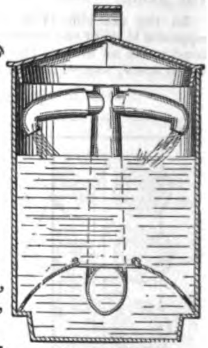
3. (*Domestic.*) A board with a ribbed or fluted surface, over which clothes are rubbed to cleanse them. They are made of wood, of crimped zinc, earthenware, vulcanized rubber, etc.

Fig. 7040.



Wash-Boiler.

Fig. 7041.



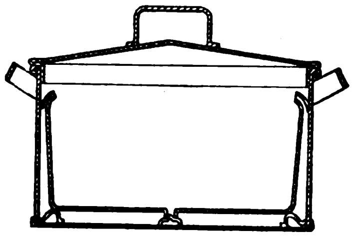
Wash-Boiler.

Wash'board Ma-chin'-er-y. Includes the following set of tools: —

Dovetailing-machine.	**Boring-machine.**
Fluter.	**Setting-up and nailing machine.**
Jointer.	

Wash-boil'er. A domestic boiler for clothes. It is usually made to stand upon a stove, and ingenuity

Fig. 7042.

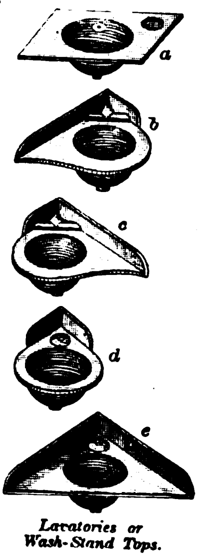


Wash-Boiler.

is shown in various modes of inducing a circulation of water through the clothes, the hot water from below being raised by the generation of steam, and poured in a cascade over the clothes in the boiler. It is a domestic illustration of the keir used in calico-printing works and bleacheries. See BUCKING-KEIR, Fig. 958, page 397.

Wash-bowl. (*Plumbing.*) Fig. 7043 illustrates various kinds of lavatories or wash-stand tops.

Fig. 7043.



Lavatories or Wash-Stand Tops.

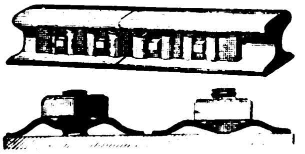
a, square-top plug-bowl.
b, left-hand corner bowl.
c, right-hand corner bowl.
d, angle round-bowl.
e, angle-bowl.

Wash'er. 1. (*Machinery.*) An annular disk of metal or wood which slips over a bolt, and upon which the nut is screwed fast.

Washers are also placed beneath bolt-heads; between contacting surfaces which are screwed together, where it forms a packing.

Many locking washers have been invented for preventing nuts from jarring loose. See NUT-LOCK, Fig. 3350, page 1538. See also WALL-WASHER.

Fig. 7044.



Washer and Lock-Nut.

Fig 7044 illustrates a spring-lock for nuts and washers, showing its application to the fish-plate of a rail. Its resiliency permits it to yield to the vibration caused by the passage of the train, keeping the plate in place without disturbing the relation of the nut or washer to the bolt.

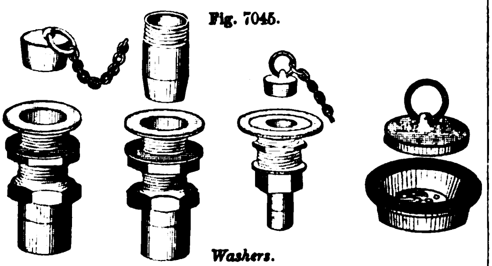
2. (*Paper-making.*) *a.* A *beating-engine* in which rags are washed and coarsely reduced, to bring them to the condition of half-stuff. See STUFF-ENGINE.

b. A kind of revolving colander which is formed of wire-gauze, and wallowing in the pulp carries off the dirty water but leaves the pulp.

3. (*Plumbing.*) *a.* The trade term for a bottom outlet in cisterns, etc. The figure shows : —

Ring-plug and washer.
Washer and waste, with *fly-nut* and *union*, for slate cisterns.
Plug and washer.
Basin plug and washer, with fly-nut, union, and chain.

Fig. 7045.

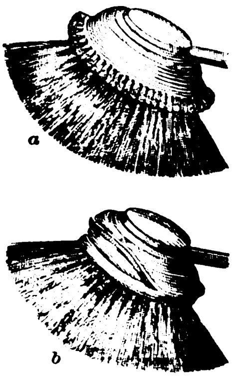


Washers.

b. A street-washer or pavement-plug, where a hose may be attached to water the street, pavement, or urban garden.

4. The term is also applied to domestic apparatus for cleansing; as *window*-washer, *dish*-washer, *tumbler*-washer, *vegetable*-washer, etc., etc.

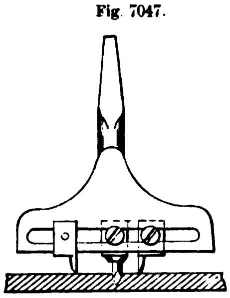
Fig. 7046.



Leavens's Washer-Brushes.

a (Fig. 7046) is a window-brush, having a projecting row of bristles to keep the wood from breaking the glass.
b is a car-washer, having an elastic band which acts as a fender.

Fig. 7047.



Washer-Cutter.

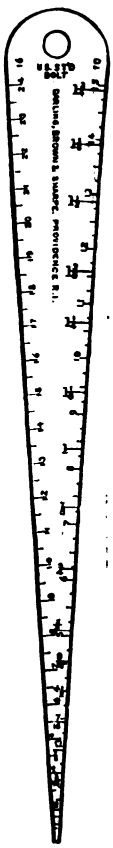
5. See also GOLD-WASHER; and for many other applications of water in sorting ores and saving metals, see list under METALLURGY.

6. A device for precipitating smoke or fumes by a shower of water. See CONDENSER; SMOKE-CONSUMER, Fig. 5225.

Wash'er-cut'ter. A tool for cutting annular disks for washers.

That shown in Fig. 7047 has cutters which may be set out or in the radial slots on each side of the center-pin. The tang of the tool is adapted to be held in the socket of a brace. The cutters are held in any required position by set-screws, and one or both may be used. For washers which are annular, they are set to the sizes of the inner and outer circles required. For wads which are disks, one alone is revolved around the center-pin.

Fig. 7048.



Brown and Sharpe's Nut and Washer Gage.

Wash'er-gage. An instrument for measuring diameter and thickness, also holes of nuts and washers.

The figures upon one edge are for 16ths and 32ds, and on the other for 10ths and 20ths of inches; also, United States standard sizes for holes to tap for bolts. Opposite side is graduated the same as a steel rule to 32ds of inches.

Wash'er-hoop. A gasket between the flange and curb of a water-wheel.

Wash-hole. (*Mining.*) A place where the refuse is thrown.

Wash'ing-en'gine. (*Paper-making.*) The first of the rag-engines in which the rags are worked, cleaned, and finally cut when the cylinder is let down upon them. "From the washing-engine the *half-stuff* passes to a second engine, called the *beating-engine.* See RAG-ENGINE.

Wash'ing-ma-chine'. One for cleaning clothes with water and soap.

The oldest fashions are the rubbing between the hands, the dashing of the clothes on the water, and the pounding of the clothes on stones in the stream.

The modern machines have several other typical forms.

The present state of the art may be said to embrace the following modes : —

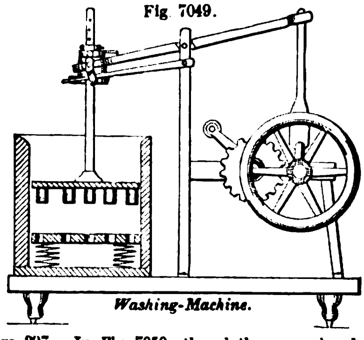
1. *Churning.* The clothes are beaten by a pounder in a tub. In some cases, wooden balls are added to increase the friction.

Fig. 7049 has a combined up-and-down circular motion.

2. The *dash-wheel.* The clothes are put in a barrel which is turned upon an axis, — longitudinal, transverse, or oblique. Such are used in bleacheries. See Fig. 710, page 297.

3. *Sluicing.* The hot water is driven through the clothes. See WASH-BOILER for one form. See also BUCKING-KEIR, Fig. 958, page 397. In Fig. 7050, the clothes are placed in the slat-sided cylinder, and the water circulated by the paddle-wheel at the other end of the suds-box. A stove beneath the metallic bottom gives means of heating. The cylinder and wheel are rotated by a winch upon the paddle-wheel shaft, and a chain connects the shafts.

Fig. 7049.



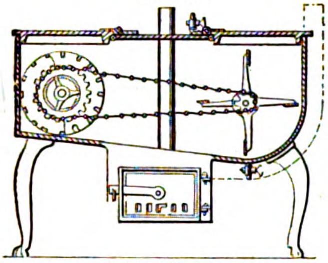
Washing-Machine.

4. *Centrifugal.* This is on the principle of the sugar-drainer, and is shown at Fig. 1214, page 514.

5. *Twisting.* The clothes are alternately wetted and then placed in a strong cloth and wrung out.

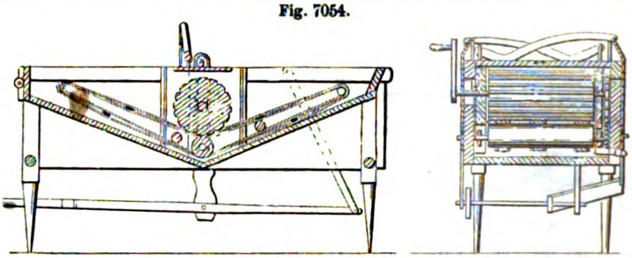
6. *Squeezing.* In Fig. 7051, the clothes are rolled over and

Fig 7050.



Washing-Machine.

Fig. 7054.

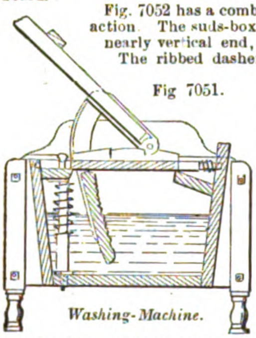


Washing-Machine.

over, and squeezed by the segmental arm against a presser-board.

Fig. 7052 has a combined squeezing and rubbing action. The suds-box has a curved bottom and a nearly vertical end, armed with transverse ribs. The ribbed dasher is pivoted to a transverse shaft, sweeps over the curved surface, and presses the clothes against the end.

Fig 7051.

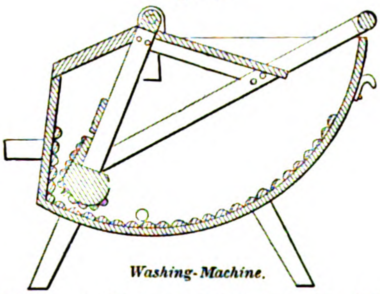


Washing-Machine.

7. *Rolling.* The clothes are carried by an apron between fluted rollers (Fig. 7053).

Fig. 7054 is another form, in which the upper and lower rollers are geared together and turned by a hand-crank. The clothes are passed on an endless apron between the rollers. The operating parts are attached to an inner frame, which is lifted from the tub by a treadle-lever and connecting side-rods. The lower roller is pressed upward against the driving roller by transverse levers connected to its respective ends.

Fig. 7052.

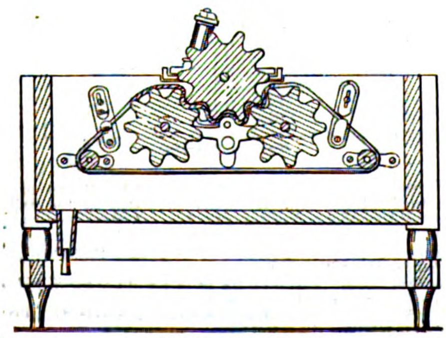


Washing-Machine.

8. *Rubbing.* *a.* Between vertical surfaces. The clothes are attached to a gate, which reciprocates vertically between the corrugated surfaces of two spring-pressure bands attached to removable frames in the suds box (Fig 7055).

b. On a curved bed. A series of concave, corrugated, and

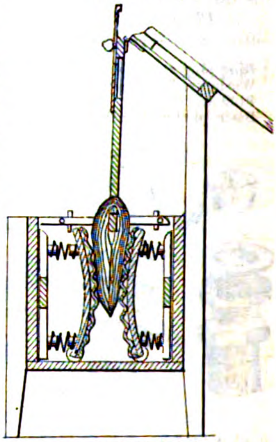
Fig. 7053.



Washing-Machine

yielding fingers, each having a pin encircled by a spiral spring, is hinged by a bolt to the yielding frame, the front edge of which is upheld by spiral springs, its rear edge resting on the tank bottom. Arms and a pin of vibrating rubbers are hung to a frame, and the pressure is adjusted as required (Fig. 7056).

Fig. 7055.



Washing-Machine.

c. Between flat disks.

In Fig 7057, the rubber has a circular reciprocating motion, and with its driving mechanism may be vibrated vertically on a hinge to remove the rubber from the tub.

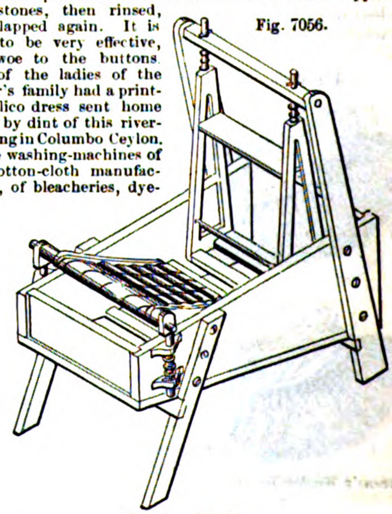
d. Between surfaces reciprocating in a direct line. The clothes are thinly spread between two rubbing surfaces, to which latter are given a quick and short alternately reciprocating motion (Fig. 7058).

9. *Rocking.* *a.* On a flat bed (Fig. 7059).

b. In a concave (Fig. 7060).

The Oriental "washing-machine" is rather *hard on clothes*, and has caused some surprise to ladies who have sent colored cotton goods *to the wash*, and have received them with all the color beaten out of them. Fig. 7061 illustrates the operation. The clothes are wetted and slapped upon flat stones, then rinsed, and slapped again. It is said to be very effective, but woe to the buttons. One of the ladies of the writer's family had a printed calico dress sent home white by dint of this river-washing in Columbo Ceylon.

Fig. 7056.



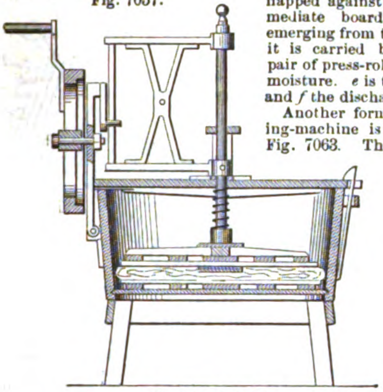
Washing-Machine.

The washing-machines of the cotton-cloth manufactories, of bleacheries, dye-shops, etc., are on a somewhat extensive scale, and have specific names, among which may be mentioned *bucking-machines*, *wincing-machines*, *keirs*, *dash-wheels*. Bridson's washing-machine (Fig 7062) consists of a tank *a* in which are two rollers *b b'* having bars *c c'* placed diametrically to each other. The cloth is conducted by guide-rollers through the water in the

trough in the direction indicated by the arrows, passing eight times around the bars c c'; as these come in line with each other, the material is flapped against the intermediate board d. On emerging from the trough it is carried between a pair of press-rolls to expel moisture. e is the supply and f the discharge-pipe.

Another form of washing-machine is shown in Fig. 7063. The cloth is

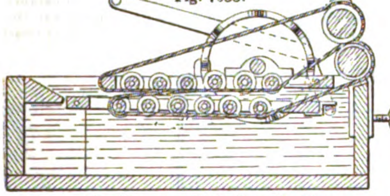
Fig. 7057.



Washing-Machine.

arranged in folds on a shelf b to the left of the vat a, whence it is conducted by rollers through the first compartment, and upward between a pair of rollers which press out the water, and so on successively through the seven compartments of the vat until

Fig. 7058.

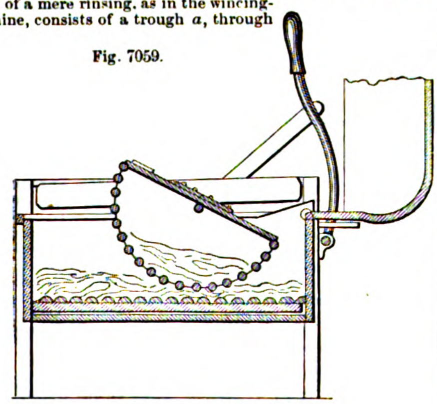


Washing and Wringing Machine.

arriving at c, where it passes between a pair of rollers kept together by weighted levers, which express most of the moisture. Water is first admitted to the higher right-hand compartment, and flows from that into the next, and so on, causing a current opposite to the direction taken by the cloth.

The dyer's washing-machine, to give a positive washing instead of a mere rinsing, as in the wincing-machine, consists of a trough a, through

Fig. 7059.



Washing-Machine.

which the folded cloth is carried a number of times in succession as it winds spirally about the roller b, being at the same time struck by a series of beaters c c' (Figs. 7064, 7065). In all these machines it is customary to tack a number of pieces of the fabric end to end, forming one continuous length.

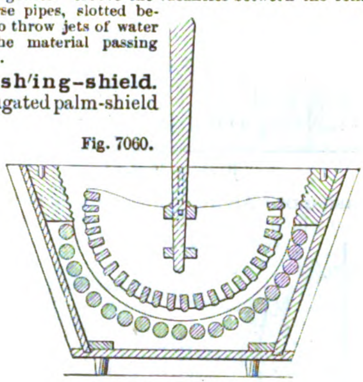
See also Ure's "Dictionary" (American edition), Vol. III. page 257 *et seq.*

Wool-washing machines vary in their construction almost as much as the domestic article.

In Fig. 7066, the wool is passed upon an endless apron between the lower fixed and upper spring rollers, which are all geared together. Above the vacancies between the rollers are transverse pipes, slotted beneath, to throw jets of water upon the material passing through.

Wash'ing-shield. A corrugated palm-shield

Fig. 7060.



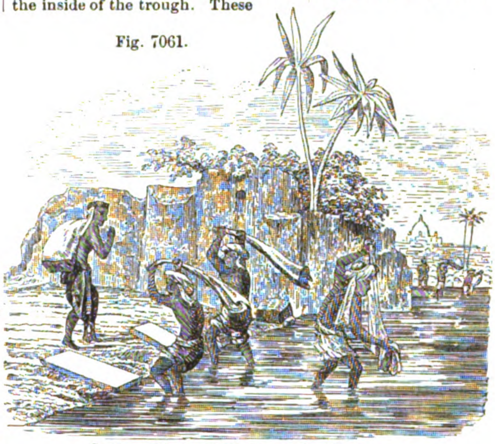
Washing-Machine.

or armor to protect the person and form an effective surface for rubbing, or upon which to rub the clothes.

Washing-ta'ble. (*Metallurgy.*) A shaking-trough in which ore is sorted by gravity.

Fig. 7068 consists of a long rectangular trough, suspended by hooks, and provided with stops at suitable distances apart on the inside of the trough. These

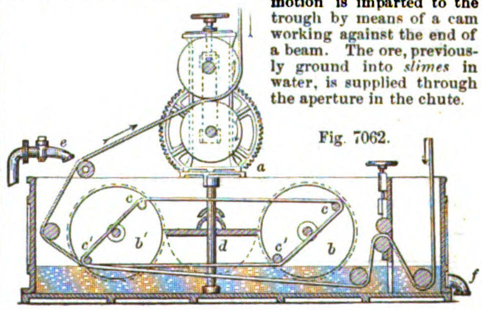
Fig. 7061.



Indian Dhobees (W..shermen), Hindostan.

stops consist of strips of wood extending from one side of the trough to the other, and kept in place by posts. A vibrating motion is imparted to the trough by means of a cam working against the end of a beam. The ore, previously ground into *slimes* in water, is supplied through the aperture in the chute.

Fig. 7062.



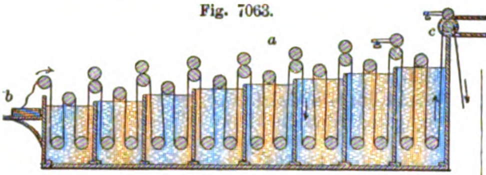
Washing-Machine.

Wash'ing-tub Saw. An annular saw for sawing tub-staves.

Wash-leath'er. Split sheep-skins prepared with oil in the manner of chamois. See CHAMOIS.

Alumed, tawed, or *buff* leather.

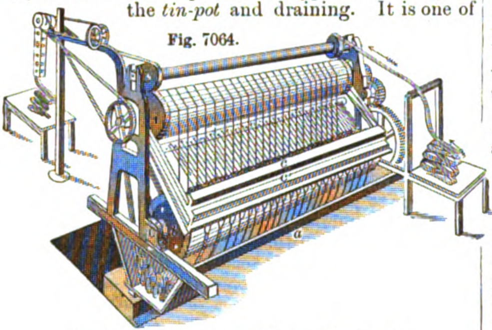
Fig. 7063.



Washing-Machine.

Wash-pot. An iron pot containing melted grain tin, into which iron plates are dipped after a dip in the *tin-pot* and draining. It is one of

Fig. 7064.



Dyer's Washing-Machine (Perspective View).

the series of five pots and pans used in the manufacture of tin-plate. The *tin-pot*, *wash-pot*, *grease-pot*, *pan*, and *list-pot*. See TIN-PLATE.

Wash-stand. A lavatory for the hands and face. See WASH-BOWL.

In Fig. 7069, the reservoir is filled from above and has a cock in the lower side.

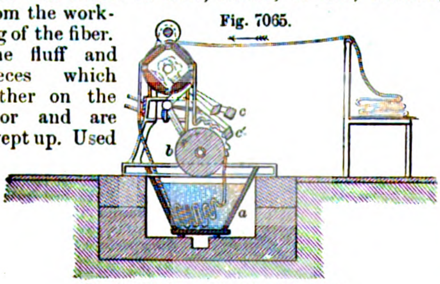
Fig. 7070 is a portable wash-stand.

Waste. The refuse of a factory or shop.

1. Broken or spoiled castings which go to the heap to be remelted.

2. The refuse of wool, cotton, or silk, resulting from the working of the fiber. The fluff and pieces which gather on the floor and are swept up. Used as swabs for wiping machinery, as an absorbent in railway axle-boxes, etc.

Fig. 7065.



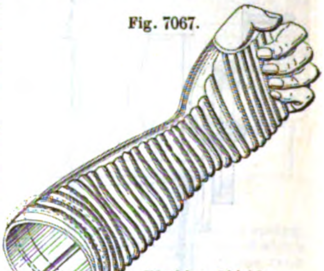
Dyer's Washing-Machine (Section).

3. Paper scraps of an office, printing-house, bindery, etc. Worked over into paper.

4. *Machinist's Waste.* Soiled cotton waste which is too dirty to be longer serviceable for wiping machinery. It is treated to recover the oil.

5. *Engineer's Waste.* The cotton stuff which has served its turn in the axle-box, and may be treated to recover the oil.

Fig. 7067.



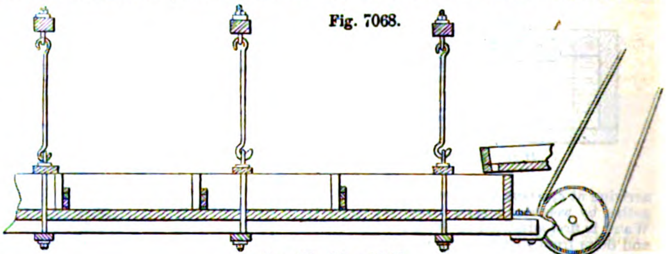
Washing-Shield.

"The consumption of soap and paper, the quantity of letters exchanged, the extension of public libraries and the use made of them, etc., are often taken as a measure of the actual degree of civilization of a nation.

"An extensive and refined use made of the waste materials of industry and housekeeping might be considered with equal right as the measure of the degree of industrial development and capability. It would also scarcely be possible to find in the trades and in economy of agriculture an instance which shows to the same extent the really creative force of science and the characteristic tendency of a nation to economize so well as its endeavor to keep, like nature, all within the circle of reproduction.

"Side by side with the increase and growth of wants, we see the quantity of useful material augmented in a twofold manner. This is accomplished partly by making use of substances formerly useless, because their qualities were unknown; but still more by the use made of substances which, formerly considered as used up, appeared to be of no value, and were often incommodious and in many cases troublesome.

Fig. 7068.



Ore-Washing Table.

"In order to prove only by a few actual cases the assertion last made, that the use of waste materials increases, and that thus difficulties are removed, and that the wealth of the nation at the same time increases, it is only necessary to take, for an example, the quantities of waste materials of soda-factories which were formerly a real nuisance. Nowadays a great part of the sulphur contained in them is extracted, and the remainder, containing chalk and gypsum, is employed as valuable material for agriculture.

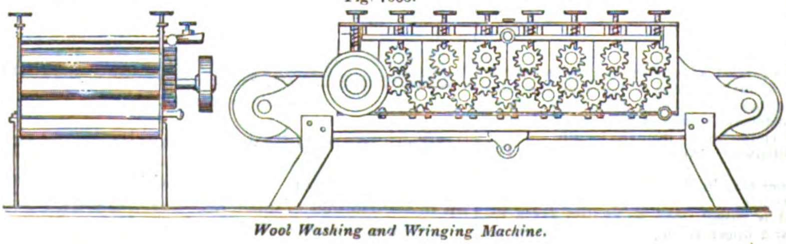
"The acid manganese solutions of chloride of lime factories have become restored to use by means of an ingenious chemical process.

"The *scoriæ of metals* produced by blast-furnaces is now used in glass-making, and becomes, by a simple process called *basalting*, a substance useful in the construction of buildings and streets. *Coal and wood tar* play in our time an important part. It is sufficient to call to mind the beautiful *aniline* colors, without speaking of a host of substances which have become useful, like *benzine*, *paraffine*, *creosote*, *carbolic acid*, *pyrocatechin acid*, etc.

"Injurious and even *poisonous gases*, which escape during the process of smelting (*sulphuric acid*, *arsenic*, *zinc* vapors, etc.), have not only been rendered innocuous by contrivances to condense and absorb them, but have even been rendered very useful.

"*Cotton-seed*, which was formerly utterly useless, acquired an increased importance from

Fig. 7066.



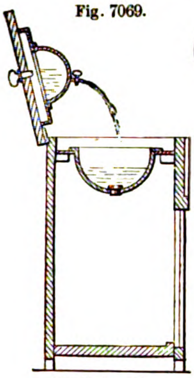
Wool Washing and Wringing Machine.

the moment when the means of making *oil* from it was discovered. So also with *soap-lees* from laundries, for we now know how to obtain *fat acids* from them.

"Before the International Exhibition of London in the year 1851, the *glycerine* in the factories of *stearine acid* and *candle* manufactures, and the ammonia in *coal-gas* were lost altogether; since then they have both become important objects of manufacture.

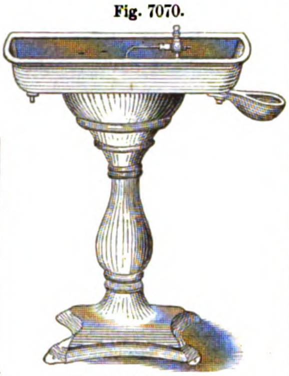
"Woolen *rags*, which were formerly only used for the production of *Prussian blue* and inferior *paper*, but which were for

Fig. 7069.



Wash-Stand.

Fig. 7070.



Portable Wash-Stand.

the most part thrown on the waste-heap, have now become raw materials, just as well as silk and cotton refuse, for textile industry, and thus render very respectable clothing material accessible even to persons of very moderate means

"The *distillers' wash* produced in molasses-distilleries, and which was formerly thrown away, has become just as useful for the reproduction of *potash* which is obtained from it, and which forms the base of so many valuable alkaline salts; *blood* became useful for the production of *albumine*; *cork* refuse for the manufacture of *floor-cloths*: old *horseshoe-nails* and other *scrap-iron* for the fabrication of the *soft* and *malleable iron* for English fowling-pieces; and so on, with *sawdust* and *leather refuse*, etc.

"China and Japan mainly owe their flourishing agriculture to the extensive use made of human excrements; and one of the greatest chemists of our time, Baron Liebig, has acknowledged that they contain the means of restoring to the soil of Europe its power of production, a power which will soon be exhausted otherwise" — *Vienna Exhibition Programme*, 1873.

The quantity of anthracite coal-dust which is heaped up in the Pennsylvania coal regions is estimated at 50,000,000 tons. This has heretofore had no commercial value, and indeed it costs 30 cents per ton to dispose of it. Mr. J. E. Wootten, Superintendent of the Philadelphia and Reading Railroad, has succeeded in constructing steam-boiler, locomotive, and puddling furnaces which burn this dust perfectly, and will thus utilize this immense amount of fuel already mined. The furnace consists, in general terms, of perforated grate plates (instead of bars), steam-jet air-blast, and an otherwise hermetically closed ash-pit.

6. (*Hydraulics.*) *a.* A contrivance for allowing the escape of surplus water, as the *waste-weir*, *waste-pit*, or *waste-sluice* of a reservoir.

Fig. 7071.

Waste.

b. The water so escaping; through a gate, for instance, rather than into the mill-race or penstock.

c. Overflow water from a sink or trap.

A pipe for running waste-water from a bath, standing wash-tub, or sink. It is secured by means of jam-nuts *a a* and gaskets to the object. *b* is the plug for bath or basin.

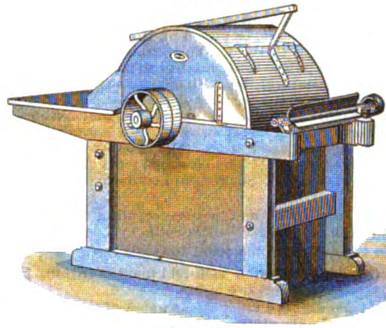
7. (*Mining.*) A vacant space in the *gob* or *goaf*. Old workings.

Waste-box. (*Mining.*) A box in which the waste-water is conveyed away from the frames.

Waste-dust'er. A machine for cleansing factory waste by subjecting it to the action of rotary beaters, which remove the dust, etc.; these impurities fall through a wire grating, by which the waste is retained.

Waste-gate. A gate to allow the passage of surplus water from a pond or canal.

Fig. 7072.



Waste-Duster.

Waste-leaves. (*Bookbinding.*) Additional blank (or fly) leaves, — usually eight, — bound in with a book next to the covers at the commencement and end of the book proper.

The end *waste-leaves* are pasted to the cover, and in fine work the leaves facing the covers, and their opposites are of marble-paper, to give finish.

Waste-pick'ing Ma-chine'. A machine for tearing refuse fabric into shoddy.

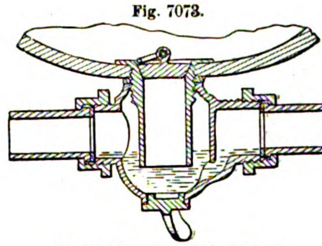
Waste-pipe. A discharge-pipe for superfluous water; or of water which has served its purpose.

Wast'er. (*Founding.*) The technical term for a casting which is spoiled, and sent to the scrap-heap.

Waste-steam Pipe. (*Steam-engine.*) The pipe leading from the safety-valve to the atmosphere.

Waste-trap. One for allowing surplus water to escape without permitting air to pass in the other direction. See TRAP.

Fig. 7073.



Waste-Trap for Wash-Basins.

Waste-wa'ter Pipe. (*Steam-engine.*) The pipe for carrying off the surplus water from the hot-well.

Waste-weir. A cut in the side of a canal for carrying off waste-water.

Watch. 1. (*Horology.*) A time-keeper actuated by a spring, and capable of being carried on the person. The essential difference between a clock and a watch has been defined to be that the latter will run in any position, but the former in a vertical position only. Since the invention of the cheap spring-clock this definition must be abandoned. Another characteristic which was formerly distinguishing was that the watch escapement was always controlled by a balance-wheel and spring, while the clock escapement was generally governed by a pendulum. There is no law to prevent a person from carrying a small spring-*clock* in his pocket and calling it a *watch*.

The word *watch* is derived from an Anglo-Saxon word, signifying "to wake," and in the sense of a time-keeper first occurs in a record of 1542, which states that Edward VI. "had onne larum or watch of iron, the case being likewise of iron gilt, with two plumettes of lead"; in other words, it was driven by weights. The invention is said to have originated at Nuremberg, 1477; so that watches were formerly playfully called "Nuremberg animated eggs." The invention has also been claimed for Geneva. See also HOROLOGICAL INSTRUMENTS.

For early notices of time-keepers, see CLOCK; CLEPSYDRA.

The first portable time-indicator was the pocket-dial or the Chinese traveler's companion mounted on the head of a cane, suspended on the breast, or placed on the rail of the wagons in which the Celestials traveled. The Chinese compass is fitted to act as a dial, the points being marked to represent the 24 hours or divisions of a natural day. Of course only a part of these are available, and at the periods of the solstices would be very far from the mark except at noon, but they may have had some system of correction for aught we know. See MARINER'S COMPASS.

Watches are mentioned in an Italian sonnet of 1490, by Gaspar Visconti. Henry VIII. had a watch; the Emperor Charles V. had several of them; Shakespeare refers to one in "Twelfth Night": —

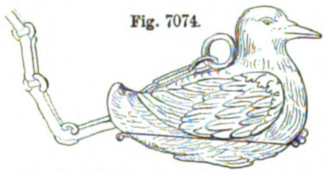
"I frown the while; and, perchance, wind up my watch or play with some rich jewel." — *Malvolio.*

Also in the answer of the priest to Olivia: —

"Since when, my watch hath told me, towards my grave
I have traveled but two hours."

Fig. 7074 represents a fancy silver watch of the time of Queen Elizabeth. It is shaped like a duck, the feathers chased. The lower part opens, and the dial-plate, also of silver, is encircled with a gilt ornamental design of floriated scrolls and angels' heads. It has an outer case of thin brass, covered with black leather and ornamented with silver studs.

Fig. 7074.



Watch of the Time of Queen Elizabeth.

Fig. 7075 is a watch made for Louis XIII. of France to present to King Charles I. It is of silver, richly gilt, the ornaments covered with transparent enamel in white, red, green, blue, and yellow. The back is chased in high relief with the figure of St. George and the Dragon. On the side of the watch is the motto of the order of the Garter. The interior of the case is enriched by a delicately executed arabesque filled with black enamel upon a dotted ground. The entire works take out of the case, being secured thereto by springs, and are all more or less decorated with engraving, the whole interior being chased and gilt.

Fig. 7075.

Watch made for Charles I.

In a Swiss museum is an antique watch only $^3/_{16}$ inch in diameter, inserted in the top of a pencil-case. The dial indicates not only hours, minutes, and seconds, but also the days of the month.

Fig. 7076 is the *memento mori* watch presented by Mary Queen of Scots to Mary Seaton, her maid of honor, one of the four Marys who waited upon her.

"Yestreen the Queen had four Maries,
The night she 'll hae but three;
There was Marie Seaton, and Marie Beaton,
And Marie Carmichael, and me"

The watch is of silver, in the form of a skull, and was made by Moyse of Blois.

The watch is opened by placing the skull in the palm of the hand and lifting the hinged lower jaw. The works occupy the place of the "brains," the dial occupying about the position of the palate and to the rear of it. The dial is of silver, fixed in a golden circle, the hours marked in Roman letters. The watch had originally a catgut between the spring barrel and the train. A bell fills the hollow of the skull, and receives the works within it. A hammer set in motion by a separate escapement sounds the hours. It was evidently intended for a *prie-dieu*, or domestic altar.

Fig. 7076.

Memento Mori Watch of Mary Queen of Scots.

Watches stolen from Charles V. and Louis XI. in crowds were discovered by their striking while in possession of thieves. When Guy Fawkes and Percy were detected in the third year of James I. in attempting to

"Blow up the House of Lords,
The king and all his ministers,"

they had a watch "to try conclusions for the long and short burning of the touchwood [fuse] which was prepared to give fire to the train of gunpowder."

"This day was left at my house a very neat silver watch." — PEPYS's *Diary*, 1665.

The early watches had but one hand, and required winding twice a day. The substitution of a spring for weights was made about 1550. The spring was at first merely a straight piece of steel, not coiled. A spring to regulate the balance was first applied by Dr. Hooke, 1658; this was at first made straight, but soon improved by making it of spiral form. (See HAIR-SPRING.) This invention has been attributed to Huyghens, but Hooke's priority appears unquestionable. This is the greatest one of all the inventions in the watch, not excepting the compensation balance of Harrison (see page 600). It effected for the watch what the pendulum had done for the clock, and depended upon similar laws. Dr. Hooke showed that the vibrations of such a spring are nearly isochronous, whatever their length, and cause the balance to which they are attached to make its excursions in equal times, although the excursions are longer when the spring is at its greatest power, when just wound up, and less in extent when the spring is nearly run down. The actual difference in the excursions is from nearly a full revolution down to about half a revolution.

The repeating-watch was invented by Barlow, 1676; Quare invented a repeating movement about the same period. The drilling of jewels for the pivots was first done by Nicolas Facio, a Genevan, in 1700. The order of the jewels for hardness is as follows: diamond, sapphire, ruby, chrysolite, aqua-marine, garnet.

The introduction of the main-spring, with its barrel and fuse, and the hair-spring for regulating its movement, were succeeded by other improvements, which rendered the watch, in its most perfect form, the chronometer, sufficiently accurate to be employed for determining the longitude at sea. Among these were the horizontal escapement of Graham, 1700, and the dead-beat clock escapement of the same inventor, considered to be the original of the lever-escapement for watches. The *detached-lever* escapement may be said to be the product of the labors of Berthoud, LeRoy, Earnshaw, Graham, and Mudge. Harrison, 1735-1762, invented the going fusee and the compensation balance for chronometers, finally obtaining the reward offered by the English Board of Longitude for his improvements in time-keepers, which rendered the long-sought solution of the longitude problem practicable. See page 600; also specific index HOROLOGY, articles BALANCE; CLOCK; CHRONOMETER; FUSEE; etc.

For a long period England has maintained a pre-eminence in the quality of her watches, which are, however, expensive. Those of Switzerland do not rank so high, but are cheaper, and are turned out in great quantity, so as to have nearly monopolized the markets of the world. Both classes of these are made entirely by hand, and it was not until 1850 that the plan of employing machinery for the purpose was suggested. This originated with Mr. A. L. Dennison and Edward Howard of Boston, who erected a watch-factory at Roxbury, Mass.; but the site being found unsuitable, on account of the dust, the establishment was in 1854 removed to Waltham, where it still remains, its products constituting the "Waltham" watches of the "American Watch Company," now so generally and favorably known. The factory is located at Waltham, is on the banks of the Charles River, and is a chain of buildings, roofing nearly two acres, and inclosing a flower-garden. The company's

product amounts to about $ 1,500,000 per year. It turns out commonly about 350 movements a day, or 105,000 per year, and 4,000 silver cases a month; in the production of which about 900 workpeople are employed, half of them women.

The underlying principle which gives their excellence to these watches consists in the fact that each part is made by a machine specially constructed for the purpose, which imparts to it an accuracy far beyond that attainable by the most skilled hand-labor, nothing being left to the eye or hand of the workman. Every piece is accurately gaged, some of the gages employed being capable of measuring to the $^1/_{17000}$ part of an inch. Each piece is thus capable of replacing the corresponding piece in every other watch of the same class, and any number having been assembled to form so many complete watches, from lots taken at random, each watch will be equally perfect, requiring merely to be regulated. Among these parts are screws so minute that it takes nearly 150,000 to weigh a pound. The jewels, with their caps, are also formed by machinery, in a more perfect manner than was formerly done by hand.

One feature claimed as an excellence in these watches consists in dispensing with the fusee, chain, and main-wheel, and their appendages, thus reducing the number of separate parts from 800 to 158, the chain alone being composed of several hundred pieces. This enables the watch to be produced at much less cost, reduces the chances of failure from flaws in the workmanship, and diminishes by one half the friction on the train, enabling thinner and lighter springs to be used, which are more durable and equable in their action. The parts removed, moreover, were the most difficult and expensive to repair. The wide and free motion of the isochronous balance proves quite sufficient to govern and equalize the movement of the train.

After a watch is designed and modeled, and all the special machinery and tools necessary to its reproduction are built, the manufacture of all its several parts begins nearly simultaneously in the several departments. First there is the press-room, where most of the pieces, whether of brass, steel, nickel, silver, or gold, get their crude forms from punches and dies. Next in the frame-rooms all those punched pieces which form what is called the frame or foundation of the watch are completely shaped by turning, milling, or drilling in thousands so precisely alike that they require, when they are put together as single frames, no selection or fitting. These frames are then taken to the engraving department, where they are duly numbered and engraved with their proper trade-marks. Meantime, in the dial department, in the steel-work department, in the wheel and pinion rooms, the balance and escapement rooms, all the other parts of the watch have been started, and are going forward, through a thousand processes, to meet the frame in the jeweling and springing departments, where the movement is assembled and set going for the first time. Nearly the last process is the gilding, after which the watch is finally put together and regulated for sale.

Nearly a thousand processes are used in producing the complete watch, the balance-wheel alone undergoing eighty-four distinct operations.

The watches made are of fifteen general kinds, distinguished by shape and size. These are subdivided into 150 varieties, in which the differences are of finish, number of jewels, construction of the balance and escapement, etc. This is independent of casing.

See also under the following heads: —

Alarm-watch.	Repeating-watch.
Case-winding watch.	Stem-winding watch.
Center-seconds watch.	Stop-watch.
Chronometer-watch.	Watch-alarm.
Independent-seconds watch.	Watch-glass.
Lepine watch.	Watch-key.
Lid-winding watch.	Watch-spring.
Pendant-winding watch.	

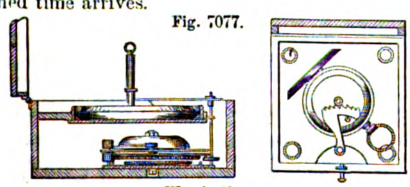
Other watches are distinguished by their escapements. See ESCAPEMENTS. See also HOROLOGICAL INSTRUMENTS.

2. (*Pottery.*) A trial-piece of fire-clay so placed in a pottery-kiln as to be readily withdrawn, to enable the workmen to judge of the heat of the fire and the condition of the ware.

Watch-a-larm′. An instrument with going works to sound an alarm at a specified period. It is found in several forms.

a. An attachment to a watch, by which the latter operates the alarm-mechanism when the predetermined time arrives.

Fig. 7077.



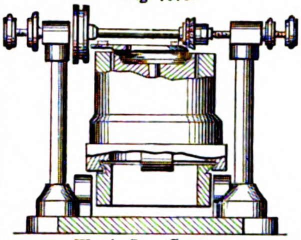
Watch-Alarm.

b. An instrument with works arranged to trip an alarm after a certain lapse of time, as may be determined.

Watch-case Cut′ter. A machine for cutting the hinge-recesses in watch-cases.

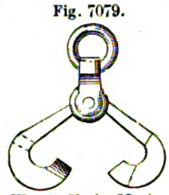
The cover or center is clamped to a block which rests upon a disk that is vertically adjustable in a cylindrical turret upon the carriage, and is brought in contact with the rotary cutter to form the hinge-recess.

Fig. 7078.



Watch-Case Cutter.

Fig. 7079.



Watch-Chain Hook.

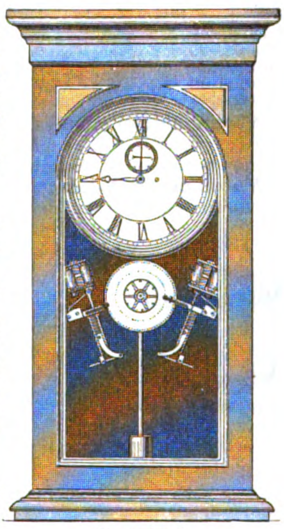
The block has a concave end to receive the convex side of the cover, and the same or another block has a convex or frusto-conical end to receive the concave side of the cover. The upper side of the cover rests against a removable plate and is clamped thereto by the upward movement of the block.

Watch-chain Hook. A *breguet* or mousing-hook.

In the instance represented, the saddle is united to the mousing-hooks by a joint-pin, and has a swivel-ring for the attachment of the chain-ring.

Watch-clock. A clock having electro-magnetic devices for recording by means of a pencil on a paper-dial the time at which a watchman touches a knob, or turns a key at each of a number of stations on his round, each station being connected by a wire with the recording mechanism.

Fig. 7080.



Watch-Clock.

The time at which every station was visited, and that occupied in making the entire round, is thus indicated. The paper-dials are changed daily, and the recording instruments for a number of watchmen may be combined in the same case. The clock shown in the illustration is adapted for two watchmen. See also ELECTRO-MAGNETIC WATCH-CLOCK.

Watch-di′al.

Watch-dials are usually made of thin sheet-copper cut into squares, then into circular disks, and worked to the proper convexity in a concave die by means of a pressing-tool. The necessary holes are then punched and dressed, and a fine glass enamel applied to the exterior side, the inner surface being coated with an inferior sort. This is principally effected with a small spatula. It is then baked in an enameling furnace, and finally the figures and dots for the minutes and seconds are painted on in colored enamel, applied by a camel's-hair brush.

Watch-glass. The commonest kind of watch-glasses are simply cut from blown-glass globes and afterward finished by trimming the edge, and more or less perfect smoothing.

The flattened kind are formed from similar globes by first applying a glass of given size to the globe, and striking all around with a red-hot pipe-tube, which breaks out an irregular circle, the angles of which are afterward roughly rounded by means of a dull chisel. 2. These are placed in fire-clay molds of proper size and curvature, and are heated for a few moments

in a muffle to soften the glass, which is then dabbed with a paper pad, causing it to take the form of the mold. 3 The surplus material at the edge is taken off with a wide flat chisel. 4. The glass is stuck with pitch upon a wooden chuck, and the bezel is roughly ground on a grindstone with sand; it is next placed in a lathe, and the bezel finished with pumice-stone. 5. It is smoothed upon a vertical wheel by the action of pumice-powder and water. 6. Polished upon a horizontal wheel with rouge or tin ashes (oxide of tin obtained by calcination). The glasses are finally assorted by gaging into the different sizes known to the trade.

Watch-jew'el. A diamond, sapphire, ruby, chrysolite, aqua-marine, or garnet, used for the pivot-hole of a watch to reduce friction and wear. The invention of Nicolas Facio, of Geneva, about 1700.

The list is in the relative order of their hardness. The precious stones are cut into slips by circular saws, and afterward broken into cubes. Then each is turned out in a lathe, fixed in its setting, drilled, and secured in the plate by screws.

In the Waltham Watch Company's works these operations are effected by a beautiful series of machines.

Watch-key. An instrument with a socket to fit the *fusee square* or *winding arbor* of a watch, whereby the watch is wound.

The key with a click and ratchet, and which is only effective when turned in the proper direction, is the invention of Breguet of Paris.

Watch'mak-er's Files. These files are of various kinds and grades, as to size, degree of taper, coarseness of cut, shape, safe-edged, or otherwise.

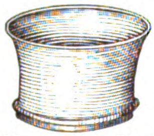
Among the varieties specially described under their names alphabetically, are a number adapted to watchmaker's uses; but the following, whose names are derived from their special adaptation or application to particular parts, are not included in the enumeration.

Balance-wheel.	Oval dial.
Banking.	Piercing.
Barrel-hole.	Pivot.
Clock-pinion.	Shouldering.
Clock-slitting.	Swing-wheel.
Endless screw.	Verge.
Flat dovetail.	Watch-pinion.
French pivot.	Watch-slitting.
Nicking.	See also FILE.

Watch'mak-er's Glass. A double convex lens set in a tubular socket, adapted to be held to the eye by the contraction of the orbital muscles.

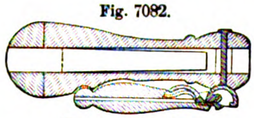
Watch'man's A-larm'. In the olden time the watchmen were provided with rattles, consisting of a ratchet-wheel and a spring tongue, which clicked loudly as it snapped

Fig. 7081.



Watchmaker's Glass.

Fig. 7082.



Watchman's Alarm.

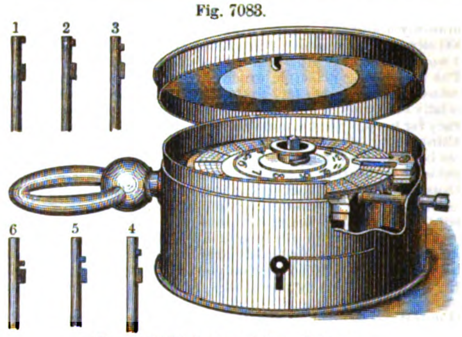
on each tooth as the rattle was revolved upon the axis of the ratchet.

Modern times have developed other means of sounding an alarm, such as striking upon the pavement with a club, blowing a whistle, exploding a torpedo, or firing a pistol.

Watch'man's Time-de-tect'or. Fig. 7083 shows an instrument carried by a watchman who visits the various places on his beat where the keys are within reach. Six keys are shown for as many watchmen, and when inserted in the watch will prick a hole at a point opposite to the hour at which the visit is made, and each man's record in his own row. See also Fig. 7080.

The clock (Fig 7084) has a small central slate-edged dial over the main dial, and its face is protected by a plate of glass having a perforation large enough to admit a pencil, by which a mark may be made on the small dial; this is connected with and carried around by the hour-hand, so that the time at which each mark is made is shown; and if the watchman omits to perform this duty at the proper time, the absence of the corresponding mark shows the fact. The marks are readily wiped off from the slate. Paper dials, which may be filed away as records,

Fig. 7083.

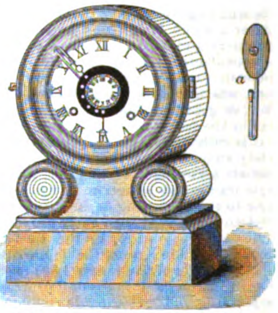


Buerk's Watchman's Time-Detector.

can also be used. *a* is a reverse view of the sub-dial, showing its means of connection with the clock.

The time-indicator used on the French railways (1853) is the invention of M. Aresa. It is also used in other public establishments guarded by police or watchmen.

Fig. 7084.

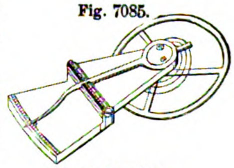


Watchman's Time-Detector.

A sort of table-clock is placed at a particular spot, at which the watchman must be at every quarter of an hour during his night-patrol; at that time he is required to press his finger on a stud or button, which is the only part of the apparatus at his command. Beyond this he knows or does nothing in the matter; but when the clock-case is opened next day by a superintendent, a circular graduated card is found to be pierced with as many small holes as the guard had made pressures on the stud; and the card also shows the exact hour and minute when each hole was pierced. The mechanism is very simple; the circular card or paper is made to rotate by connection with the hour-wheel of the clock, and the button or stud acts upon a sharp needle, which pierces the card. If the card is not pierced opposite to a particular quarter of an hour, the conclusion is drawn that the guard has failed in vigilance.

Watch-reg'u-lat'or. (*Horology.*) A lever for regulating the effective length of the balance-spring, in order to affect the pulsations of the latter, and so of the rate of going of the watch.

Fig. 7085.



Watch-Regulator.

In Fig. 7085, by turning the screw, delicate adjustment is given to the arm of the regulator, whose outer end has a finger resting on the graduated scale.

Watch'-spring. The steel spring which drives the watch-movement.

Watch-springs are hammered or rolled out of round steel wire, of suitable diameter, until they fill the gage for width, which at the same time insures equality of thickness; the holes are punched in their extremities, and they are trimmed on the edge with a smooth file. The springs are then tied up with the binding-wire in a smooth coil, and heated over a charcoal fire on a perforated revolving plate; they are then hardened in oil and *blazed off*. This latter term refers to the inflammation of the grease when they are held over a fire after being hardened. See TEMPERING.

The spring is now distended in a long metallic frame, similar to that used for a saw-blade, and ground and polished with emery and oil, between leaden blocks. Its elasticity is restored by a subsequent hammering on a very bright anvil, which *puts the nature into the spring*.

The coloring is done over a flat plate of iron, or hood, under which a little spirit-lamp is kept burning; the spring is continually drawn backward and forward, about two or three inches at a time, until it assumes the orange or deep blue tint

throughout, according to the taste of the purchaser; by many the coloring is considered to be a matter of ornament, and not essential. The first process is to coil the spring into the spiral form, that it may enter the barrel in which it is to be contained; this is done by a tool with a small axis and winch-handle, and does not require heat.

The balance-springs of marine chronometers, which are in the form of a screw, are wound into the square thread of a screw of the appropriate diameter and coarseness; the two ends of the spring are retained by side-screws, and the whole is carefully enveloped in platinum-foil, and tightly bound with wire. The mass is next heated in a piece of gun-barrel closed at the one end, and plunged into oil, which hardens the spring almost without discoloring it, owing to the exclusion of the air by the close platinum covering, which is now removed, and the spring is *let down to the blue*, before removal from the screwed block.

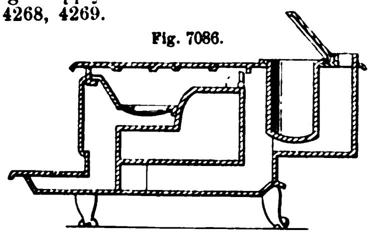
In hardening them, they are heated by being drawn backward and forward through an ordinary forge fire, built hollow, and they are then immersed in a trough of plain water. In tempering them, they are heated until the black red is just visible at night; by daylight the heat is denoted by its making a piece of wood sparkle when rubbed on the spring, which is then allowed to cool in the air.

Watch-tack'le. (*Nautical.*) A luff-tackle with a *tail* double-block and a hook single-block. See TAIL-TACKLE.

Wa'ter-an'chor. A *drag-anchor*. A sail spread on spars and thrown overboard to keep a vessel's head to the wind, or to prevent her drifting so fast. See DRAG-ANCHOR, Fig. 1738, page 737.

Wa'ter-back. A permanent reservoir at the back of a stove or range, to utilize the heat of the fire in keeping a supply of hot water. See also RESERVOIR, Figs. 4268, 4269.

Fig. 7086.

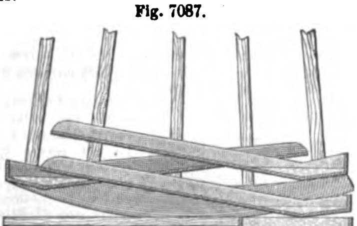


Stove Water-Back.

Wa'ter-bal'ance. An oscillating, pendulous frame, having a series of troughs in vertical series and inclined in alternate directions, so that, as the frame oscillates, the water dipped by the lower one shall be poured into the next above, which, on the return motion, shall pour it into the next, and so on.

It is an old contrivance, and is susceptible of a variety of modifications, which are cited in some of the older works on hydraulics.

Fig. 7087.



Water-Balance.

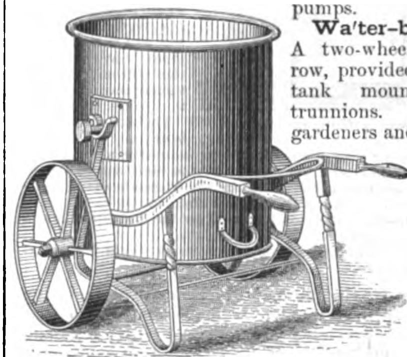
Wa'ter-ba-rom'e-ter. One in which water is employed instead of mercury for indicating the fluctuations in atmospheric density.

An instrument of this kind was constructed in 1832 by Professor Daniell in the hall of the Royal Society; the glass tube, in one piece, was 40 feet long, and about an inch in diameter. Originally, the water in the cistern was covered with a layer of castor oil, but this was found not to prevent the access of the exterior air; it became necessary to refill the tube in 1845, when a solution of caoutchouc in naphtha was substituted for the oil. The average hight of the column of water in the tube was 400 inches, and its sensibility was much greater than that of mercury, so that in windy weather it appeared to be in a state of perpetual fluctuation. Its indications also preceded by an hour those of the mercurial barometer of $\frac{1}{4}$-inch bore, which precedes by a similar interval the mountain-barometer of 0.15-inch bore.

Wa'ter-bar'rel. (*Mining.*) A large wrought-iron barrel with a self-acting valve in the bottom, used in drawing water where there are no pumps.

Wa'ter-bar'row. A two-wheeled barrow, provided with a tank mounted on trunnions. Used by gardeners and others.

Fig. 7088.



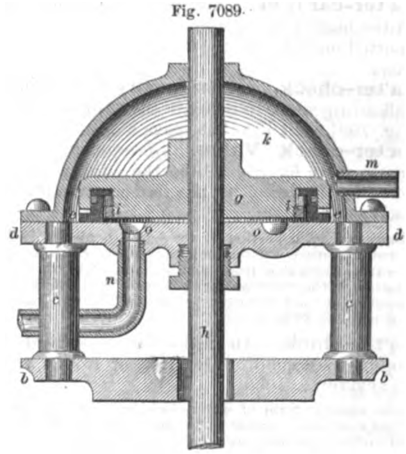
Water-Barrow.

Wa'ter-bath. A means of heating an object by application of hot water to the vessel containing it. See Chambers's "Encyclopedia," Fig. on page 398, Vol. VII.

Wa'ter-bear'ing. A device in which water or steam pressure is employed to counterbalance the downward pressure upon a rotating shaft, thereby obviating friction.

In Shaw's (Fig. 7089), water from a pump, or steam, is admitted through a pipe *n* communicating with an annular groove *o* in the plate *d*, supported by pillars *c c* resting on the bed-plate *b*. To the rotary shaft *h* is attached the disk *g*, having a circular groove near its edge for receiving the annular piston *e*, which bears upon the upper face of the plate *d* until the pressure exceeds a certain regulated amount; when this is exceeded, the disk *g* rises until the ring *i* surrounding the disk touches the upper inwardly projecting part of the piston, lifting it clear of the plate, and allowing the fluid to escape into the dome-shaped chamber *k*, whence it is drawn off by the pipe *m*.

Fig. 7089.



Water-Bearing.

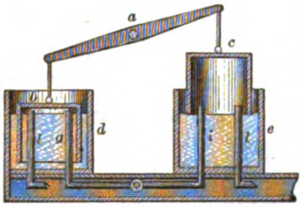
See also PALIER GLISSANT, Fig. 3496; HYDRAULIC PIVOT. Described in Bramah's English patent, 1802.

Wa'ter-bel'lows. A form of blowing-machine invented by Hornblower.

It consists of two or more inverted vessels *b c* suspended from the ends of a working-beam *a*, and alternately rising and falling in the cisterns *d e*, which are nearly full of water. Induction

and eduction pipes pass from below upward into the cisterns, their upper open ends being above the level of the water. *h* is the eduction-pipe, with branches *g i* to the air-spaces beneath the inverted vessels. *l* are the eduction-pipes leading to a common trunk, by which the air is discharged. The induction-pipes *g i* have valves on top, and the eduction-pipes *l* have valves at the bottom, so that the air cannot pass in the wrong direction.

Fig. 7090.



Hornblower's Blowing-Machine.

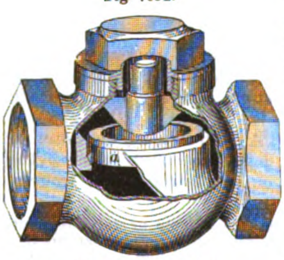
The action is as follows: —

As the vessel *c* rises, air passes by the induction-pipe *i* to the space in the said vessel, the vessel *b* at the same time descending and driving the air contained therein by means of the eduction-pipe *l* to the exit. When the working-beam *a* oscillates in the other direction, the vessel *c* becomes the induction and *b* the discharging vessel.

This is a common form of water-bellows in air and gas carbureting machines.

Wa'ter-bosh. A metallic basin in a puddling or boiling furnace, which is made double, so that water may circulate therethrough to protect the furnace from the destructive action of heat and cinder.

Fig. 7091.



Water-Check Valve.

Wa'ter-bridge. (*Steam.*) A low vertical partition at the back of a furnace to deflect the flame upward. The bridge is hollow and connected with the water-space of the boiler, of which it forms a part.

Wa'ter-car'ri-er. A form of water-elevator in which the bucket lifted from the well or cistern is transported on wires to the house at a considerable distance.

Wa'ter-check. A check-valve, belonging to the Giffard injector, to regulate the supply of water. See Fig. 7091, and Fig. 123, page 56.

Wa'ter-check Valve. (*Steam-engine.*) An automatic valve for controlling the supply of water delivered to the boiler by the feed-water pipe. See CHECK-VALVE.

In the example, a portion of the liquid is always inclosed in the annular space surrounding the disk *a*, which in falling to its seat is prevented from coming immediately in contact with the metal, the water acting as a cushion. The disk and seat therefore are not distorted by hammering, and the valve is almost noiseless in its action.

Wa'ter-clock. An instrument to indicate the time by the passage of water into or from a vessel. See CLEPSYDRA.

A more modern form of water-clock was invented in the seventeenth century, probably by an Italian ecclesiastic at Bologna; or by a pewterer at Sens, in Burgundy.

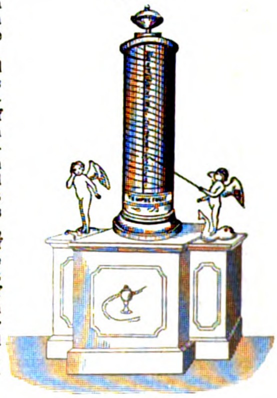
It consists of a cylinder divided into several small cells, and suspended by a thread fixed to its axis, in a frame on which the hour distances, found by trial, are marked out. As the water flows from one cell into the other, it changes very slowly the center of gravity of the cylinder and puts it in motion, much like the quicksilver puppets invented by the Chinese.

Beckmann refers to an alarm-apparatus attached to one of these clocks "which consists of a bell and small wheels, like those of a clock that strikes the hours, screwed to the top of the frame on which the cylinder is suspended. The axis of the cylinder, at the hour when one is desirous of being wakened, pushes down a small crank, which, by letting fall a weight, puts the alarum in motion. A dial-plate with a handle is also placed, sometimes, over the frame."

An instrument of the kind presented by Haroun al Raschid to the Emperor Charlemagne had a striking-apparatus. When the 12 hours were completed, 12 doors opened on its face, and from each rode forth an automaton horseman, who waited until the striking was over, and then rode back again, closing the door behind him.

Fig. 7092 illustrates one in which the descent of the water and its accumulation in the reservoir forming the base cause the two figures with wings to rise, the one with the wand pointing out the hours.

Fig. 7092.



Water-Clock.

"The clepsydra is still used on board the *praus* of the Malayan Archipelago. It is a bucket half filled with water, in which floats the half of a well-scraped cocoa nut shell. In the bottom of this is a small hole, so that a small jet rises in the shell, which is gradually filled thereby, and so nicely is the size of the hole graduated to the capacity of the shell, that it sinks exactly at the end of an hour. The man on watch then cries out the number of hours from sunrise, and sets the shell afloat again empty." — WALLACE'S *Malayan Archipelago.*

Wa'ter-clos'et. A commode with water-supply to empty the basin and carry off the contents.

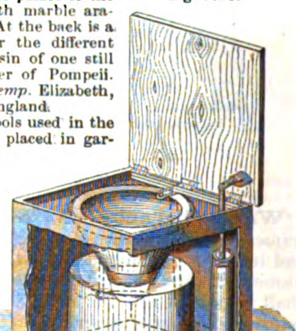
The water-closet in its essential features, was invented by Bramah. These features may be described as a pan, a discharging valve, and a water-cock which comes into action as the discharge-valve is opened.

The water-closet of the palace of the Cæsars was adorned with marble arabesques and mosaics. At the back is a cistern with faucets for the different seats. The pipe and basin of one still remain near the theater of Pompeii. Sir John Harrington, *temp.* Elizabeth, introduced them into England.

The portable close stools used in the reign of Elizabeth, and placed in garrets, were called *ajaxes*.

Fig. 7093 is a portable, self-acting water-closet.

Fig. 7093.



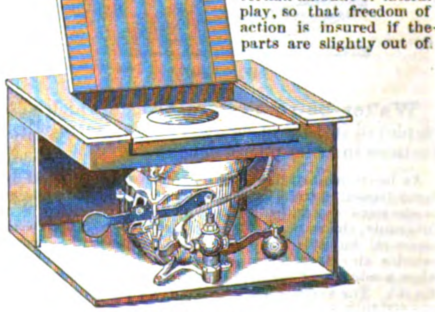
Portable Water-Closet.

In that shown in Fig. 7094, depressing the seat pushes down a rod connected to a weighted lever, which opens the water-pipe valve, and also to the end of a second weighted lever, which opens the valve at the bottom of the pan. On the removal of the pressure, the weighted levers automatically close the valves.

In one form of closet there is a jet for the purpose of applying a douche in cases of hemorrhoids.

In the Carr closet (Fig. 7095), the valve-pull operates through a series of jointed levers having a certain amount of lateral play, so that freedom of action is insured if the parts are slightly out of

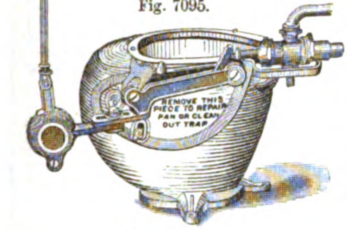
Fig 7094.



Water-Closet.

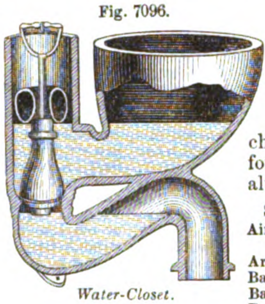
their proper adjustment. By removing the front piece of the container, the pan may be removed and replaced, and the trap of the closet cleared, if foul, without interfering with the other parts or shutting off the water-supply.

Fig. 7095.



Water-Closet.

Fig. 7096.



Water-Closet.

Fig. 7096 is the Jennings water-closet.

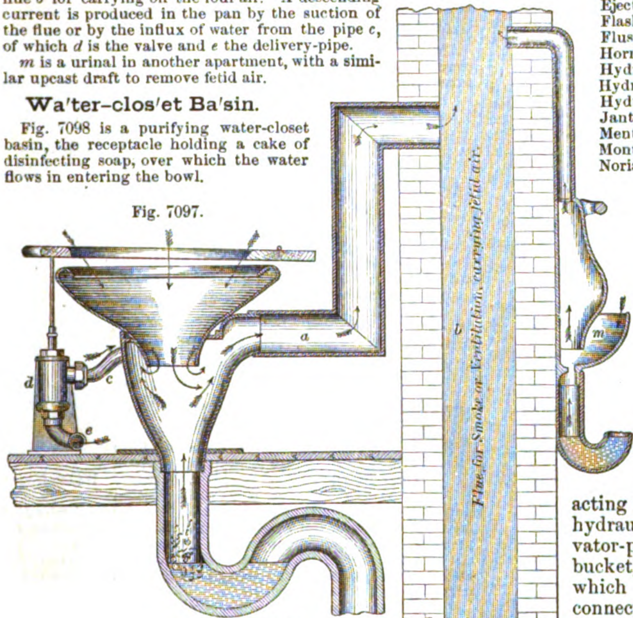
Fig. 7097 illustrates R. D. O. Smith's ventilating water-closet. It is provided with a pipe *a* leading into a ventilating pipe or flue *b* for carrying off the foul air. A descending current is produced in the pan by the suction of the flue or by the influx of water from the pipe *c*, of which *d* is the valve and *e* the delivery-pipe.

m is a urinal in another apartment, with a similar upcast draft to remove fetid air.

Wa'ter-clos'et Ba'sin.

Fig. 7098 is a purifying water-closet basin, the receptacle holding a cake of disinfecting soap, over which the water flows in entering the bowl.

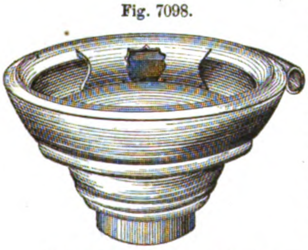
Fig. 7097.



Smith's Ventilating Water-Closet.

Wa'ter-clos'et Valve. One adapted to be brought into operation by the handle, and also limit the amount of water supplied to empty and cleanse the pan.

Fig. 7098.



Purifying Water-Closet Basin.

Wa'ter-cool'-er. One in which water and ice are cased with a non-conducting material to prevent access of heat. See pages 1169, 1170.

Wa'ter-core. 1. A body of water occupying a hermetically closed axial cavity in a car-axle, for the purpose of conducting away heat from the journals. See patent No. 136,791. 2. A hollow core containing flowing water used in some modes of casting.

Wa'ter-crane. A goose-neck apparatus for supplying water from an elevated tank to the tender of a locomotive-engine. See TANK.

Wa'tered Goods. See WATERING; MOIRE.

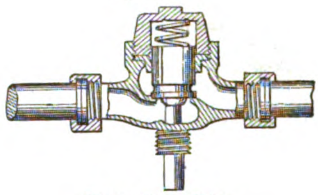
Wa'ter-el'e-va'tor. 1. A device for raising buckets in wells.

The forms are various; the special arrangements being for tipping, discharging, and returning the buckets; for acting upon counterbalancing buckets alternately, etc.

See under the following heads: —

Air as a water-elevator.	Persian wheel.
Archimedean screw.	Picotah.
Baling-machine.	Pot-wheel.
Bascule.	Pump (varieties; see PUMP).
Bucket-wheel.	Ram. Hydraulic
Cane. Hydraulic	Scoop.
Chapelet.	Scoop-wheel.
Driven well.	Screw. Archimedean
Dutch-scoop.	Shadûf.
Ejector.	Steam water-elevator.
Flash-wheel.	Sweep.
Flush-wheel.	Turbine.
Horn-drum.	Tympanum.
Hydraulic belt.	Water-appliances (see list under HYDRAULIC ENGINEERING, etc.).
Hydraulic cane.	Water-balance.
Hydraulic ram.	Water-carrier.
Jantee.	Water-screw.
Mental.	Well-bucket elevator.
Monte-jus.	
Noria.	

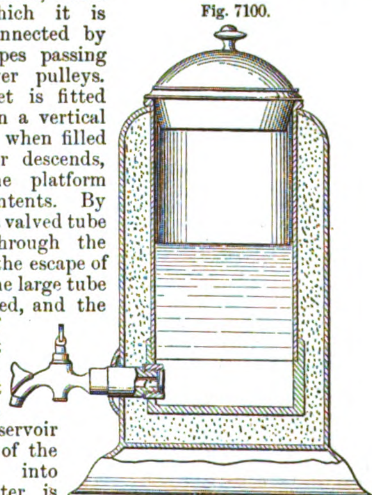
Fig. 7099.



Water-Closet Valve.

2. An elevator for warehouses and other buildings, operated by water acting through the medium of gravity or by hydraulic pressure. In one form, the elevator-platform is balanced by a large iron bucket, with which it is connected by ropes passing over pulleys. The bucket is fitted air-tight in a vertical shaft, and when filled with water descends, raising the platform and its contents. By means of a valved tube passing through the platform, the escape of air from the large tube is controlled, and the rapidity of descent regulated. The bucket is filled from a reservoir at the top of the building, into which water is pumped by a

Fig. 7100.

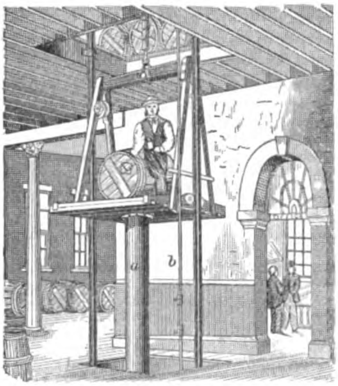


Water-Cooler.

steam-engine. See HYDRAULIC ELEVATOR; ROPE-ELEVATOR; etc.

In Fig. 7101, the pillar *a* on which the platform is sustained is the ram of a hydraulic press, the cistern of which is located beneath the floor of the lowest story from which the goods are to be elevated. The rod *b* is employed for operating a cock, by which the water is admitted to or shut off from the cylinder to raise or to suspend the platform.

Fig. 7101.



Water-Elevator.

On forcing water into the cistern in which the ram *a* works, it, with the platform, is caused to rise, and is lowered by opening a cock, which allows the water to escape and the apparatus to descend by its own gravity, at a rate proportioned to the size of the efflux opening.

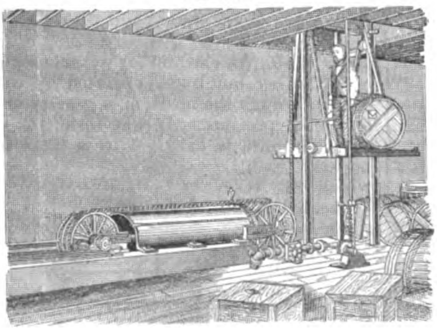
Fig. 7102 is another form, in which a ram in a water-cylinder actuates a set of sheaves, and works a rope from which the cage is suspended. See ROPE-ELEVATOR.

Wa'ter-en'gine. 1. One driven by water, as a WATER-WHEEL (which see, for a list of varieties).

2. The term is somewhat more definitely applied to an engine in which water under pressure of a head acts upon a piston. See HYDRAULIC ENGINE; WATER-MOTOR.

Engines of this kind are employed in some mines on the Continent of Europe. They are either double or single acting. In the first class, the motion of a descending column of water entering below the piston of a suitable cylinder with open top is

Fig. 7102.



Hydraulic Elevator.

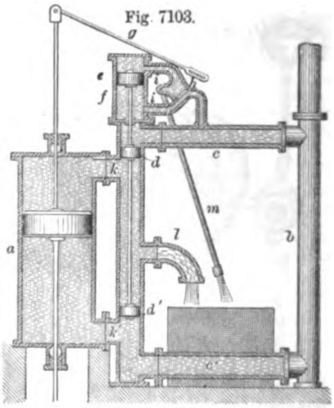
caused to lift the piston, which, when the water is withdrawn, descends by atmospheric pressure. The alternate induction and eduction are automatically effected by appropriate valve connections through pipes at the bottom of the cylinder.

In the double-acting water-engine (Fig. 7103), the cylinder *a* is closed at both ends, and has a vertical supply-pipe *b*, communicating with the cylinder through the two horizontal pipes *c c'*, each of which alternately serves for induction and eduction. The pistons *d d'* are on the same rod with the piston *e* contained in a cylinder *f* above and separated from that which contains the two lower pistons. A lever *g* attached to the piston-rod of the main cylinder *a* is connected with a four-way cock *h*, which is, by the back-and-forth movement of the said piston-rod, caused to admit water through the pipes *i i* alternately above and below the piston *e*, which thus throws the pistons *d d* into such position as that each of the openings *k k'* by turns receives water from the pipes *c c'* and communicates with the discharge-pipe *l*. The small pipe *m* serves as the eduction for the cylinder *f*.

See also WATER-ELEVATOR; and list under HYDRAULIC ENGINEERING.

Wa'ter-float. A device in a cistern, boiler, etc., which, floating on the water, actuates a valve. See WATER-GAGE.

Fig. 7103.



Water-Engine.

Fig. 7104 has a stone which is so far counterbalanced by the suspended ball as to float on the water and actuate a valve when the water is too high or too low in the steam-boiler.

Wa'ter-frame. A name conferred upon the spinning-machine invented by Arkwright, and patented 1769.

The term *frame* was commonly applied in the midland counties of England, where the cotton, wool, and flax manufactures most abounded, to a mechanical structure in a wooden framework. Such were the *silk-frame*, *stocking-frame*, and *lace-frame*.

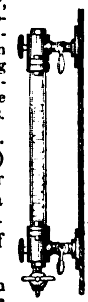
Fig. 7104.

Water-Float.

The *water-frame* was so named because its enterprising inventor, who first brought together the various machines for working on cotton, organizing them into a mill, employed water as the motor. See THROSTLE.

Wa'ter-gage. (*Steam-engine.*) An instrument or attachment to a steam-boiler to indicate the depth of water therein.

Fig. 7105.

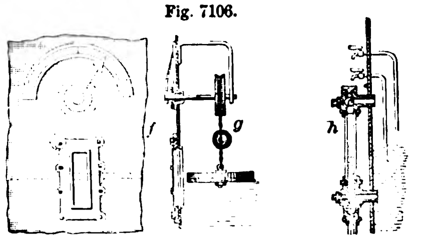


Water-Gage.

The ordinary form of a water-gage is a strong glass tube placed in a vertical position outside the boiler, and communicating at top and bottom by metallic tubes with the interior of the boiler. The tubes are provided with stop-cocks, by which access of steam or water is cut off when desired. The water enters at the lower end, and steam at the upper end, the water-level in the tube coinciding with that in the boiler.

Another *water-gage* takes the form of a *float* in the boiler, and a protruding stem, whose rise against a graduated index shows the condition as to level of the water in the boiler.

Fig. 7106.



Water-Gages.

f and *g* are views of a *window-gage*, so called because a pane of glass in front of the boiler shows the float and the water-level. The float is suspended by a string over a wheel, whose oscillations move the finger on the dial.

Another form of glass-gage (*h*) is a tube having connection through hollow posts with the interior of the boiler, above and below the water-line respectively. The hight of the water in the glass tube coincides with that in the boiler. Above it are gage-cocks.

Other water-gages are in the form of alarms: —

1. A tube let in to the top of the boiler has an open end descending below the proper water-line, and is crowned above with a whistle When the water sinks below the desired level the water retreats from the tube, the steam enters and sounds the alarm

2. A disk of fusible metal is placed in position in a tube, such as that last described. As long as the column of water is sustained in the tube by the pressure of steam within the boiler, the fusible disk remains intact; but when the water-level subsides below the mouth of the tube, the water runs out, steam rushes in, and the heat of the latter fuses the metal and the steam escapes, sounding an alarm.

3. A tube similar to the foregoing has a thermostatic rod, which, so long as the tube is filled with water, is not brought into action; but, as soon as the water leaves the tube and it becomes filled with steam, the metal is expanded by the increment of heat and actuates a valve-rod, which opens an escape for the steam and sounds an alarm.

See also LOW-WATER ALARM.

Wa'ter-gas. Gas obtained by the decomposition of water. Water in the form of steam is passed over red-hot coke, resolving it into hydrogen and carbonic oxide, the oxygen being absorbed. The hydrogen and carbonic oxide are then passed through a retort, in which carbonaceous matter, such as resin, is undergoing decomposition, absorbing therefrom sufficient carbon to render it luminous when burnt. See English patents, Cruickshanks, 1839; White, 1849.

Wa'ter-gate. A water-plug or valve.

Wa'ter-gild'ing. A mode of gilding by an amalgam in which the articles are pickled and then dipped in or brushed with a dilute solution of nitrate of mercury and gold, called *quick-water*, which leaves a film of amalgam on the surface.

The gold is dissolved in ten times its weight of mercury; the amalgam is strained through leather and dissolved in dilute nitric acid. After dipping, the articles are exposed to heat in a cage within a furnace, and the mercury thus driven off. The gold surface is then polished with a bloodstone-burnisher.

Wa'ter-glass. A silicate of soda or potash soluble in boiling water, and applied to various purposes in the mechanical and fine arts. See SOLUBLE GLASS.

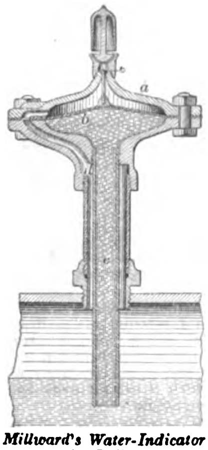
Wa'ter-heat'er. See HEATING-APPARATUS.

Wa'ter-hole. (*Mining.*) A place where the water collects; a *sump*.

Wa'ter-in'di-ca'tor. A *float*, *gage-glass*, etc., arranged to show the hight of water in a boiler or tank (see WATER-GAGE); or to give an alarm if it be decreased below a certain level. See WATER-GAGE; LOW-WATER ALARM, page 1359.

Millward's indicator is designed for showing that there is either an excess or deficiency of water in the boiler.

Fig. 7107.



Millward's Water-Indicator for Boilers.

The low-water indicator is shown in Fig 7107. It consists of a chamber *a*, divided by an elastic diaphragm *b* into two portions, the lower one of which is filled with water, and communicates by the pipe *c* with the water in the boiler; a passage *d* establishes a communication between the steam-space and the upper division of the chamber *a*. Connected to the top of the diaphragm *b* is an upwardly opening valve *e*, raised when in normal position by the tension of the diaphragm. So long as the level of the water in the boiler does not fall below the lower end of the pipe *c*, the downward pressure of the column of water in the pipe, aided by the atmospheric pressure on the upper surface of the valve *e*, more than counterbalances the steam-pressure on the upper surface of the diaphragm; but when the water-level in the boiler falls below the end of the pipe, the water in the latter escapes, and each side of the diaphragm being then exposed to an equal steam-pressure, with the exception of a part equal in area to the valve-seat, which is counterbalanced only by the atmospheric pressure, the elasticity of the diaphragm causes it to assume its normal position, the valve rises, and permits steam to escape.

The high-water indicator is similar in construction, but has a downwardly opening valve, which is closed when the diaphragm is exposed to a boiler-pressure of steam on both sides. It is opened by the deflection of the diaphragm when there is an unbalanced pressure due to the presence in tube *c* of a hydrostatic column.

A piston sliding in a cylinder may be substituted for the diaphragm, and other modifications made in the instrument, without affecting the principle of its construction.

Wa'ter-in-fork. (*Mining.*) When all the water is extracted.

Wa'ter-ing. 1. (*Flax.*) The soaking of flax halm to loosen the *shives* from the *hare* and remove the mucilage. *Steeping; Retting.*

2. (*Fabric.*) A process of giving a wave-like appearance to fabrics, by passing them between metallic rollers variously engraved, which, bearing unequally upon the stuff, render the surface unequal, so as to reflect the light differently. Watering silk is said to have been invented by Octavius May, at Lyons, seventeenth century. See MOIRE, etc.

In 1780, the mode of ornamentation was by pressing between figured steel plates. Steel cylinders were introduced afterward.

"Moire silk for watering is made of double width, which is indispensable in obtaining the bold waterings, for these depend not only on the quality of the silk, but greatly on the way they are folded when subjected to the enormous pressure in watering. They should be folded in such a manner that the air which is contained between the folds of it should not be able to escape easily; then, when the pressure is applied, the air, in trying to effect its escape, drives before it the little moisture that is used, and hence causes the watering. The pressure is from 60 to 100 tons." — BAMBER.

Wa'ter-ing-bri'dle. For artillery service it is composed of one bit and one pair of reins. The bit is of blued wrought-iron, made in two pieces united at the middle by a loop hinge. Their ends have holes to receive the two rings to which the reins are sewed. Two chains and toggles are welded into the rein-rings. The reins are sewed to each other at one end, and to the rings at the other.

Wa'ter-ing-buck'et. In the United States service the regulation bucket is made of sole leather, fastened with copper rivets and having a copper rim. These are very durable, but expensive. A much cheaper bucket is made of gutta-percha, but it has not the endurance of the leather article.

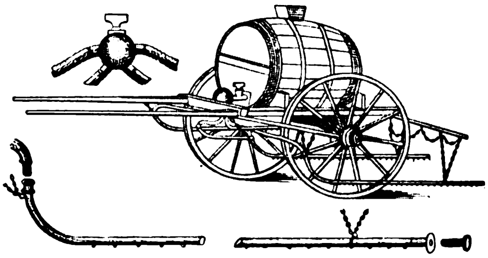
Wa'ter-ing-can. (*Founding.*) This, with a rose, is of the usual form employed by gardeners, but, like the shovel and sieve, is so indispensable a molder's implement with which to keep the sand of the right degree of moisture, that it should be cited here.

Wa'ter-ing-cart. A cart designed for watering plants in drills.

It was designed by Young (Scotland), and has 4 pipes, each having 20 small orifices; the 4 pipes are intended to pass along as many drills, sprinkling each. The barrel is estimated to carry 200 gallons. The tubes are 5 feet long, ¾ inch caliber; the aspersion taking place through an opening of 1/16 inch.

The water in the reservoir will be discharged in 2 hours 20 minutes. A horse going 2½ miles per hour will go 5⅚ miles in the time. The width of ground covered by the 4 pipes is 6¾

Fig. 7108.



Watering-Cart.

feet. The area of the surface watered from 1 barrelful in the time mentioned will be over 4¾ acres.

Wa'ter-ing-pot. Mentioned by Pollux, and much later by Montfaucon, Du Cange, and Shakespeare.

Wa'ter-in-ject'or. A form of pump used on steam-boilers. See INJECTOR.

Wa'ter-laid. (*Rope.*) Coiled "against the sun," that is, over to the left. *Cablet.*

Wa'ter-laid Rope. Rope laid up and twisted "against the sun," as it is termed; in contradistinction to *right-hand* rope.

Wa'ter-leg. A vertical water-tube in a steam-boiler connecting other water-spaces and crossing a flue-space by which its contents are heated. In Galloway's boiler the flue is large, and the *water-legs* form stays.

Wa'ter-lev'el. A level consisting of a trough or tube partially filled with water.

A tube with upturned ends will show the level position by the even rising of the water in the ends. This is the *libra aquaria* of the Romans, described by Vitruvius as the *chorobates.* See LEVEL.

Another *water-level* consists of two cups fitted to the ends of a straight cylindrical tube of an inch in diameter and three or four feet long, by which the water freely communicates from one cup to the other. The tube is movable on its stand by means of a ball and socket, and thus the surfaces of the water, when the cups are equally full, show the line of level. This is also described by Vitruvius as the *libra aquaria.*

The cups may constitute chambers, and floating pistons on the surfaces of the liquid may indicate by graduated stems the condition of the level. Invented by Parker.

Wa'ter-line Mod'el. (*Shipbuilding.*) A model formed by board shaped according to the draft-lines on the paper, and laid upon each other to form a solid model. A *key-mold.*

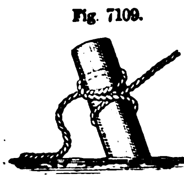
Wa'ter-lines. 1. (*Shipbuilding.*) Ship's lines drawn parallel with the surface of the water, at varying hights. In the *sheer plan* they are straight and horizontal; in the *half-breadth plan* they show the form of the ship at the successive hights marked by the *water-lines* in the sheer plan.

2. (*Nautical.*) The line up to which the hull of a vessel is submerged in the water.

Load water-line: the line to which a ship sinks with all her cargo and stores on board.

Wa'ter-lute. A diaphragm or curtain whose lower edge is submerged in water, and which acts to prevent the passage of air while the liquid is allowed to flow. An *air-trap.*

Fig. 7109.



Waterman's Knot.

Wa'ter-man's Knot. A sailor's mode of bending a rope to a post or bollard.

Wa'ter-mark. (*Paper-making.*) Any distinguishing device or devices indelibly stamped in the substance of a sheet of paper while yet in a damp or pulpy condition.

The practice dates to at least as far back as the early part of the sixteenth century, or soon after the introduction of printing. In the old process of hand paper-making the bottom of the mold was formed of a close series of parallel wires supported by a few others at right angles to them. The impressions of these are distinctly visible in old sheets of paper; but what is distinctively known as the water-mark is made by a wire sewed to the surface of the mold so as to make the paper thinner where it is prevented by the wire from coming in direct contact with the longitudinal wires. The water-marks used by the earlier paper-makers have given names to several of the present standard sizes of paper, as *pot, foolscap, crown, elephant, fan, post,* the latter dating from the year 1670, when a general post-office was established in England, and formerly bearing the device of a postman's horn; the first was in use at least as early as 1580.

Up to the year 1855, the very elaborate water-mark employed by the Bank of England, which for a long series of years had its paper made at one mill in Hampshire, was formed by affixing wires to the molds as above indicated, involving, in a pair of molds for the production of the device, several hundred thousand stitches.

At present, the device representing the water-mark is stamped in the fine wire gauze of the mold itself. The design is engraved on a block, from which an electrotype impression is taken; a matrix or mold is similarly formed from this; these are subsequently mounted upon blocks of lead or gutta-percha, to enable them to withstand the necessary pressure, and serve as a cameo and intaglio die, between which the sheet of wire gauze is placed to receive an impression in a stamping-press. By this means the tones of the original are reproduced in the paper, the deepest shadows of the water-mark corresponding to the deepest engraving on the die, and the lighter shades to the shallower parts. In the hand process, the wire thus treated constitutes the mold itself; but in the machine, it forms the periphery of the *dandy,* or first roller, under which the paper passes in its progress from the vat along the endless wire web, and beneath which are the vacuum-boxes by which the water is sucked out of the pulp.

Wa'ter-me'ter. A device for measuring the amount of water received or discharged through an orifice.

Water-meters may be divided into seven classes: —

1. Those in which the water is passed through a horizontally rotating case having a peripheral discharge, or fixed case containing a horizontal wheel with spiral flanges, like a turbine, and delivering a known amount at each rotation.

2. A piston or wheel with vanes or buckets rotating in a chamber and operated by the pressure of the water. These act on the principle of the rotary steam-engine, and are the converse of the rotary pump, in which the *rotating piston drives the water.*

3. The Archimedean screw rotating in a tube.

4. A piston reciprocating in a cylinder of known capacity. This acts on the principle of the ordinary steam-engine, in which the steam drives the piston, and is the converse of the ordinary force-pump, in which the piston drives the water.

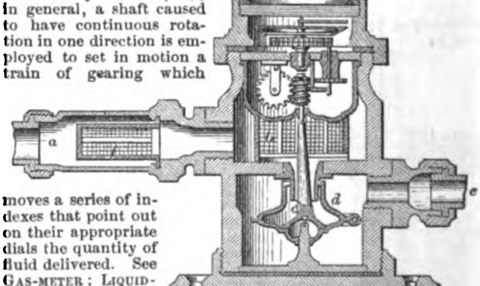
5. The *meter-wheel.*

6. The pulsating diaphragm, which displaces the water from its respective sides alternately, and is the converse of the old Cracknell pump (English).

7. The bucket and balance-beam, in which the reservoirs of known capacity on the respective ends of the beam are alternately presented to catch the water, and are depressed and emptied as they become filled.

Whichever of these principles be adopted, the number of oscillations, reciprocations, or rotations, each of which permits a definite quantity of the fluid to pass through the meter, must be registered by appropriate mechanism. This may be variously modified, but, in general, a shaft caused to have continuous rotation in one direction is employed to set in motion a train of gearing which moves a series of indexes that point out on their appropriate dials the quantity of fluid delivered. See GAS-METER; LIQUID-METER; SPIRIT-METER.

Fig. 7110.



Siemens and Adamson's Water-Meter.

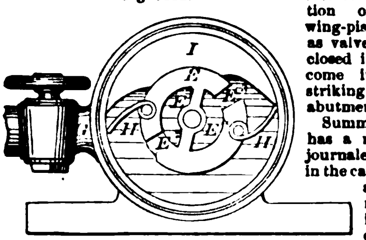
CLASS 1. Siemens and Adamson's meter acts on the principle of Barker's mill. The water is conveyed by a tube *a* to a horizontal drum *d*, rotating on a vertical shaft *c*, having at its upper end a worm which communicates motion to the registering gearing. The drum has three or more tangential apertures at its periphery, and discharges a given amount of water at each revolution, which is carried away by the pipe *e*. *b f* are gratings to arrest impurities.

See also Fig. 2970, *A*, page 1827.

CLASS 2. In Turner's meter (Fig. 7111), water admitted through the pipe *G* enters alternately into the hollow rotary piston *E* through the openings E^2 E^3, and passing behind the pivoted wing-pistons *H H*, causes continuous motion in one

direction. The water entering the chambers $E^1 E^{11}$ is discharged as each port arrives at the eduction opening. The wing-pistons also act as valves, and each is closed in so as to become inoperative by striking against the abutment I.

Fig. 7111.

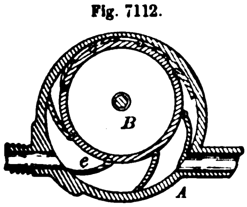


Turner's Rotary Piston Water-Meter.

Summer's (Fig. 7112) has a rotary disk B journaled eccentrically in the case A, which has a shallow, lunate cavity at its upper side, concentric with the disk, to give longer packing surface to the pivoted wings e, which bear against the side all around. See also Figs. 2970, C; 2971, pages 1327, 1328.

See also ROTARY PUMP, Figs. 4465, 4466; ROTARY METER, Fig. 4461; ROTARY STEAM-ENGINE, Plate LIII., page 1990, etc.

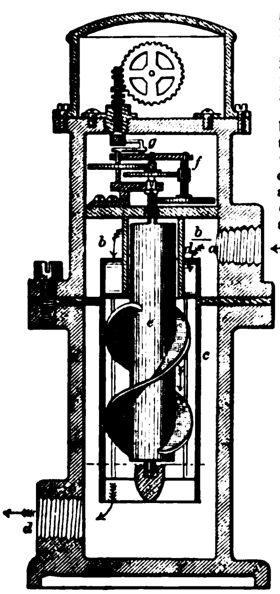
Fig. 7112.



Summer's Rotary Piston Water-Meter.

CLASS 3. Maxim's meter (Fig. 7113) is of the screw-shaft class. The liquid entering through the opening a is received in a chamber b, flows downward through the square trunk c, and is discharged at d. The trunk c has a vertical inwardly projecting web at each angle, just cleared by the wings of the screw, and preventing the water from acquiring a rotary motion. A casing d prevents the water from causing a lateral displacement of the screw-shaft. The shaft e is hollow, and is made slightly more buoyant than water, so that when a small quantity only is flowing, the shaft will be buoyed up and turn upon its upper pivot, which is made sharp and delicate, so that the resistance is reduced to a minimum; but when a larger quantity of water is passing, the shaft is depressed, and turns on its lower and larger bearing. Bicarbonate or supercarbonate of soda and dry tartaric acid are placed in the shaft, so that in case of water sweating through, a combination ensues, causing the evolution of a gas which resists the farther entrance of water and maintains the buoyancy of the shaft.

Fig. 7113.



Maxim's Archimedean-Screw Water-Meter.

A train of gearing in the chamber f communicates, through the medium of a crank and arm connection g, rotary motion to a shaft passing through a water-tight plug and actuating the indicating mechanism. See also Fig. 2972, page 1328.

CLASS 4. The *reciprocating piston.*

Worthington's double-piston meter ("Pioneer") has two parallel cylinders, in each of which are two pistons connected by a stem and acting together as a double piston. The space between the pistons is greater than the stroke, is filled with water, and contains the mechanism which actuates the valves. Under the central space of each set of pistons is placed the slide-valve of the other set, so that each piston in its motion actuates the valve to admit water against the other piston, the action being reciprocal.

A somewhat different construction, which has its analogue in many modern steam-engines and steam-pumps, is that in which two pistons and two valves or sets of valves are employed. One piston is smaller than the other, and operates in a cylinder connected by a port with the larger cylinder. The duty of the smaller piston is to operate the valve of the larger one. The larger piston in its motion actuates a small valve, admitting water to the smaller cylinder; the pressure of water in the latter operates the smaller piston, and this actuates the main valve.

Somewhat similar is the construction adopted by the Hudson Brothers in their steam-pump, and it likewise is applicable to liquid meters. The larger piston in its motion uncovers a port leading to the smaller cylinder; the pressure of water in the latter actuates the small piston, and this moves the valve. But one valve is thus used at each end of the double-acting apparatus. The valve-apparatus of R. C. M. Lovell's steam-quarrying machine is thus constructed.

George I. Washburn's engines, whose construction adapts them to be used as meters, are suggested by the foregoing remarks on the Worthington meter. In Washburn's, two piston-stems are used, reciprocating in their several cylinders, and each having a plurality of disks. Though his numerous engines vary in details, the feature of a plurality of disks on pistons reciprocating in separate cylinders is preserved. In most of his engines, the piston of each cylinder is alternately a working piston and a valve, each governing the admission and exit of steam (or water) to the other cylinder, reciprocally. In some other of his engines, the valve-stem is connected by a *reach* to the working piston.

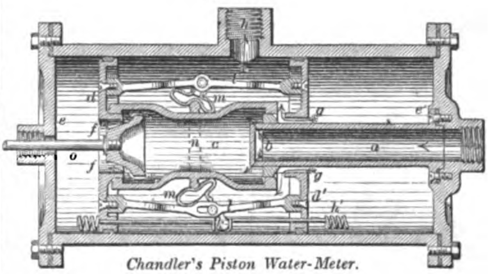
As it is not desirable to duplicate cuts in a work where they are necessarily so numerous, we refer the reader to STEAM-ENGINE, where the above and other steam-engines capable of adaptation as water-meters will be found described. It is, however, proper to remark in this connection, that this feature of making one reciprocating piston act as a valve to another similarly moving piston is found in the old and the new steam-hammer. The main piston in its descent, for instance, uncovers a port which admits steam to a piston-valve, whereby the steam induction is accomplished. See also PISTON-VALVE.

The Jopling meter (English) consists of "two short, double-acting cylinders and pistons, each cylinder supplied at the side with a common D slide-valve, in appearance precisely like two steam-engine cylinders with usual pistons and slide-valves, with the only difference that the port in one of the latter is reversed. These cylinders are so placed opposite each other that the piston-rod of the one at the end of its stroke can move the valve of the other on the 'tappet' mode, and *vice versa*. The whole is surrounded by a strong casing full of the water to be measured. The mode of operation is similar to that of Worthington's meter, with the exception that the pistons have no dead-water to carry with them. The piston-rods, however, pass through stuffing-boxes, which in the Worthington meter is avoided."

See also Fig. 2974, page 1328.

The Hicks meter is adapted from his ingenious steam-engine, in which the cylinders are situated radially around a central space occupied by the common crank, to which their piston-rods are attached. The piston-rods of opposite cylinders, being continuous or practically so, may thus be considered as one,

Fig. 7114.



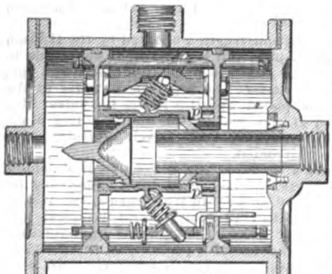
Chandler's Piston Water-Meter.

having a piston operating in two opposite cylinders, with a steam (or water) space between them. The effective strokes of the pistons are made consecutively, each commencing a stroke at each quarterly point in the revolution of the main shaft. In the meter the main shaft is connected to a register which records the revolutions, each revolution representing on the index (in gallons, for instance) the sum of the capacity of the several cylinders. No valves of ordinary construction are used, but each cylinder and piston has ports so arranged as to form induction and eduction passages. Each of the pistons forms an induction-valve for the piston in advance and an eduction-valve for the piston in the rear.

Chandler's meter (Fig. 7114) is one of the reciprocating-piston class. The water, entering by the induction-pipe a, passes through ports b to the interior of a valve c, having a reciprocatory motion within the piston, which consists of two heads d d' connected by rods l l; flowing through the ports f f, it forces the piston away from the head e of the case toward the head e', the water contained between the latter and the head d' of the piston passing through the ports g g between the valve and the piston to the discharge-opening h of the meter. On approaching the

head e', the spiral spring h' on the rod i strikes against this head, reversing the movement of the valve by means of a lever k, one end of which is pivoted in a slot in one of the stays l and connected with one of two elliptical springs m having a depression in which a collar n centrally surrounding the valve rests. This movement of the valve closes the ports $f f$ and opens the corresponding ports between the valve and piston, producing a reverse movement of the piston, and causing the water which had accumulated between the heads d e of the piston and meter to flow between the valve and piston at that end toward the discharge-opening.

Fig. 7115.



Piston Water-Meter.

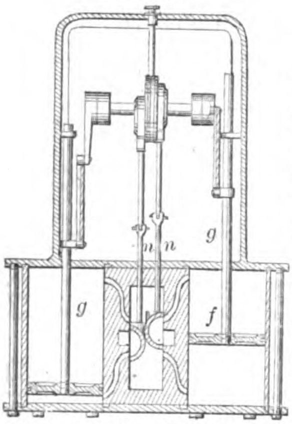
The piston-rod o is connected with suitable mechanism for registering its reciprocations.

Fig. 7115 shows another form of this meter, having a differently arranged spring and rod for causing the throw of the valve, which is cushioned by annular water-chambers p p at each end of the piston.

In a third modification, the valve is shifted by a weighted forked lever partially embracing it and connected with the sliding rod.

The Despers water-meter has two connected pistons, a valve, and registering-pinion.

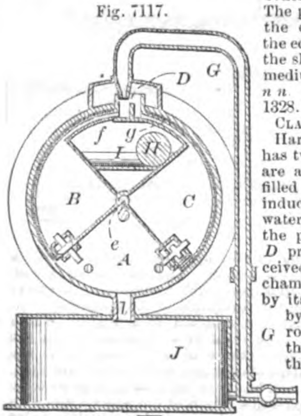
Fig. 7116.



Spencer's Piston Water-Meter.

In Spencer's (Fig. 7116), two measuring-chambers f g act alternately to receive and discharge the water The case containing the operating parts is tight, and is so constructed as to form the heads of the cylinders, whereby stuffing-boxes are dispensed with. The pistons are connected to the cranks of the shaft of the eccentrics, which operate the slide-valves through the medium of connecting-rods n n. See also Fig. 2974, page 1328.

Fig. 7117.

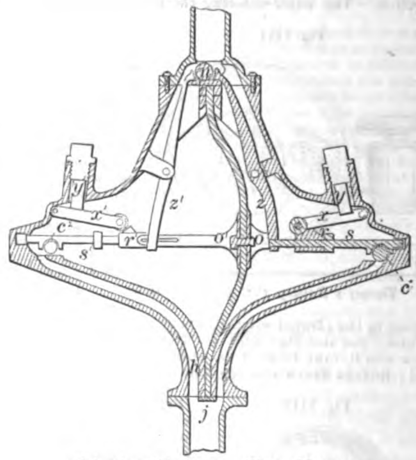


Meter-Wheel Water-Meter.

CLASS 5. *The meter-wheel.*

Hargrave's meter (Fig. 7117) has two chambers B C which are alternately tilted to be filled with water from the induction-pipe G G. The water flows in turn through the pipes f g, the partition D preventing its being received into the opposite chamber. When full, it is, by its own gravity, assisted by the weight H, which rolls from side to side on the track I, tilted until the projecting stem of a valve at its lower angle strikes a stop in the chamber A, which opens the valve and allows the water to escape into this chamber, whence it passes through opening l into an air-chamber J, or direct to the place of delivery. In the mean time the other chamber is being filled, to be tilted in its turn. The chambers B C are balanced on a knife-edge e, and the induction and eduction cocks are arranged to be simultaneously opened and closed. See also LIQUID-METER, Fig. 2970, A.

Fig. 7118.



Pulsating-Diaphragm Water-Meter.

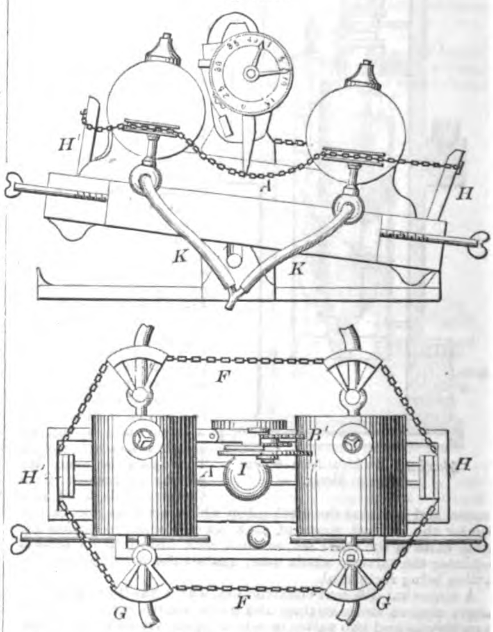
CLASS 6. The *pulsating diaphragm.*

Baldwin's meter (Fig. 7118) has an elastic diaphragm dividing it into two chambers, each having an inlet and outlet aperture, the former provided with a valve n, and the latter having the separate valves c^1 c^2. The diaphragm is centrally attached to a sleeve o o' sliding on the rod s s', and which, as it moves alternately from side to side through the medium of the levers z z', moves the valve n so as to close one and open the other of the induction-openings. The same movement operates to open one and close the other of the eduction-openings, a rapid motion being imparted to the rod s s' toward the end of each stroke by the arms x x', which have friction-rollers on their ends acting against the wipers r r', and are actuated by springs y y. The eduction-passages h i coalesce in a single pipe. See also Fig. 2970, B (two figures).

CLASS 7. The *bucket and balance.*

Weller's (Fig. 7119), though adapted for use as a water-meter, is more particularly designed for oil, spirits, etc. It consists of a box or frame A A, on which are mounted two casks of equal capacity, and rocks upon a central pivot. Two levers H H' are connected by chains F F to quadrants G G or their equiva-

Fig. 7119.



Balancing-Chamber Water-Meter.

lents, which operate to open the induction and close the eduction cock of each cask when it is tilted into elevated position, and *vice versa*. When a cask becomes filled, its weight overcomes that of the empty cask and that of a ball *I*, which runs in ways, and is then at the depressed end of the box; but as that end rises, the ball rolls toward the other end, and, striking the lever *H* at that end, causes it to pull the chain so as to open the eduction and close the induction cock of the lower cask, while opening the induction and closing the eduction cocks of the upper one. The flexible discharge-tubes *K K* belonging to each cask coalesce in a single tube.

An adjusting-ball *B'* is provided for graduating the preponderance of the ends of the box, to adapt the meter for liquids of different gravities. See also Fig. 2973.

Wa'ter-mill. Water-mills were probably invented in Asia.

One is described near one of the palaces of Mithridates of Pontus, 70 B. C. See GRINDING-MILL.

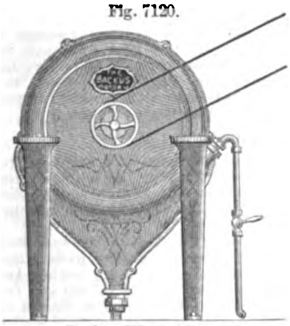
Strabo speaks of one on the Tiber, 70 B. C.

Antipater, the contemporary of Cicero, alludes to one in an epigram.

Vitruvius, 50 B. C., describes their construction as similar to the *tympanum*, with circumferential floats or paddles which were acted upon by the force of the stream, driving the wheel round. On the axis of the water-wheel was another wheel with cogs, which meshed into the cogs of a horizontal wheel, on the upper head of whose axis was a tenon inserted in the millstone.

Pliny refers to water-mills (died A. D. 79).

Fig. 7120.

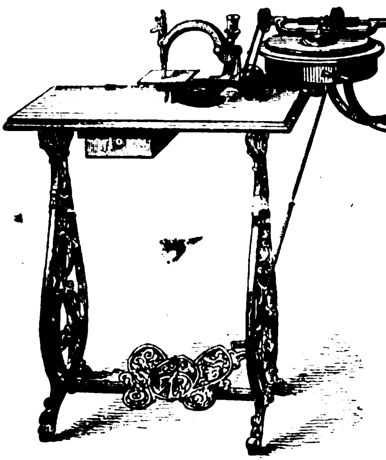


Backus Water-Motor.

Public water-mills were established in Rome in the time of Honorius and Arcadius (A. D. 398). They were driven by the water of the aqueducts.

When the Goth Vitiges besieged Rome, A. D. 555, he caused the water-supply of the fourteen aqueducts to be cut off, and reduced the people to great straits for meal. Procopius says that below the bridge which reaches the walls of the Janiculum, Belisarius extended ropes, well fastened and stretching across the river, secured on both banks; to these he moored two boats of equal size, separated by a small space in which a water-wheel revolved and turned the grain-mills erected on the boats. At different places on the river, where the current was strongest, he arranged other mills, and thus ground a sufficient provision for the city. This was in the reign of Justinian.

Fig. 7121.



Lane Water-Motor, attached to a Sewing-Machine.

Wa'ter-mo'tor. An application of the water-wheel to purposes of a domestic nature, such as running sewing-machines, organs, etc., being driven by water from the customary city mains.

See also devices in ROTARY PUMP, ROTARY STEAM-ENGINE, etc., which may be adapted to be driven by the force of a current of water. This is the converse of the condition first stated, where the engine raises the water; as it is a mere substitute of water for steam in the last-mentioned case.

Wa'ter-pack'er. (*Well-boring.*) A cap on the top of a pipe to exclude surface-water.

Wa'ter-pil'lar. A hollow standard and overhung arm for supplying a tender with water. Also known as a *water-crane*, from its form. It has a revolving swan neck, and the valve is operated by a hand-wheel, rods, and miter gear. Also called a WATER-CRANE (which see).

Wa'ter-pipes. James Watt devised sectional water-pipes with flexible articulations to enable the pipe to accommodate itself to the inequalities of a river bottom across which the water was to be conveyed. He derived the suggestion from the articulations of the tail of a lobster.

See PIPE, for enumeration of kinds and purposes.

"The water brought from the mountains of Cordova was conveyed to the palace of the Khalifs, and thence distributed into every corner and quarter of the city by means of leaden pipes, from which it flowed into basins of different shapes made of the purest gold, the finest silver, or plated brass, as well as into vast lakes, curious tanks, and amazing reservoirs, and fountains of Grecian marble, beautifully carved. In this palace, too, was an astonishing *jet d'eau*, which raised the water to a considerable hight, and the like of which was nowhere to be seen in the East or West." — MAKKARIS (*Arabic*), *History of the Mohammedan Dynasties of Spain.*

Wa'ter-plate. One heated by water in the jacket, to keep the viands warm. Count Caylus has engraved a very handsome specimen of one.

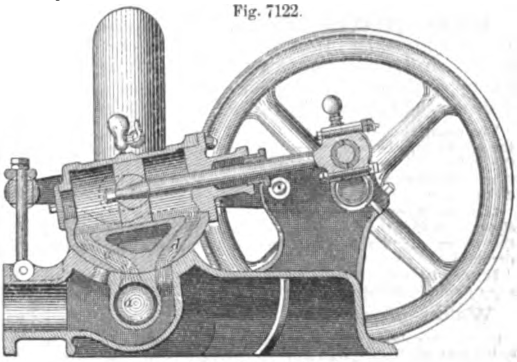
Wa'ter-press. Another name for the HYDROSTATIC PRESS (which see).

Wa'ter-press'ure En'gine. An engine used where there is a considerable fall of water of moderate quantity. It is used in some of the German mines. The water under pressure drives a piston in a cylinder, somewhat in the manner of steam.

The name is sometimes applied to the turbine-wheel, which was first used on the Continent of Europe, and, in some remarkable instances, falls of several hundreds of feet are thus utilized. See TURBINE; HYDRAULIC ENGINE; WATER-ENGINE; WATER-MOTOR.

Fig. 7122 shows Schmid's oscillating-cylinder water-engine (Swiss). The steam-passages are in the lower face of an arc having its center at the trunnions, *a* being the main water-pipe, and *c d* becoming alternately the induction and eduction passages.

Fig. 7122.

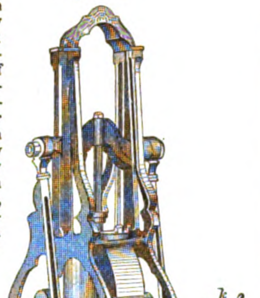


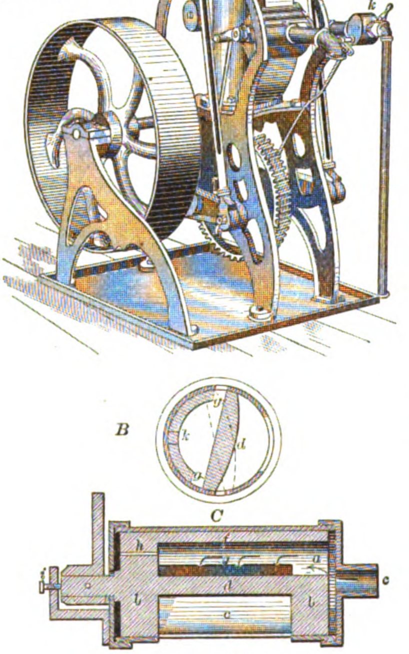
Water-Pressure Engine.

The Coates and Lascell engine (Fig. 7123) is of the vertical kind. The valve shown at *B C* is balanced and self-packing. The induction-port *a* is located at one end in one of two transverse disks *b* at the end of the valve. These fit closely the interior of the valve-chest *c*, and are connected by a flat plate *d*. A hollow trunnion *e* admits the water, which flows in the direc-

tion of the arrows into the valve-chest. A curved plate *f*, having openings *g* serving as eduction-ports for the valve, diffuses the pressure. An orifice *h* opposite the hollow trunnion admits water back of the disk and nearly balances the end pressure of the valve, only sufficient excess of pressure being allowed to pack the washer which keeps the joint from leaking. This pressure may be relieved, if necessary, by means of the set-screw *i*. An auxiliary pipe and valve *k*, opened by means of a separate eccentric, are arranged to give an additional supply of water when the piston has traversed one

Fig. 7123.





Water-Pressure Engine.

fourth of the length of the cylinder, so as to equalize the motion of the crank.

Wa'ter-press'ure Pump. (*Hydraulics.*) A machine for using the pressure of a body of water to raise a smaller quantity to a greater elevation, as to the upper stories of houses where the pressure in the water-mains and regular service is not sufficient.

The pump is placed in the cellar of the house, attached to the service-pipe between the street-main and the kitchen. All the water used in the house passes through it, works its pistons, and forces a percentage to a reservoir on the top story for distribution.

It moves when water is drawn, and is at rest as soon as it is stopped, so that the free use of the water in the lower part of the house supplies that part which is higher than the city pressure.

It may be worked with brook-water, the pump taking its supply from a spring.

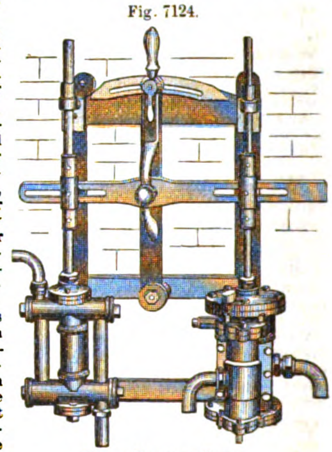
Wa'ter-proof Glue.

Dissolve one ounce of gum-sandarac and one ounce of mastic in half a pint of alcohol, and add one ounce of clear turpentine. At the same time a very thick glue is to be prepared and added to the first-mentioned solution, both of them heated almost to the boiling-point, and stirred intimately together. After mixture, it is to be strained through a cloth, when it will be ready for use. This glue is to be applied hot.

Wa'ter-proof'ing. The process of rendering any substance impervious to water.

Its principal application is to textile fabrics; many solutions and compositions having been employed for the purpose, among which may be enumerated petroleum; whiting and water; alum, white lead, and water; the same ingredients, with acetic acid added; tar, for tarpaulins; oil, for oilskins; a mixture of boiled linseed-oil, pipe-clay, burnt umber, white lead, and pumice-stone, for tarpaulins, coach-covers, awnings, etc. India-rubber has now nearly superseded all other agents for water-proofing textile fabrics. See INDIA-RUBBER.

Fig. 7124.



Water-Pressure Pump.

Dr. Reimann's process consists in precipitating an insoluble salt, as sulphate of lead, in the fiber of the cloth by drawing it through a tank divided into three compartments: the first containing a warm solution of alum; the second, warm solution of acetate of lead; and the third, pure water, which is kept constantly renewed. The cloth is then beaten and brushed, to remove the salt adhering to the exterior, and finally hot-pressed and brushed. Cloth thus treated, it is claimed, is rendered impervious to water, but permits air to pass freely through it.

Wa'ter-proof'ing Leath'er.

A number of special compositions have been employed for rendering leather water-proof by filling up the minute pores. Among them are: 1. Boiled linseed-oil, mutton suet, yellow beeswax, and rosin, melted and applied while hot to the leather slightly warmed. 2. Linseed-oil, rosin, white vitriol, spirits of turpentine, and white-oak sawdust. 3. Yellow beeswax, Burgundy pitch, turpentine, and linseed-oil. 4. Two parts tallow and one rosin. 5. Apply a coating of tallow to the leather, and afterward a second coating of one part copaiba balsam and two naphtha. 6. Caoutchouc, boiled for two hours in linseed or neatsfoot oil.

Wa'ter-proof'ing Pa'per.

Szerlmley's process is as follows: *a*, 30 ounces of glue, gelatine, or size, and 3 ounces of gum-arabic, are melted in 10 pints of hot water; *b*, 20 ounces of soap and 4 pounds of alum are also melted in 30 pints of hot water, and the compounds *a* and *b* are mixed, constituting composition No. 1. ½ gallon benzole and 1 gallon paraffine oil are mixed and heated, and 24 ounces resin melted in; to these, resin, oil, and copal, or mastic varnish, may in some cases be added; the whole is boiled to a moderate degree of consistency, forming composition No. 2. The article to be water-proofed is dipped in composition No. 1 and dried, and afterward composition No. 2 is applied with a brush or in other convenient manner.

A water-proof packing-paper is made by first coating the paper with a resinous liquid; it is then painted over with a solution of glue and soot; when this is dry, the water-proofing compound is applied with a brush. This is prepared by dissolving 2½ ounces of shellac in 2 pints of water, which is gradually brought to a boiling heat, the shellac being stirred until thoroughly dissolved and softened, when ½ ounce pulverized borax is gradually added, until the whole becomes intimately incorporated. While hot, any mineral color, as lampblack, red or yellow ocher, or umber, may be added; when cold, it is ready for use.

Another recipe for water-proofing paper is to pass the paper rapidly over and in contact with the surface of a solution of oxide of copper in ammonia. It is then drawn in succession between two pressing-cylinders and two drying-cylinders. The solution slightly dissolves the cellulose of the paper, converting it into an impermeable varnish.

Another recipe consists in soaking good paper in an aqueous solution of shellac and borax. It resembles parchment-paper in some respects. If the aqueous solution be colored with aniline colors, very handsome paper, of use for artificial flowers, is prepared.

Wa'ter-proof Safe. A floating safe for marine emergencies.

Garlick's water-proof safe consists of an interior and exterior casing of sheet-metal, the space between the two being divided into compartments which may be filled with cork or air. Double doors provided with water-tight packing are used, so

that in case of shipwreck or other contingency the safe will float if thrown overboard, without danger of injury to the contents.

Wa'ter-pro-pel'ler. A ROTARY PUMP (which see).

Wa'ter-pump. An air-pump in which a falling or driven body of water is made the means of inducing an exhaust current of air, or air and steam, from a room, a vacuum-pan, a condenser, etc.

The aspirator of the laboratory is constructed for assisting the filtering operation by withdrawing the air from the lower surface of the filtering material, so that the superincumbent atmosphere shall press upon the upper surface of the liquid and force it through the filter. (See ASPIRATOR.) The device is called *Bunsen's* pump; also *Sprengel*-pump.

Its uses in mechanics, besides the laboratory and hospital uses, are in removing steam from the steam-engine condenser and the pan for evaporating vegetable extracts, notably the vacuum-pan of the sugar-refinery. It is also used for obtaining an induced draft in *vacuum* ventilating-machines, and for forcing a current in *plenum* ventilating-machines. This may be effected by using the natural head, or by mechanically forcing the water through the pipe into which the air is drawn by entanglement with the passing water, on the principle of the Giffard injector, or by pulsative or intermittent action, as in one illustration under ASPIRATOR. See also TROCAR.

Wa'ter-ram. See HYDRAULIC RAM, page 1150.

Wa'ter-ret'ting. The process of *retting* or *rotting* flax or hemp by steeping in water, to soften the mucilage which binds together the fibrous and cellular portions. See RETTING.

Wa'ter-room. (*Steam.*) The space in a steam-boiler occupied by *water*, as distinct from that which contains *steam*.

According to Bourne, of the whole boiler-room, or internal capacity of the boiler, there are very nearly ¾ water-room and ¼ steam-room. According to Robert Armstrong, there are ½ water-room and ½ steam-room.

Wa'ter-sail. (*Nautical.*) A sail set in very light airs and smooth water, below the lower studding-sail booms and next to the water.

Wa'ter-screw. A water-elevator on the principle of the *Archimedean screw*, but consisting of an inclined axis with a spiral projection, rotating in a cylinder whose lower end is submerged. There is a loss of water between the thread of the screw and the casing. It differs from the ordinary Archimedean screw in this, that the latter has a spiral canal in which the flange of the screw is united with the casing, and the latter revolves therewith. See Fig. 4707.

Wa'ter-shell. An invention of Professor Abel of the English ordnance-department.

It is a common shell or cast-iron cylinder filled with water, into which is fitted a small cylinder containing a quarter, or, at the most, half an ounce of gun-cotton; it is then hermetically sealed; a few grains of fulminate of mercury are placed between the gun-cotton and the fuse, and, as soon as the latter is fitted, the shell is ready for firing.

Wa'ter-snail. The Archimedean-screw pump. Also called the *spiral pump*. The spiral water-channel is wound around an inclined rotating axis, and somewhat resembles the convolutions of a shell, but preserves the same latitude while progressing longitudinally in the direction of the axis of rotation. See Fig. 4707.

The *water-screw* has an inclined axis with spiral projection, and rotates within a cylinder whose lower end is submerged.

Wa'ter-ta'ble. A coping or projecting stone to shed the wet. It occurs on the various stages of buttresses, tops of battlements, etc.

Wa'ter-test. A test for the limpidity of water. Other qualitative and quantitative tests concern the ingredients; this, the color.

Mr. King, city analyst, Edinburgh, employs a solution of caramel, made by adding 10 grains by volume of solution of ammonium chloride (3.17 grains of the salt to 10,000 grains of water) to 8 ounces of pure distilled water, contained in a glass tube, which this quantity must fill to the hight of 12 inches. When under these conditions, 25 grains, by volume, of Nessler's solution are poured into the liquid, and the whole allowed to stand ten minutes at 60° Fah., the color will be uniform, and is graded by Mr. King at 30°, on a scale in which each degree contains 10 grains of caramel solution. It is to be observed that the thickness of the liquid stratum is always an important element in the graduation of color quantities. To estimate the color of a water, it is only necessary to fill two tubes, each 15 inches long, and of such a size that 8 ounces of water fills them to within 3 inches of the top. One is filled with distilled and the other with the water to be tested, and they are placed vertically over a white slab. The caramel solution is then carefully added to the distilled water, until its color, as seen by looking through the whole hight of the tube, is the same as that of the natural water. The quantity of caramel solution used indicates the degree of coloration, since 10 fluid grains correspond to one degree.

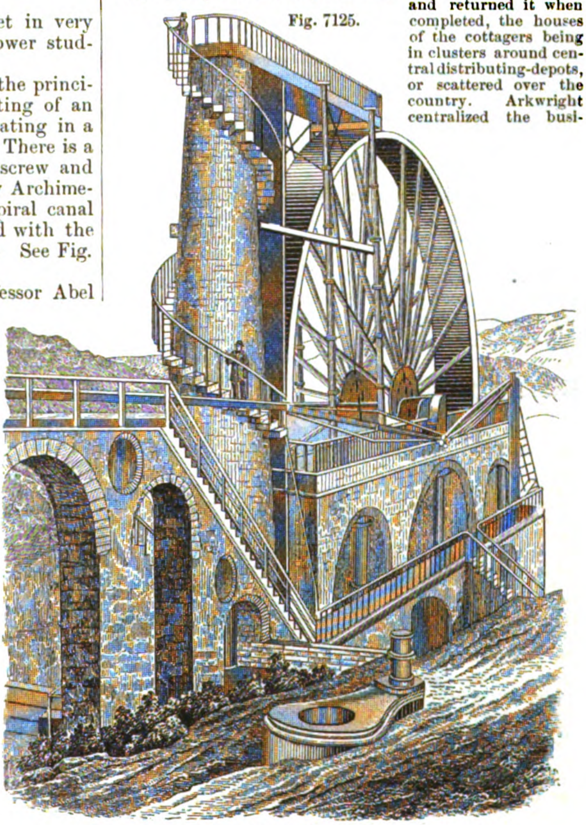
Wa'ter-trunk. A square rain-water pipe.

Wa'ter-tube Boil'er. A steam-boiler having tubes filled with water, and upon the outside of which the flame impinges. A *fire*-tube, or *flue*, is traversed *internally* by the flame or heated gases. See TUBULAR BOILER; a number are shown in Plate LIX.

Wa'ter-twist. (*Cotton-manufacture.*) Yarn made by the *throstle*, or *water-frame*; so called because in the first cotton-*mill*, which was organized by Arkwright, the motive-power was a *water-wheel*.

Previous to the time of Arkwright (his patents were 1769 and 1775), all the operations of cotton were done by operatives at their homes. The cotton was *hand-carded*, *spun*, and *woven* by men, women, and children, who took a bunch of work home and returned it when completed, the houses of the cottagers being in clusters around central distributing-depots, or scattered over the country. Arkwright centralized the busi-

Fig. 7125.



Draining-Wheel at Laxey.

ness, and organized it in manufactories where the operations were concertedly performed.

Wa'ter-twist Frame. The Arkwright spinning-machine for turning rovings into yarn, the first continuously working machine for *drawing*, *twisting*, and *winding*. See SPINNING, Fig. 5404.

Wa'ter-way. (*Shipbuilding.*) A strake on the inside of a vessel above the ends of the beams. It is bolted downward through the *beam* and *shelf*, and is bolted laterally through the *futtock* and *planking*. It is also secured by a fore-and-aft dowel to the beam. It forms a channel to lead the water to the scuppers.

In iron vessels it assumes many different forms, according to the judgment of the builders. See BEAM; SPIRKETING.

Wa'ter-wheel. A wheel which is turned by the action of water upon its floats.

In 1701, a lease for 381 years was made of the 4th arch of London Bridge for water-wheel purposes, to raise water for the city of London

The 1st arch was leased in 1581 for the same purpose, for a term of 500 years.

The 5th and 2d arches were leased in 1767 for 315 years for the same purpose.

Fig. 7125 is an overshot water-wheel employed at Laxey, Isle of Man, for driving the pumps which drain the mines at that village; these have an extreme depth of 1,380 feet. The wheel is 72 feet 6 inches in diameter, 6 feet in breadth, exerts a force of about 200 horse-power, and is capable of pumping 250 gallons per minute from a depth of 400 yards. Its crank-stroke is 10 feet. The water for driving it is conducted by pipes from a reservoir on a neighboring hill, and ascends in the column of masonry shown to the left of the wheel.

Water-wheels are of many kinds. See under the following heads: —

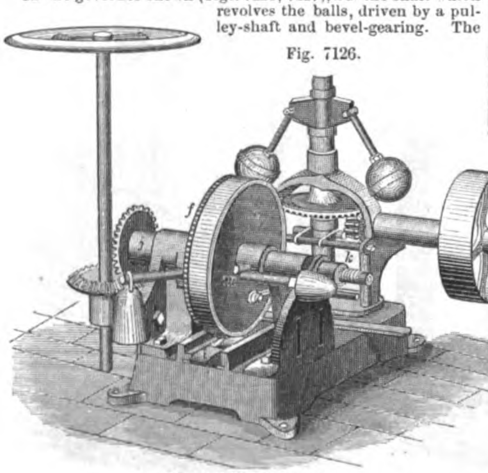
Barker's mill.	Overshot wheel.
Bascule.	Persian wheel.
Bottom-discharge water-wheel.	Pitch-back wheel.
Breast-wheel.	Radial-piston water-wheel.
Bucket-wheel.	Reaction water-wheel.
Center-discharge wheel.	Scoop water-wheel.
Chapelet.	Screw-elevator.
Danaide.	Side-discharge water-wheel.
Double water-wheel.	Stream-wheel.
Downward-discharge wheel.	Turbine.
Flutter-wheel.	Tympanum.
Horizontal water-wheel.	Undershot water-wheel.
Inward-discharge wheel.	Ventilating water-wheel.
Noria.	Vortex water-wheel.

Wa'ter-wheel Gate. One for limiting or determining the quantity of water to be allowed to flow into or on to the wheel, according to the power required.

Wa'ter-wheel Gov'ern-or. One to regulate the revolution of the wheel according to the machinery driven, so as to keep the rate uniform.

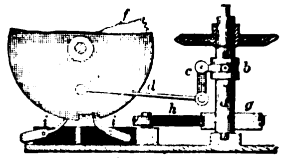
In the governor shown (Figs. 7126, 7127), *a* is the shaft which revolves the balls, driven by a pulley-shaft and bevel-gearing. The rising or falling of the balls causes a vertical upward or downward movement of the collar *b*, which, through the medium of the bell-crank *c* and connecting-rod *d*, imparts a partial rotation to the shield *e*, which consists of a disk having a rim upon its edge, turned down at right angles and covering the toothed wheel *f*, but having a notch cut in its lower part. At each revolution of the ball-shaft *a*, the eccentric *g*, through the connecting-rod *h*, reciprocates a cross-head carrying the gravity-pawls *i i*. One or the other of these pawls engages the toothed wheel *f*, according as the notch in the rim of the shield permits the engagement. As the speed varies, the movement of the collar through the bell-crank and connecting-rod brings the notch in the shield in position to be engaged by one or the other of the pawls *i i*; when the notch is midway between the pawls, neither is brought into action. When the water-supply is less than the regulated amount, the notch is brought into such position that the proper pawl can enter and engage the wheel *f*, which is turned by the reciprocating motion of the connecting-rod *h* until the gate is lifted to the requisite hight through a bevel-wheel on the shaft *j* meshing with a bevel-wheel on the gate-shaft.

Fig. 7126.



Water-Wheel Governor.

Fig. 7127.



Water-Wheel Governor.

By the turning of the wheel *f*, a nut *k* is moved upon the threaded end of *j*, until it abuts against a shoulder on the shaft and turns with it; at the same time, the pin *l* is brought under a lug *m* formed on the hub of the shield, which is thus turned until the notch is brought centrally between the pawls, when the acting pawl becomes disengaged, and farther raising of the gate is prevented. When the speed of the shafting to which the governor is belted is excessive, a reverse action takes place, and the other pawl acts to cause the lowering of the gate.

Wa'ter-works. The largest reservoir in the world was the Lake of Mœris, made by the Pharaoh of that name, and supplied by the flood-water of the Nile.

It has been explored by M. Linant, and found to be 150 square miles in extent, being retained by a bank 180 feet wide and 30 feet high, which can yet be traced for a distance of 13 miles. This reservoir was capable of irrigating 1,200 square miles of country.

The ancient city of Tlascala, in Mexico, was furnished with abundance of baths and fountains. Every house in Zempoloa had water. Tezcuco had an aqueduct from which every house was supplied by a pipe, as in modern cities. Cortez, in his first letter to Charles V., mentions the spring of Amilco, near Churubusco, of which the water was conveyed to the city of Mexico "in two large pipes, molded and hard as stone, but the waters never ran but in one at the same time." The Spaniards destroyed it, of course. Humboldt saw the remains of it, and says it was inferior to the aqueduct of Tezcuco.

The inca Garcilasso de la Vega was born in 1539 at Cusco, in Peru, about eight years after the Spanish invasion. His mother was a native princess, his father a Spaniard. He writes as follows of the Peruvian aqueducts: —

The seventh inca, Viracocha, "made an aqueduct 12 feet in depth and 120 leagues in length; the source or head of it arose from certain springs on the top of a high mountain between Parcu and Picuy, which was so plentiful that at the very head of the fountains they seemed to be rivers. This current of water had its course through all the country of the Rucanas, and served to water the pasturage of those uninhabited lands, which are about 18 leagues in breadth, *watering almost the whole country of Peru.*

"There is *another* AQUEDUCT much like this, which traverses the whole province of Cuntisuyu, running above 150 leagues from south to north Its head, or original, is from the top of high mountains, the which waters falling into the plains of the Quechuas, greatly refresh their pasturage, when the heats of the summer and autumn have dried up the moisture of the earth."

These aqueducts "were carried over craggy rocks and inaccessible passages; and to make these ways plain, they had no help of instruments forged of steel or iron, such as pickaxes or sledges, but served themselves only with one stone to break another. Nor were they acquainted with the invention of arches, to convey the water on the level from one precipice to the other, but traced round the mountain until they found ways and passages at the same hight and level with the head of the springs.

"The cisterns or conservatories which they made for these waters, at the top of the mountain, were about twelve feet deep; the passage was broken through the rocks, and channels made of hewn stone, of about two yards long and about a yard high, which were cemented together, and rammed in with earth so hard that no water would

pass between to weaken or vent itself by the holes of the channel.

" The current of water which passes through all the division of Cuntisuyu, I have seen in the province of Quechua, which is part of that division, and considered it an extraordinary work, and indeed surpassing the description and report which hath been made of it. But the Spaniards, who were aliens and strangers, little regarded the convenience of these works, either to serve themselves in the use of them, or keep them in repair, nor yet to take so much notice of them as to mention them in their histories; but rather out of a scornful and disdaining humor, have suffered them to run into ruin beyond all recovery. The same fate hath befallen the AQUEDUCTS which the Indians made for watering their corn lands, of which two thirds at least are wholly destroyed and none kept in repair, unless some few which are so useful that without them they cannot sustain themselves with bread, nor with the necessary provisions of life. All which works are not so totally destroyed but that there still remain some ruins and appearances of them."

The water supply of Rome during the first century of our era would suffice a population of 7,000,000, at the rate of the London supply. This, however, is very far from being sufficient for comfort or cleanliness. It was conveyed to Rome by nine aqueducts. (See AQUEDUCT.) Five more aqueducts were subsequently added. Three of the old aqueducts suffice for modern times. See AQUEDUCT, page 128.

The present London supply during July is 127,563,492 gallons of water to 3,645,069 persons, residing in 511,005 houses. The number of miles of streets containing mains constantly charged, and upon which hydrants could at once be fixed, is 664½ miles, while the total number of hydrants erected thereon is at present 2,507.

The supply of various cities is reputed to be as follows: —

Washington	158 gallons daily to each person.
New York	100 gallons daily to each person.
Brooklyn	50 gallons daily to each person.
Philadelphia	55 gallons daily to each person.
Baltimore	40 gallons daily to each person.
Chicago	75 gallons daily to each person.
Boston	60 gallons daily to each person.
Cincinnati	60 gallons daily to each person.
Albany	80 gallons daily to each person.
Detroit	83 gallons daily to each person.
Jersey City	99 gallons daily to each person.
Buffalo	61 gallons daily to each person.
Cleveland	40 gallons daily to each person.
Columbus	30 gallons daily to each person.
Montreal, Canada ...	55 gallons daily to each person.
Toronto	77 gallons daily to each person.
London, England ...	29 gallons daily to each person.
Liverpool	23 gallons daily to each person.
Glasgow	50 gallons daily to each person.
Edinburgh	38 gallons daily to each person.
Dublin	25 gallons daily to each person.
Paris	28 gallons daily to each person.
Turin	22 gallons daily to each person.
Toulouse	26 gallons daily to each person.
Lyons	20 gallons daily to each person.
Leghorn	30 gallons daily to each person.
Berlin	20 gallons daily to each person.
Hamburg	33 gallons daily to each person.

The first water-works in the United States were planned and constructed by Mr. John Christopher Christensen, at Bethlehem, Pa., in 1762. The machinery consisted of three single-acting force-pumps, of 4-inch caliber and 18-inch stroke, and worked by a triple crank, and geared to the shaft of an under-shot water-wheel, 18 feet in diameter, and 2 feet clear in the buckets. The water was raised by this machinery to the hight of 70 feet, and subsequently to 114 feet. The works were in operation as late as 1832. The first rising main was made of gum-wood, as far as it was subject to great pressure, and the rest was of pitch-pine. In 1789 leaden pipes were substituted, and in 1813 they were changed for iron.

The Corliss pumping-engine for the Providence Water-Works has a system of automatic self-regulation. The *table-engine* is capable of pumping 5,000,000 gallons of water per diem, or more, if needed. If all the outlets from the supply-pipes distributed over the service of the city are closed, so that no water escapes, the pumping apparatus remains perfectly at rest, but the instant any appreciable outflow occurs, the machinery proceeds to supply the waste. It has been known to be over five and a half minutes in making a single revolution, moving regularly all this time, however, and capable of automatically increasing the rate almost immediately to more than 30 revolutions a minute.

The "Holly" Water-Works in various cities of the Union have also an automatic regulator.

The first engine known to have been thus automatically regulated was one at Ross, Herefordshire, England. In that town, in 1720, John Kyrle, celebrated in Pope's "Elegy" as the "Man of Ross," established a system of water supply for that town, which, from that time to the present, has been uninterruptedly in use. The distinctive feature of this system consists in forcing water by pumps into the street mains, so as to supply the town with water under such pressure as may be required. At the Ross works, the ordinary pressure for many years has been 45 pounds per square inch. Steam-power has been substituted for the old water-wheels long since.

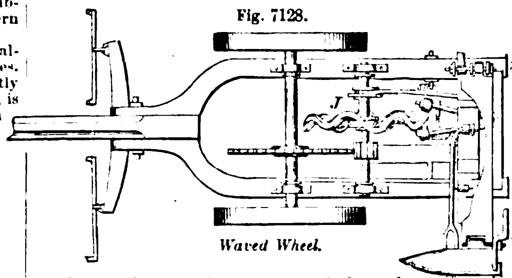
Wat'tle. A fence, panel, screen, or wall, made of withes interlaced with stakes. A very common device in Europe; not so usual here. See HURDLE.

Diodorus Siculus describes the houses of the Britons as being made of stakes wattled like hurdles, and thatched with reeds or straw. Strabo says the fashion was round, with a conical roof; Cæsar, that they resembled the houses of the Gauls, and were only lighted by the door. The Antonine Column, engraved in "Montfaucon's Supplement," III. v. 2, c. 8, and "British Monachism," page 274, shows them cylindrical, with dome-shaped or truncated conical roofs, with a central hole at the apex for a chimney.

Round houses of stone, with thatched roofs bound with straw ropes, are yet used in the Scilly Isles, the outlying lands of the Cornwall peninsula, the rough corner where the cymric autochthenes were allowed to exist when the storm of Saxon massacre swept over the land. See Woodley's "Scilly," page 165.

The wattled huts of the Britons were grouped in forests or on the banks of rivers, clustered around the residence of the chief, and protected by a ditch and rampart of earth. See Strutt, "Chronicles of England," I. 254; Fosbroke's "Encyclopedia of Antiquities," II., plate opposite page 543. For Roman camps, see *Ib.*, opposite page 556.

Fig. 7128.



Waved Wheel.

"The walls of the church [First Abbey Church of Glastenbury, England], according to Malmesbury, were made of twigs, winded and twisted together, after the antient custome, that King's palaces were used to be built. So the King of Wales, by name Heolus Wha, in the year of our Lord 940, built a house of white twigs, to retire into when he came a hunting into South Wales; therefore it was called *Ty Gwyn*, that is, the *White house*. For to the end that it might be distinguished from vulgar buildings, he caused the twigs (according to his princely quality) to be barkt; nay castles themselves, in those daies, were framed of the same materials and weaved together; for thus writes Giraldus Cambrensis, of Pembroke castle, (saith he) 'Arnulphus de Montgomery in the daies of King Henry the first built that small castle of twigs and slight turf.'" — SAMMES.

Wattled chimneys still occur in Wales; the stick chimneys, so common in the early log-cabins of our country, are very similar. The doors of the British houses were of wattled twigs and clay. Some wattled houses yet remain in Montgomeryshire, Wales; reed houses are yet found in Ireland. Dartmoor, England, has numerous remains of circular stone foundations of these ancient houses of turf or wattles: —

Junctæ cortice virgæ. — OVID.

These circles have doorways facing the south, and have diameters from 12 to 30 feet. See Fosbroke's "Encyclopedia," *ut supra*, Vol. I. pages 99 - 101.

Waved Wheel. The edge of the wheel is waved or convoluted, so that as it revolves it imparts a lateral oscillation to an arm, pitman, or what not. An anti-friction roller at the end of the arm traverses the face of the wheel, following its prominences and depressions. The cut (Fig. 7128) shows its application to a mower.

Wave-pow'er. Numerous attempts have been made to utilize in driving machinery the power of the waves.

Dr. Scoresby gives the following interesting facts with regard to the length and hight of ocean waves. The mean hight of waves in the Atlantic, driven by a westerly gale, is 18 feet. The greatest recorded hight of a wave in the North Atlantic, from the trough to the crest, is 43 feet. In northwest gales, waves 40 feet in hight have been measured off the Cape of Good Hope, while those off Cape Horn were 32 feet. The velocity of ocean storm-waves in the North Atlantic is about 32 miles an hour, and that recorded by Captain Wilkes for the Pacific Ocean

is 26½ miles. In an Atlantic storm the breadth of the waves, measured from crest to crest, is about 600 feet.

Some sixty years since a cotton-mill was built on a rocking barge, the machinery to be moved by the force of the waves.

See Buckner's patent, May 16, 1873.

One patent of March 30, 1869, has a reservoir which is filled by the waves dashing up a curved barrier wall, and the water thus raised beyond its normal hight is caused to drive a mill, and discharged at the retreat of the waves or the ebb of the tide.

See also TIDE-WHEEL; TIDE-MOTOR.

Strabo speaks of several earthquake-waves: one at an early period, recorded by Timæus, in the country of Campania.

"Helice in Achaia was overwhelmed by an earthquake-wave two years before the battle of Leuctra [373 B. C.]. Eratosthenes himself says that he saw the place." — STRABO. The disaster occurred at night; the town was 12 stadia (12 × 202½ yards) from the sea. The territory was divided among the neighboring people.

At Arica, the seaport of Arequipa, about twenty minutes after the first shock, all of which lasted but a few minutes, the sea was observed suddenly to recede and immediately afterward a wall of water, estimated to be 50 feet in hight, was seen advancing. This overwhelmed a large portion of the town, carrying with it the United States steamer Wateree and a Peruvian corvette, which had been anchored before the town, and were landed high and dry half a mile to the northward. At Chala three such waves swept in, the sea passing more than half a mile beyond its usual limits. At Islay there were no less than five such waves, each of increasing force, and an hour and a half after their commencement the waves still ran to a hight of forty feet above their usual level. At Iquique, a single wave some 50 feet in hight, after submerging an island lying in front of the town, and rushing far inland, soon resumed its usual condition.

Similar effects have been frequently noted in connection with earthquakes. Among the most remarkable was that which occurred at the great earthquake in 1755, so destructive at Lisbon, where an immense wall of water many feet in hight was observed to come rolling inward from the Atlantic, breaking with irresistible force upon the shore and carrying everything before it. The frequent earthquakes which have devastated the Pacific coast of South America, lying at the base of the Peruvian and Chilian Andes, have been accompanied by the same phenomenon. These waves, far exceeding in hight the ordinary waves of the sea, and still more the great tidal wave which twice each day makes the circuit of the globe, have twice totally destroyed the town of Callao with the greater part of its inhabitants, carrying ships far inland. None, however, have probably equalled in their hight, or in the extent for which they have been traced over the earth's surface, that which accompanied the terrible earthquake at Arequipa a few minutes after 5 P. M., on the 13th of August, 1868.

At Callao the waters retreated considerably, but the return flow was much less severe in its effects. Irregular movements of the sea, however, continued for several days.

In less than three hours after the occurrence of the earthquake the effects of this wave were experienced at Coquimbo, 800 miles south of Arica, and in about an hour it had reached Constitucion, 450 miles still farther to the southward.

At San Pedro in Southern California, nearly 5,000 miles from Arica, a few hours after the occurrence of the earthquake the sea rose upward of 60 feet above its ordinary level.

At the Sandwich Islands, over 6,000 miles distant, in the night between the 13th and 14th, the sea suddenly rose with such violence as to inundate some of the smaller islands, and its oscillations were observable for three days.

At Yokohama, Japan, more than 10,500 miles from Arica, an enormous wave poured in on the 14th of August; the hour is not given.

In the South Pacific the wave reached the Marquesas and adjacent groups shortly before midnight; some were entirely submerged. It approached the Samoa or Navigator's Islands about half past two in the morning of the 14th, and the sea, after rising to an unprecedented hight, more gradually sank; this alternate rising and falling continued for several days. New Zealand was reached about an hour later; here the water gradually receded, until at Port Littleton the whole harbor was left dry and continued so for some twenty minutes; the water then returned in a perpendicular wave, 10 or 12 feet high. About five the water retreated very slowly as before, reaching its lowest stage about six, to be succeeded an hour later by a wave similar to the first. There were four of these oscillations in all, occurring at intervals of about two hours. These disturbances, though less considerable, continued until the 17th. At hours varying from 6½ in the morning to noon the great wave had reached different points on the eastern and southern shores of Australia; but here its effects were less decided. It has been calculated that its total length could not have been less than 8,000 miles, the width varying from 200 to 1,000 miles. The length of the region where the direct effects of the earthquake were perceived is estimated at 240 miles.

Wave-trap. (*Hydraulic Engineering.*) A widening inward of the sides of piers, to afford space for storm-waves which roll in at the entrance to spread and extend themselves.

Wax. A fatty, solid substance secreted by bees. Also, some vegetable exudations, resembling true wax in qualities or appearance. See SEALING-WAX; GRAFTING-WAX; etc.

For bleaching, see patent No. 38,540.

Waxed-end. A shoemaker's sewing-thread with a bristle ingeniously fastened at the end, to enable it to lead through the hole made by the awl.

See patents, Nos.

134,998. Preparing wax-ends.
9,817. Machine for twisting wax-ends.
78,270. Machine for twisting wax-ends.

Wax'er. An attachment to a leather sewing-machine to wax the thread as it runs from the spool to the needle.

Wax'ing. 1. (*Leather-manufacture.*) The process of finishing leather which has been *shaved*, *daubed*, *grained*, *bruised*, and *whitened*. It consists of treating with *blacking* (oil, lampblack, and tallow), *black size* (stiff size and tallow), and subsequent treatment with a *slicker*.

2. The treatment of thread with soft wax in the sewing-machine for boots and shoes.

3. The process of stopping-out colors in calico-printing.

Wax-match Ma-chine'.

A machine for preparing wax-coated matches for dipping was invented and exhibited at the Paris Exposition, by Mr. Mujica of St. Sebastian, Spain. The lengths are cut by the machine, which arranges them, all the matches of each layer being cut simultaneously by one action of the knife. The material, which is flexible, being a cotton wick covered with wax, is placed in the machine in coils. From these coils, or bobbins, seventy-two little waxen cylinders are carried forward by the rotation of a pair of feeding rollers, and at the proper moment the knife cuts them, and the matches thus cut off rest upon a receiving plate covered with flannel. For the rest, the operation is essentially the same as that described above. The frame is depressed in this case by means of a screw, and a second plate is placed on the row of matches which has just been deposited. The frame will hold 4,000 or more matches, which are secured and dipped as above described. The whole operation occupies from five to eight minutes. A single workman may prepare and finish with this machine as many as 400,000 matches a day.

Wax-mod'el-ing. Wax was formerly much used by sculptors in forming their models, particularly for hollow castings. The process, however, has been generally superseded by that of clay and sand modeling, though wax is still employed by silversmiths. See STATUARY CASTING.

Founder's wax was commonly mixed with tallow, turpentine, and pitch, in the proportion of about ten of wax to one of each of the other ingredients. When the safe-mold from the model was completed it was filled in to a certain thickness with wax, and the interior was filled with a fire-proof composition of plaster and brick-dust to form a core. The mold was then removed, and the wax, after being carefully revised by the sculptor, was covered with a fire-proof mold composed of plaster, brick-dust, cow-hair, and horse-dung, laid on in layers with a brush. When sufficiently thick, the whole being properly supported and vents being made, a coal-fire was kindled around it and all the wax burned out. The mold was then bricked up, the pit filled with sand, and the metal being poured in took the place of the wax.

A simple mode of forming the wax shell is to immerse the mold, while the wax is yet fluid, into cold water; this hardens the wax superficially; the interior fluid part is then drawn off.

In the so-called *ceroplastic* art the objects, such as images, fruits, flowers, anatomical models, etc., are cast in the wax itself. The molds are composed of plaster of paris, or a composition of beeswax, burgundy pitch, and venice turpentine, with a very little olive-oil. This composition is elastic, and when thin can be peeled off the cast.

A cheap method adopted with waxen figures is to mold the face in paper pulp and size, paint it in strong colors, and apply two or three coats of fine wax through which the colors show. The eyes and hair can then be added. Local effects can be modified by painting with wax and turpentine.

Way. (*Shipwrighting.*) *a.* The timber sills upon which a ship is built, and upon which she slides in launching.

b. The inclined sills or track upon which a ship slides when being drawn up out of the water. See SLIP.

Way-end. (*Mining.*) A term applied in iron-stone mines to that part of the face where the road enters.

Way-gate. The tail-race of a mill.

Ways. Balks or skids for rolling up weights or for sliding them down.

Launching-ways support the cradle of a ship, and form the track on which it descends into the water.

The great ship of Ptolemy Philopator was built on ways; Callixenus, in his "Account of Alexandria," quoted by Athenæus in his "Deipnosophists," V. 37, says: —

"The vessel was launched originally from a sort of framework which they say was erected and made out of the wood of 50 ships of 5 ranks of oars."

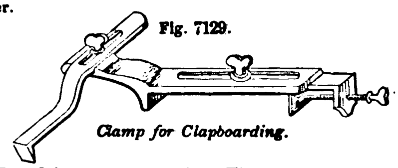
Way-shaft. (*Steam-engine.*) A shaft in a lever-beam engine which actuates the slide-valve. See LEVER-ENGINE.

Way-wis'er. A somewhat fanciful name for the *pedometer*, *perambulator*, or ODOMETER. See the latter.

Weap'ons and Ac-cou'ter-ments. See under the following heads: —

Accelerator.
Accouterments.
Air-gun.
Ammunition.
Angel-shot.
Arbalest.
Armor.
Arms.
Armstrong-gun.
Arquebus.
Arrow.
Artillery.
Assegai.
Back-sight.
Back-sword.
Ball.
Ball-cartridge.
Ballista.
Ballistic pendulum.
Ball-screw.
Bar-shot.
Battering-ram.
Battery.
Battery-forge.
Battery-gun.
Battery-wagon.
Battle-axe.
Bayonet.
Bayonet-scabbard frog.
Bilbo.
Bill.
Bird-bolt.
Birding-piece.
Blank cartridge.
Blow-pipe for blow-gun.
Blunderbuss.
Boarding-pike.
Bolas.
Bomb.
Bombard.
Bomb-chest.
Bomb for killing whales.
Bomb-lance.
Bomb-shell.
Boomerang.
Bow.
Bowie-knife.
Brake.
Breech-loader.
Breech-sight.
Broadsword.
Buckshot.
Bridge-barrel.
Bullet.
Bullet-mold.
Bullet-screw.
Bullet-shell.
Burrel-shot.
Caisson.
Cane-gun.
Canister-shot.
Cannon.
Cannon-ball.
Cannon royal.
Cap. Percussion
Carbine.
Carcass.
Carronade.
Carthoun.
Cartouch.
Cartouch-box.
Cartridge.
Cartridge-bag.
Cartridge-belt.
Cartridge-box.
Cartridge retractor.
Casemate-gun.
Case-shot.
Catapult.
Cavalot.
Centrifugal gun.
Chain-shot.
Charge.
Charger.
Chassepot-gun.
Chassis.
Chronograph.
Chronoscope.
Cimeter.
Claymore.
Coehorn.
Columbiad.
Combination fuse.
Congreve-rocket.
Cross-bar shot.
Cross-bow.
Cuirass.
Cuisse.
Culverin.
Curtal-axe.
Cutlass.
Dagger.
Dahlgren-gun.
Dart.
Dirk.
Double-barreled gun.
Double headed shot.
Enfield rifle.
Eprouvette.
Falchion.
Field-gun.
Fire-arm.
Fire-ball.
Fire-lock.
Fish-gig.
Flint.
Flint-lock.
Flying-artillery.
Foil.
Fowling-piece.
Friction-primer.
Friction-tube.
Fuse.
Fuse-lock.
Fusil.
Gatling-gun.
Gauntlet.
Gingal.
Gis-arm.
Glave.
Grape-shot.
Greek-fire.
Grenade.
Gun.
Gun-barrel.
Gun-carriage.
Gun-cotton.
Gun-harpoon.
Gun-lock.
Gunner's calipers.
Gunner's level.
Gunner's perpendicular.
Gunner's quadrant.
Gun-pendulum.
Gunpowder.
Gun-stock.
Gun-tackle.
Hair-trigger.
Halberd.
Hammer.
Hand-grenade.
Hanger.
Harping-iron.
Harpoon.
Haversack.
Helmet.
Howitzer.
Incendiary compounds.
Incendiary shell.
Javelin.
Jingal.
Junk-wad.
Knapsack.
Ladle.
Lancaster-gun.
Lance.
Langrel.
Lasso.
Leister.
Level. Gun
Light ball.
Limber.
Linstock.
Lock-gun.
Long-bow.
Lubricator.
Mace.
Madrier.
Magazine-arm.
Malkin.
Martel-de-fer.
Martin's shell.
Match.
Match-lock.
Merkin.
Metallic cartridge.
Minie-ball.
Mitrailleur.
Morning-star.
Mortar.
Musket.
Musketoon.
Muzzle-sight.
Nail-ball.
Needle-gun.
Nipple.
Onager.
Ordnance.
Ordnance-operating.
Paixhan.
Parrot-gun.
Pass-box.
Pendulum-hausse.
Percussion cap.
Percussion-fuse.
Percussion-shell.
Petard.
Pike.
Pistol.
Pistol-carbine.
Pivot-gun.
Pointing-wire.
Poniard.
Port-fire.
Pot-gun.
Powder-flask.
Powder-hose.
Primer.
Priming-tube.
Priming-wire.
Pritch.
Projectiles. See List.
Prolonge.
Proof.
Quick-match.
Quiver.
Quoin.
Rammer.
Ramrod.
Rapier.
Repeating fire-arm.
Retractor.
Revolver.
Ribadoquin.
Rifle.
Rifling.
Rocket.
Rocket-harpoon.
Round-shot.
Saber.
Saber-bayonet.
Sabot.
Saker.
Salamander.
Sand-shot.
Scabbard.
Scimeter.
Segment-shell.
Shell.
Shield.
Shot.
Shot-cartridge.
Shot-gun.
Shot-pouch.
Shrapnel.
Shunt-gun.
Siege-gun.
Sight. Gun
Signal-rocket.
Sling.
Slow-match.
Slug.
Small-arm.
Smoke-ball.
Spear.
Spherical case-shot.
Sponge.
Stanchion-gun.
Steam-gun.
Stiletto.
Stock-fowler.
Stretcher.
Sumpit.
Swab.
Swivel-gun.
Sword.
Tangent-scale.
Tape-primer.
Thumbstall.
Time-fuse.
Tinker.
Tomahawk.
Tompion.
Torpedo.
Traverse-circle.
Tube. Priming
Tumbler-punch.
Twist.
Vent-stopper.
Wad.
Wad-mill tilt.
Wad-punch.
Whip.
Whitworth-gun.
Wiper.
Wire-cartridge.
Worm.

Fig. 7129.



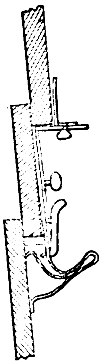
Clamp for Clapboarding.

Weath'er. (*Nautical.*) The side of the vessel exposed to the wind; in contradistinction to the *lee* or *leeward* side, which is away from the wind.

Weath'er-board. Lapping siding-boards for houses.

Weath'er-board'ing Clamp. One for holding the board against the studding while nailing. The device is clamped to the corner board or sash-facing of the house, and the adjustable claw-arm supports one end of the board.

Fig. 7130.



Clapboard-Gage.

Weath'er-board'ing Gage. One for spacing and holding the boards at a gaged distance apart while being nailed.

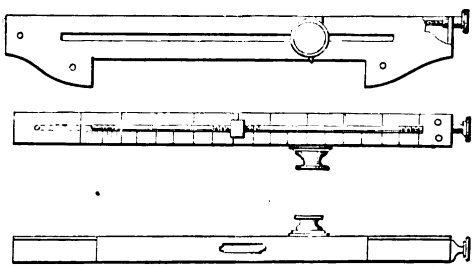
The fixed dog takes under the edge of a board, and the spring-dog is depressed by a lever to engage the face of a board below and give support to a board above.

Fig. 7131 is not for holding, but is for making the scribe-mark for the lower edge of the next board. The adjustable scribe is used for marking the weather-boarding. The slide-gage is used for spacing, is set to the scale, and is adjusted by a longitudinal screw-rod turned by a knob at the end. The spur is used to denote the place for the next gage-nail.

Weath'er-board'ing Saw. A machine for cutting logs into feather-edge boards for weather-boarding.

It is a circular saw which cuts kerfs the length of the log from the bark toward the heart the depth being that required for the width of the boards, after which

Fig. 7131.



Scribe-Hook for Weather-Boarding.

another rank of boards is cut off, if the size of the log permit. See "Holtzapffel," II. 797, Fig. 790.

Weath'er-cock. A vane, turned by the wind to show the direction thereof.

A brazen triton holding a rod in his hands was a common figure in Greece and Rome. In Constantinople, a female figure was placed on the summit of a brazen obelisk, and turned by the impulse of the wind; it was called the *handmaid of the winds*. An anemoscope near the Appian Way had a round table of stone divided and inscribed with the names of the twelve winds. The cock became a favorite form of vane, as an emblem of vigilance, and hence the name *weathercock*.

Fig. 7132.

Weather-Prophet.

Weath'er-glass. An instrument for indicating coming changes in the weather.

A *barometer*, or a *hygrometer*. One acts by the varying *weight* of the atmosphere; the latter by changes in its *wetness*.

The sympiesometer is a form of barometer.

"Walked to Greatorex's, and have bespoke a weather-glasse of him." — PEPYS's *Diary*, 1662.

Weath'er-ing. The angle at which the sails of a windmill are set.

Weath'er-proph'et. A *hygrometer*. Usually certain mechanical results from the weight or flexure of materials, due to dampness, are made to move a figure or pair of figures, — a man and a woman on a poised arm, for instance, so that the former advances from his porch in wet, the lady in dry weather.

In Fig. 7132, the seed of a geranium, which is found to coil itself up by the action of moisture, and uncoil when dry, is connected with a shaft, upon which is balanced a delicate diminutive umbrella, so that in moist weather the umbrella shall be raised up over the head of a little figure of a man, to which the shaft is attached, and fall down to a horizontal position when the weather is dry. See also HYGROMETER.

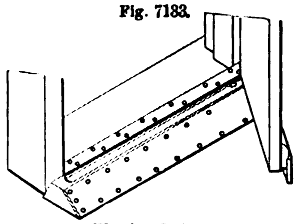
Weath'er-strip. A pliable piece of rubber, for instance, which closes accurately the space between the shut door and the threshold.

Or a jointed piece which lifts clear when the door is opened, and shuts tightly down when the door is closed.

In Fig. 7133, a flexible strip, attached to the bottom of the door, occupies, when the door is closed, a metallic trough which carries the water away.

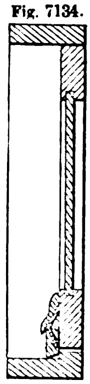
In Fig. 7134, the leaf is attached by an elastic strip to the cleat on the door. The hinging portion admits of the depression of the leaf, and, by its resiliency, acts as a spring to raise it when the door is open.

Fig. 7133.



Weather-Strip.

Fig. 7134.



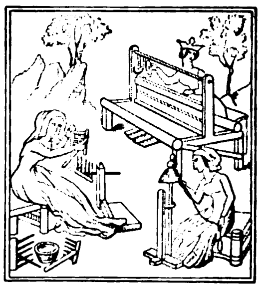
Weather-Strip

Weath'er-til'ing. That placed in vertical position on the side of a house.

Weav'ing. See LOOM.

Fig. 7135 is from an illuminated MS. of the "Boccace des Nobles Femmes," and illustrates the story of Cyrille, the wife of King Tarquin. One lady cards the wool, another spins it, using a distaff and whorl; the queen weaves.

Fig. 7135.



A Queen and her Maids at Work.

See under the following heads: —

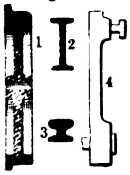
Abb.
Bar-loom.
Barrel-loom.
Basket-weaving loom.
Batten.
Bead loom.
Beam.
Beaming.
Belting-weaving loom.
Bier.
Blind-weaving loom.
Bobbin for shuttle.
Bottle-case loom.
Braiding-machine.
Brussels-carpet loom.
Button-loom.
Caam.
Card.
Carpet-loom.
Case.
Chain.
Circular loom.
Circular shuttle-box loom.
Compass-board.
Corded-fabric loom.
Cording.
Counterpane-loom.
Couper.
Crinoline-loom.
Cross-weaving loom.
Cross-shed.
Curvilinear-weaving loom.
Cut-piled fabric-loom.
Cut-mark.
Cuttee.
Damask-loom.
Double-cloth loom.
Double-piled fabric-loom.
Draft.
Drawing-in.
Draw-loom.
Driver.
Drop-box.
Elastic-fabric loom.

Electric loom.
End.
Fell.
Figured-fabric loom.
Figure-weaving.
Filling.
Flaw.
Floating.
Flushing.
Fly-shuttle.
Fringe-loom.
Gauze-loom.
Haircloth-loom.
Hand-loom.
Harness.
Harness-motion.
Heald.
Heck.
Heck-box.
Heddle.
Horsehair-loom.
Hose-loom.
Ingrain-carpet loom.
Jacquard-loom.
Lash.
Lathe.
Lay.
Lay-race.
Leaf.
Lea-rod.
Lease.
Lease-rod.
Leash.
Let-off.
Loom.
Loom-card.
Loom-harness.
Loom-shuttle.
Mail.
Matting-loom.
Metallic-tissue loom.
Narrow-fabric loom.
Palmleaf loom.
Pattern-box.
Pattern-card.
Pattern-chain.
Pattern-cylinder.
Picker.
Picker-staff.
Picking-peg.
Piled-fabric loom.
Pile-weaving.
Pile-wire.
Pirn.
Positive-motion loom.
Power-loom.
Race.
Raddle.
Ravel.
Reed.
Ribbon-loom.
Rocking-tree.
Satin-loom.
Scarf-loom.
Shaped-fabric loom.
Shawl-loom.
Shed.
Shell.
Shoot.
Shot.
Shuttle.
Shuttle-box.
Shuttle-check.
Shuttle-winder.
Sleve-cloth loom.
Silk-loom.
Simblot.
Simple.
Sley.
Split.
Stop-motion.
Straw-fabric loom.
Stripe.
Swivel-loom.
Sword.
Table.
Take-up.
Tanty.
Temple.
Templet.
Terry-fabric.
Thrum.
Travers.
Trevat.
Tubular-fabric loom.
Twill.
Twist.
Two or three ply carpet-loom.
Velvet-loom.
Warp.
Warp-beam.
Warp-dresser.
Warping-jack.
Warping-mill.
Weft.
Weft-fork.
Weft-hook.
Wire-weaving loom.
Woof.

Web. 1. Woven fabric.

2. *a.* The plate, or its equivalent, in a beam or girder which connects the upper and lower flat plates or laterally extending portions (2, Fig. 7136).

Fig 7136.



Car-Wheel.

b. The corresponding portion, between the *tread* and *foot* of a railway-rail (3).

3. That portion of a car-wheel which extends between the *hub* and the *rim* (1).

4. The blade of a saw.

5. (*Vehicle.*) Stout bands of textile fabric, used as straps to limit the extension of the hood. See also WEBBING.

6. (*Anvil.*) That portion of an ordinary anvil which is of reduced size below the *head*, and from which the divergent horns proceed.

7. The *arm* of a crank, connecting the *shaft* and the wrist (4).

8. The *bit* of a key consists of the *web* and the *wards*. The latter are the slots which are traversed by the wards of the lock as the key turns. See KEY.

Web'bing. (*Saddlery.*) 1. Canvas employed in the lining of a saddle.

2. A woven band of cotton or flax, generally striped, and used for reins, girths, straining-pieces of saddles, surcingles, bed-bottoms, etc.

Web Print'ing-ma-chine'. A printing-machine which takes its paper from the web or roll.

The *web-press* is a late improvement, and bids fair to supersede all others for large editions and long numbers where great nicety is not required. It is not yet expected that for fine book-work and cuts it will supersede the flat-bed presses.

The Walter press is described and illustrated at page 1667, Fig. 3641.

The Bullock press at page 1667, Figs. 3642, 3643.

The "Victory," page 1797, Fig. 3951.

The Campbell is running on a Jersey City newspaper, but is not illustrated in this book, not having been received in time.

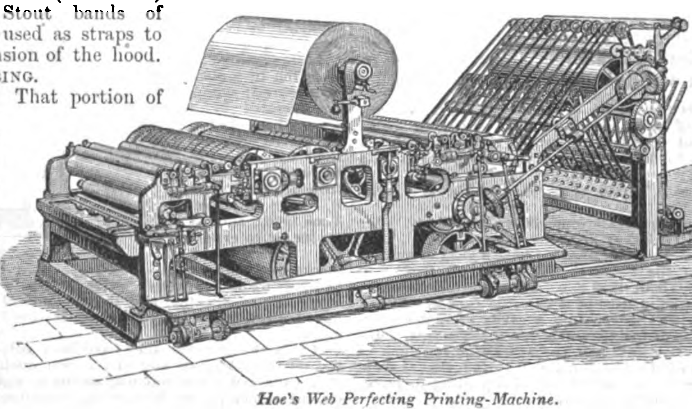
In the Hoe web perfecting-press (Fig. 7137), the paper is printed from a roll containing a length of over four miles and a half, — equal to 10,000 papers. The machine has three pairs of cylinders geared together. A roll, having been previously damped, is lifted into place by a small crane, and the paper from it passes between the first pair of cylinders, the circumferences of each of which are just equal to the required length of the sheet. One of these cylinders has its periphery covered with stereotype plates of the matter to be printed, and is supplied in the usual manner with an ink fountain and distributing rollers, which, as the cylinder revolves, apply the ink to the stereotype form. The other cylinder is covered with blanket, and as they revolve together with the paper between them they print its first side. The paper then passes on between the second pair of cylinders, and presents its blank side to the stereotype plates of the second type cylinder. The paper then passes onward to the cutting-cylinders, on the periphery of one of which is a projecting knife, that, as they revolve, enters into a narrow groove in the opposite cylinder, and thus at each revolution severs a sheet from the roll. These sheets are successively conveyed by two series of endless tapes to a revolving cylinder, which retains them until six (or any desired number) are collected upon it, when they are delivered in a body to the sheet-flyer. A circular cutter cuts the double sheets into single copies. A counter is attached which shows the number of sheets printed. The machine occupies a space of about 20 feet long, 6 feet wide, and 7 feet high.

These machines have a reputation on both sides of the Atlantic, being used by the London "Lloyd's News," "Standard," and "Telegraph," while several of them are now used in newspaper offices in the United States.

The latest form of this press was exhibited in the Machinery Hall, Centennial grounds, having an automatic folding attachment and deliveries on each of four banks, at the rate of 7,500 each, a total of 30,000 per hour of the Philadelphia "Times," equal to 15,000 of a paper of the size of the New York "Tribune," for instance.

Fig. 7138 illustrates a web perfecting-press, made at Augsburg. The paper passes first through damping-rollers, adjustable to give any required degree of wetness, then through adjustable tension-rollers to the first type-cylinder, which is the lowest in the vertical series of four, seen in the cut; the two central ones are the impression-cylinders, and the upper one the second type-cylinder.

Fig. 7137.



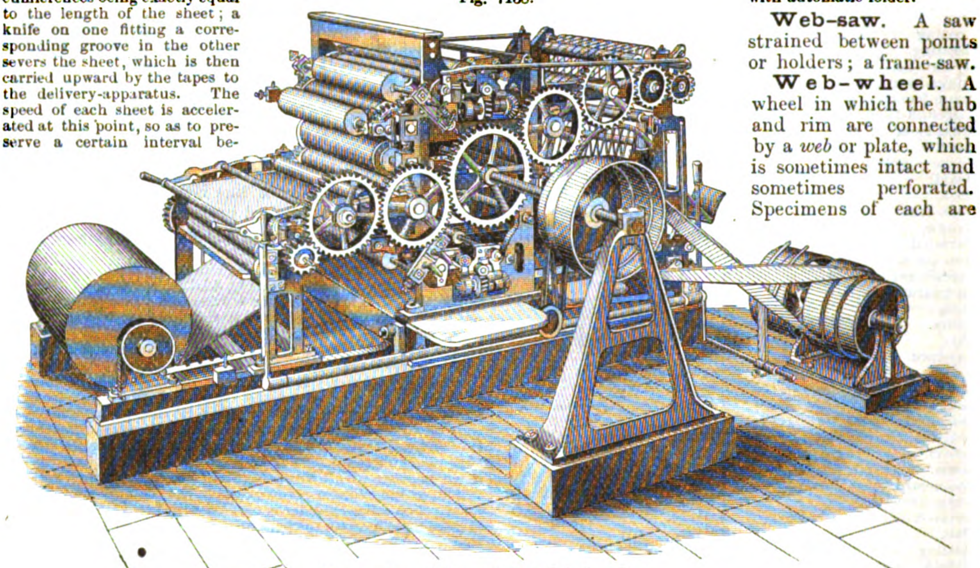
Hoe's Web Perfecting Printing-Machine.

Receiving an impression between the lower type and impression cylinders, it is carried upward and backward, and, passing forward between the upper type and impression cylinders, is printed

on the other side. These four cylinders are all exactly of the same size, producing a perfect register. The paper now passes horizontally forward to the cutting-cylinders, which are on the same level as the two upper printing-cylinders, and of the same diameter, their circumferences being exactly equal to the length of the sheet; a knife on one fitting a corresponding groove in the other severs the sheet, which is then carried upward by the tapes to the delivery-apparatus. The speed of each sheet is accelerated at this point, so as to preserve a certain interval between them. The delivery is to the right and left alternately. An index registers the number of copies printed as they are cut off.

The Campbell perfecting-press is also a two-impression and two-printing roller-machine, with automatic folder.

Fig. 7138.



The Augsburg (German) Web Printing-Press.

Web-saw. A saw strained between points or holders; a frame-saw.

Web-wheel. A wheel in which the hub and rim are connected by a *web* or plate, which is sometimes intact and sometimes perforated. Specimens of each are to be found among car-wheels. The term is applied in contradistinction to one with spokes. Clock and watch wheels are cast or stamped with webs and then *crossed out;* the web being perforated and filed till it assumes the form of a cross, having four spokes.

Wed'ding-knot. (*Nautical.*) A tie for uniting the looped ends of two ropes.

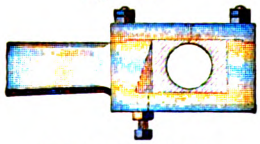
Fig. 7139.

Wedding-Knot.

a b, eyelets.
c d, the *join*.
e, the fastening.

Wedge. The uses of wedges for splitting timber or stone, for driving up tenons or the parts of scarf-joints, are familiar, and are noticed in their connection with these and other operations.

Fig. 7140.



Wrist-Box and Wedges.

The iron wedge is the *cugnus* of the Middle Ages. The ancient wedges were of holm, laurel, or elm. A Roman wedge found in Wales had a square perforation through which a handle was thrust to hold it, while it was being driven by a maul.

The mining-wedge is known as a *gad*. See Fig. 2140, page 932

Wedges for some purposes are made by machinery. See patents 121,264 and 119,306 of 1871.

Some machines for splitting firewood have a gang of wedges.

The invention of the wedge is ascribed by the Greeks to Dædalus of Athens, about 1240 B. C. Its character, however, is such that it is futile to attempt to date the time at which a tapering block was first driven into a cavity to split open a fissure. The largest of the Pyramids were built several hundred years before Dædalus, and perhaps about the time of Cecrops. The size of the blocks makes it certain that at some time in the quarrying, transportation, and depositing in place, the wedge and lever were freely used.

Fig. 7140 illustrates the use of a wedge for tightening up the box by which a shaft is secured to a crank, and for similar purposes. The bearing in each half of the box is originally made to constitute rather less than half a semicircle. The two halves do not meet, but one is advanced toward the other by turning a screw which acts on the wedge as the bearings become worn.

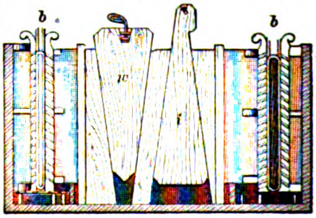
Wedge-cut'ter. A form of cutting-pliers used by dentists for cutting wooden wedges by which teeth are pried apart.

Wedge-press. A form of press, more used in Europe and formerly than now, for expressing oil from crushed seeds, such as those of flax, nuts, poppy, hemp, olive, almond, mustard, sunflower, rape, colza, castor, cocoa, cotton, etc., etc.

A screw-press has been substituted for the wedge-press in the expression of some of the above oils, but the great dependence now is upon the hydraulic press, which is more convenient, compact (according to duty performed), and powerful than any other press.

In the wedge-press, the hair-bags *b* containing the crushed seeds are placed between perforated iron cheek-plates, which allow the expressed oil to escape downward to the cistern below, whence it passes off by an opening. The space between the bags and their enveloping plates is occupied by blocks and wedges. The tightening-wedge *w* is driven by a maul or a vertical stamper, operated by a wiper-wheel, and is considered to be tight enough when the stamper makes three rebounds from it, after a blow. Time being allowed for the oil to exude, the wedges and blocks are loosened by blows upon the inverted wedge *i*. The bags being removed, others are substituted, and the contents of the bags which have been subjected to pressure are removed for farther treatment.

Fig. 7141.



Wedge-Press.

If it be the first time they have been subjected to pressure, the oil is cold-drawn and of the best quality. The meal is then subjected to the action of stampers, and another body of oil, the second quality, is expressed therefrom. The magma is

then heated, and a third quality expressed. An inferior quality may be obtained after boiling the ground cake in water. After the third expression, the cake is suitable for cattle feed. After the fourth, it is used for manure.

See Perkins's patent, August 30, 1832.

Wedg'ing. (*Pottery.*) The process of dividing a lump of clay and dashing the parts together in a direction different from its former contact. It brings the mass to a homogeneous condition, develops plasticity, and expels air-bubbles.

Wedg'wood-ware. (*Pottery.*) A kind of semi-vitrified ware without a superficial glaze, and named after the inventor, Josiah Wedgwood. See POTTERY.

Several other kinds were introduced by Wedgwood.

1. Queens-ware or cream-colored ware, made by combining metallic oxides with pipe-clay and sand.
2. Terra-cotta; a ware in imitation of porphyry, granite, and other kinds of hard stone.
3. Basalt; a very hard black ware.
4. Porcelain-biscuit; differing from the above chiefly in being of a white color.
5. Bamboo-ware; a kind of cane-colored biscuit.
6. Jasper; a delicate white biscuit, suitable for cameos and statuettes.

Weed'ing-hoe. See HOE.

Weft. The *filling* or *woof* of a *web*; running from selvage to selvage. Also known as the *shoot*, or *tram*.

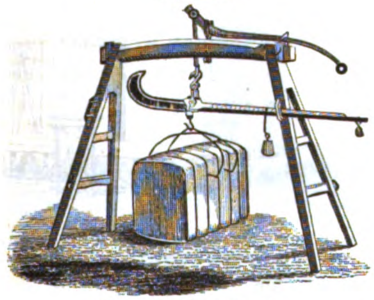
Weft-fork. (*Weaving.*) *a.* One used in certain kinds of looms where the filling is laid in, one piece at a time. See SLAT-WEAVING LOOM.

b. An arrangement for stopping the loom if the weft-thread should break or fail. The original *stop-motion.*

It was invented by James Bullough. English patent enrolled July 14, 1841.

"In the end of the reed three or more wires are inserted, and when the stay moves the reed forward to beat up the weft, the forks of an elbow-forked lever enter between these wires, and, being pressed against the weft, are forced back a little, thereby raising the hooked end of the lever, which is the heavier. But when the weft-thread fails, the forks project through the wires, and the hooked end of the lever falls by its own weight, and is caught by another hook, formed in the segmental head-piece of a vibrating lever and drawn back. By this movement a horizontal lever is made to strike the knocking-off rod, which shifts the belt from the fast to the loose pulley, and lifts the click of the taking-up apparatus out of the teeth of its ratchet-wheel."

Fig. 7142.



Cotton-Weigher's Beams.

Weft-hook. (*Weaving.*) One for drawing in the filling in the case of *slat-weaving looms* and some forms of narrow-ware and ribbon looms.

Weel. A trap-basket to catch fish. *Weal.*

Weigh-beam. Fig. 7142 shows one of Fairbanks's weigh-beams, adapted for cotton-bales or barrels, but by suspending a suitable cradle, pig-iron, hams, or any other merchandise may be weighed.

Weigh-board. (*Mining.*) Clay intersecting the vein.

Weigh-bridge. A scale for weighing loaded vehicles.

Weigh'ing-scale. A contrivance for ascertaining the weight of an object. Considered under BALANCE; DYNAMOMETER; SCALE; etc.

The compound lever weighing-scale was invented by Thaddeus and Erastus Fairbanks of St. Johnsbury, Vt., who obtained their first patent for the same, June 13, 1831.

The first scale described in the patent as a "machine for weighing heavy bodies" was a comparatively small affair, and was designed for a special emergency. The farmers of Vermont, whither the brothers Fairbanks had removed from Massachusetts, in 1815, and commenced the manufacture of stoves and plows, had engaged largely in the culture of hemp, and found the ordinary steelyard a somewhat inconvenient means of weighing. From this special machine the whole business has grown. They now manufacture 400 different sizes and modifications, a few of which are shown on Plate LXXIII. The usual run of the modification in a given line may be judged from the following partial list:—

Kinds.	Varieties.
Railway-track scales	30
Hog, depot, and stock	35
General-use platform-scales	80
Grocer's and counter use	100
Druggist's and prescription	24
Gold and coin	18
Weighmaster's beams	47
Post-office	7

The factory now employs 500 men inside, and several hundred outside; making 50,000 scales annually.

Accuracy must always be the greatest merit of a scale. If it break down under its bearings it is no scale at all; if it fail to act promptly with the addition or subtraction of a relatively small weight when nearly empty, or when loaded nearly to its capacity, it fails in quality; just as a watch fails in the test for *isochronism* when it runs relatively faster or slower when just wound up or nearly run down. The difference of a very small fraction of a grain is quite sufficient to affect the assayer's scale; the addition of a bucket of water will throw out of poise the beam of the 300-ton canal-Fairbanks-boat scale.

The test for *position* in watches has its parallel also in the test of platform-scales, in which large masses of metal are placed alternately on the different corners of the platform.

They are sold all over the world and adapted to the standards of all nations, being marked with the peculiar sign of each. Hon. Thaddeus Fairbanks received the Order of Francis Joseph in 1873.

The essential points in the Fairbanks scales are: 1. The conveyance of a precisely known, often very small fraction of the weight of the commodity to the graduated beam, this being at a point of easy inspection. 2. The broad open platform, at the level most convenient for the reception of commodities.

The weight of the platform is distributed upon the shorter arms of a series of steelyard levers, whose longer ends are connected by an upright rod with a horizontal graduated beam with sliding and attachable weights.

Some of the features once peculiar to this scale are now open to the world, the patents having expired; but it is understood that there are yet twenty-two living patents which protect special features.

Emery's scale of January 30, 1872, and subsequent patents, is an application of the hydrostatic principle, the platform resting upon pistons in cylinders containing water; a portion of the pressure is transferred by pipes to the graduated beam, the whole being the converse of the hydrostatic press, in which the pressure of a column of water of small area through a pipe is made to act beneath a piston in a cylinder of much greater relative area.

Emery's testing-machine, made for the "United States Commission for testing iron and steel," is constructed on the same principle.

Weigh-shaft. The rocking shaft used in working the slide-valves by the eccentric.

Weight. A piece (usually) of metal of known gravity and used with scales to determine the gravity of other bodies.

The weights of ancient Egypt were often rings of metal or little images. The public weighers are represented at their avocations in the pictures at Thebes. See BALANCE, Fig. 530, page 213.

The Roman weights were of lead, stone, or bronze. Some were cubes, rings, disks, and some were shaped like the lower half of a pear. A pair of scales, a touchstone, a nest of weights inscribed with the names of Trajan, Constantius, and Chlorus, and a decayed wooden case, were found in a Roman barrow in England.

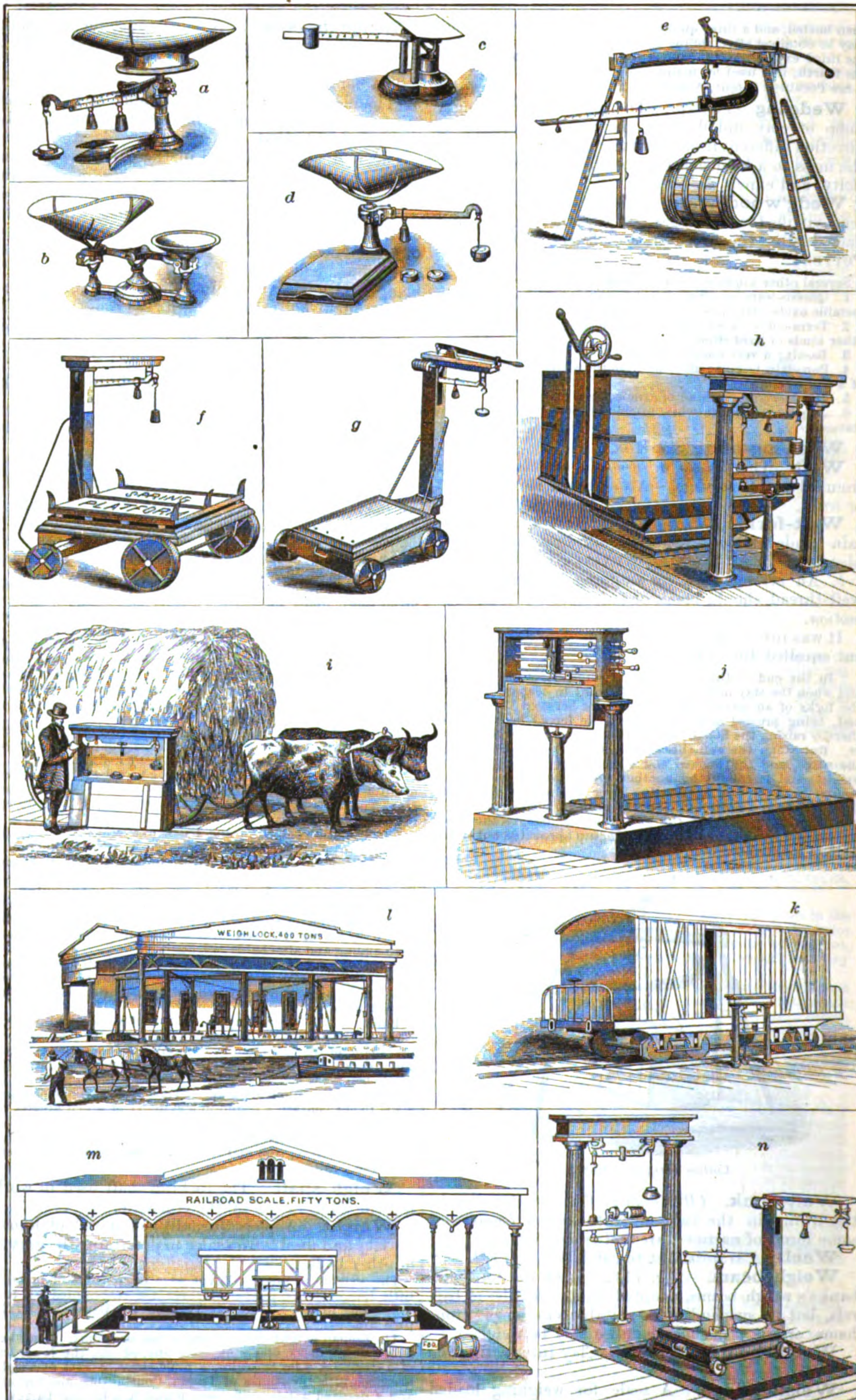


PLATE LXXIII. SOME OF THE FORMS OF THE FAIRBANKS SCALES. See page 2753.

In England (1876) there are ten different systems of weights, most of which are established by law: —

1. The *grain*, computed decimally, for scientific purposes.
2. Troy weight.
3. Troy ounce, with decimal multiples and divisions, called *bullion weight*.
4. Banker's weights for sovereigns.
5. Apothecaries' weight.
6. Diamond weight and pearl weight, including the *carat*.
7. Avoirdupois weight.
8. Weights for hay and straw.
9. Wool-weights; using as factors 2, 3, 7, 13, and their multiples.
10. Coal-weights, decimal numbers 1, .5, .2, .1, .05, .025.

Besides these the gramme, etc., of French metric system, are used by many scientists.

There are also ten different *stones*.

A *stone* of *wool* at Darlington is 18 pounds.

A *stone* of *flax* at Downpatrick is 24 pounds.

A stone of flax at Belfast is 16¾ pounds, and also 24½ pounds.

The hundred weight may mean 100, 112, or 120 pounds.

A pound weight varies in the avoirdupois and the troy.

Weights for small scales are *nest*, *cup*, *ring*, or *disk*.

Weight'ed Lathe. One in which the rest is held down firmly on the shears by a suspended weight.

Weight'ing. (*Founding.*) When the flasks in which a mold has been made cannot be held together by *cotters*, *glands*, or *clamps* alone, the top part has to be held down by weights placed upon it, so as to enable it to resist the upward pressure of the metal. Every four inches perpendicular hight of liquid cast-iron exercises pressure of one pound on the square inch; and when high *gates* are used, considerable force is necessary to hold the boxes together.

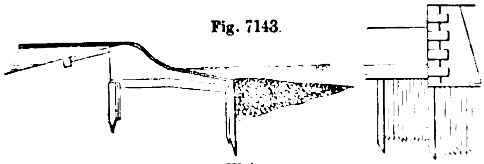
Weight-nail. (*Nautical.*) A nail heavier than a *deck*-nail, and used for fastening buttons, cleats, etc.

Weight-rest. (*Lathe.*) One which is held steadily upon the shears by a weight suspended beneath.

Weir. 1. A dam across a stream to raise the level of the water above it. The water may be conducted to a mill, a sluice, or a fish-trap.

In the fourteenth and fifteenth centuries and earlier, and indeed down to the present date, the mill-privileges on the streams of England have been improved at the expense of the surrounding country, whose drainage has been impeded thereby. In 1351, in the reign of Edward III., a special commission was issued to demolish all dams which impeded navigation, the act of Parliament refusing to allow compensation for said demolition. Seventy-six years afterward, under Henry VI., a survey and commission was ordered for the same purpose. From that day to this the interests of the landholders and millers have been at variance, the latter being to some extent aided by the interests of the slack-water navigators on many streams. Within a few years it was shown that on many streams in England the original sill of the factory over which the water flowed to the wheel is now buried 8 to 10 feet deep in the soil, and the head increased that much, minus the silt or filling in below which had backed up the tail-water. The effect has been to make marshes; "villages," as one authority states, "having been thereby placed in a morass, their soil, once loose and dry, becoming saturated with water."

Fig. 7143.



Weir.

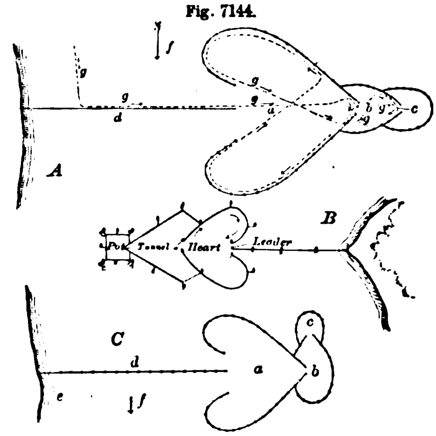
Much engineering talent has been bestowed on weirs, and many noble examples are found on the American streams both East and West.

2. An inclosure of stakes or nets, forming a fish-trap or pond.

A (Fig. 7144), salmon-weir, No. 1, Penobscot River.

a, great pound.
b, second pound.
c, fish-pound.
d, leader.
e, shore.
f, direction of current.
g, course of fish.

Fig. 7144.



Fish-Weirs.

B, improved pound-net of Lake Erie.
C, salmon-weir, No. 3, Penobscot River.

a, great pound.
b, second pound.
d, leader.
e, shore-line.
f, direction of current.

Weir-table. A table by which the number of cubic feet of water per minute can be ascertained by means of weirs.

The table indicates the number of cubic feet per minute for each inch in width, and from one to eighteen inches in depth. The water must be set back to a dead level before it passes over the weir-board, and must have a clear discharge below the weir: —

Depth of water in inches.	Cubic feet per minute, according to DuBut's formula.	Cubic feet per minute, according to experiments made in Scotland.	Depth of water in inches.	Cubic feet per minute, according to DuBut's formula.	Cubic feet per minute, according to experiments made in Scotland.
1	0,403	0,428	10	12,748	13,535
2	1,140	1,211	11	14,707	15,632
3	2,095	2,126	12	16,758	17,805
4	3,225	3,427	13	18,895	20,076
5	4,507	4,789	14	21,117	22,437
6	5,925	6,395	15	23,419	24,883
7	7,466	7,933	16	25,800	27,413
8	9,122	9,692	17	28,258	30,024
9	11,844	12,564	18	30,786	32,700

Weld. The junction of metals by heating and hammering the parts. It differs from soldering and brazing in that no more fusible metal is made to form a bond of union between the parts. The partial fusion of the parts may be assisted by a flux; borax, for instance.

Great pressure may make a perfect weld without applied heat. It is probable that heat is developed at the point of junction.

Weld'ed Tube. A gas or water pipe made of a skelp bent to a circular form, raised to a welding-heat in an appropriate furnace, and as it leaves, almost at the point of fusion, it is dragged by the chain of a draw-bench through a pair of bell-mouthed jaws. These are opened at the moment of introducing the end of the skelp, which is welded without the agency of a mandrel.

They are made from six inches, internal diameter, and ⅛ to ⅜ inch thick, to ¼ inch diameter with $\frac{1}{16}$ inch bore. See TUBE.

Weld'ing. The process of uniting two pieces of a fusible material together by hammering or by compression while softened by heat. This process is

applicable to but few of the metals, iron, fortunately, being pre-eminent among these.

Platinum also possesses this property, which is availed of in forming the granules, in which it is received from its sources of production, into masses of sufficient size to be practically useful in the arts. Horn, tortoise-shell, and a few other substances may also be joined by welding.

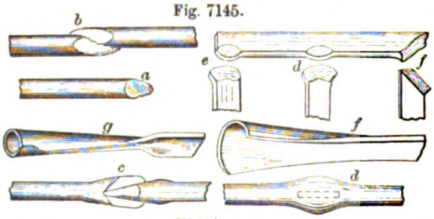
By far the most common and useful application of the process is, however, in uniting iron to iron or to steel.

This is, except in special cases, effected under the hammer, and at a particular degree of heat just above whiteness, known as the welding heat, when iron begins to emit vivid sparks.

The welding temperature of steel is, on account of its greater fusibility, considerably less than that of iron.

The process, technically called *shutting together* or *shutting up* is effected where the ends of two pieces of moderate size are to be joined, by bringing the ends of each piece to about a white or working heat, upsetting the ends to thicken them,

Fig. 7145.



Welding.

forming a widely stepped scarf (*a*, Fig. 7145), and again placing them in the forge until each is at the point of ignition; a little sand is then sprinkled over each, which fuses and spreads, serving to prevent oxidation of the surfaces.

The smith and his assistant each take a piece, and, striking them across the anvil to remove any loose cinders, place the ends together as at *b*, when the smith with the hand-hammer sticks them together, and, the helper joining in with his sledge, the two finish the operation and smooth down the work. This requires to be done with rapidity, "striking while the iron is hot." The smith afterward jumps the end of the rod upon the anvil, partly to test the soundness of the work; but principally to enlarge the part should it have become reduced below the general size.

In very heavy works the welding is principally accomplished within the fire, the two parts being previously prepared in the form of the *tongue* or *split-joint* *c*, or the but-joint *d*. When at the proper heat, they are jumped together endways, while suspended from the crane, afterward struck on the ends with sledge-hammers, and, the heat being maintained, the work is withdrawn from the fire and finished on the anvil. The but-joint is frequently strengthened, as in the case of large shafts, by *stick-in pieces*, *dowels*, or *charlins*, which are heated at another fire and inserted into notches cut in three or four sides of the joint, the whole being well hammered at the welding heat.

When two bars are required to form a T-joint, the transverse piece is thinned down as at *d*; for an angle or corner the form *e* may be adopted; but *f*, in which each part is cut off obliquely, is preferable. In most cases where two separate bars are to be joined, the metal should be first upset and then set down in ridges upon the edge of the anvil, or with a set-hammer, as the plain chamfered or sloping surfaces are liable to slide asunder when struck by the hammer. When a T-joint is made of square or thick iron, the one piece is upset and molded with the fuller, much in the form of the letter; it is then welded against the flat side of the bar; such works are sometimes welded with dowel or tenon joints.

The conical sockets of chisels, and a variety of other implements, are formed from bars of flat iron, which is spread out sideways by the hammer, and then bent (*f*) within a semicircular bottom tool, after which the sockets are still more curled up by blows on the edges and finished (*g*) upon a tapering mandrel, so that the two edges somewhat overlap at the mouth of the socket, and meet pretty uniformly for the remainder of the length; an inch or more at the mouth only is usually welded, but sometimes the whole length.

For the method of making and welding gun-barrels and wrought-iron tubing, see GUN-BARREL; TUBING; WROUGHT-IRON.

Borax, either alone or mixed with other substances, is frequently employed in place of sand, particularly when steel is to be welded. A variety of these compositions have been recommended: —

1. Borax, 10; sal-ammoniac, 1. Pound or grind together, and melt them into a clear liquid. Pour the liquid out, and, when cool, pulverize for use.

2. Borax, 5 pounds; sal-ammoniac, 1 pound; prussiate of potash, ½ pound; rosin, ½ pound; alcohol, ½ pint; water, ½ pint; iron-filing, ½ pound. Melt them in an iron pot, over a gentle fire; allow the compound to boil for a few minutes, until it becomes dry and charred; then pulverize.

3. A Belgian patented composition consists of iron-filings, 1,000; borax, 500; balsam copavia, or other resinous oil, 50; sal-ammoniac, 75. They are mixed, heated, and pulverized.

4. Borax, 15; sal-ammoniac, 2; prussiate of potash, 2. Dissolved in water, which is gradually evaporated at a low temperature.

5. Schierloh's patent. Calcined borax, mixed with wrought-iron, reduced by grinding or other means to particles a little larger than coarse filings. Applicable for steel-facing rails and other large welds.

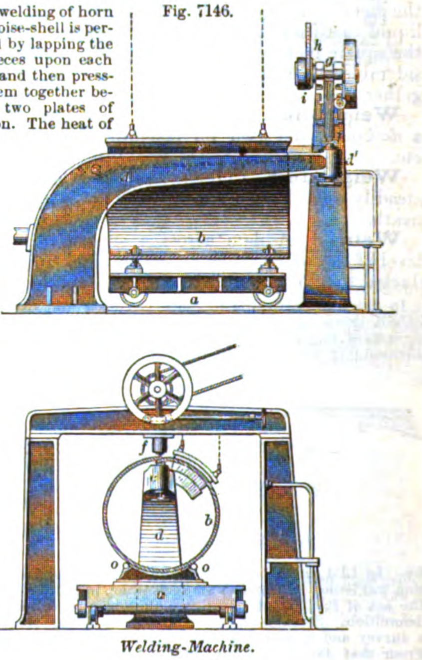
6. "Antimonoid." A German welding-powder, composed of iron-turnings, 4; borax, 3; borate of iron, 2; water, 1.

Mr. Rust, Bavarian inspector of salt-works, writes to Dingler's "Polytechnic Journal," that he succeeds perfectly in welding copper by using the phosphate of soda and ammoniac, or, what is cheaper, a mixture of 1 part phosphate of soda and 2 parts boracic acid. The welding-powder should be strewn on the surface of the copper, at a red heat; the pieces are then heated up to a full cherry red, or yellow heat, and brought immediately under the hammer. Great care must be taken that no charcoal or other solid carbon come in contact with the points to be welded, causing the production of a phosphide of copper, which would effectually prevent a weld. On account of the softness of the copper at its welding point, less force must be exerted in uniting the two by means of the hammer.

W. B. Adams (English) welds by making a close joint to the parts and heating by jets of gas and air supplied under pressure.

The welding of horn or tortoise-shell is performed by lapping the two pieces upon each other, and then pressing them together between two plates of hot iron. The heat of the iron is prevented from injuring the shell by the interposition of a wet linen cloth, and by immersing the whole in hot water.

Fig. 7146.



Welding-Machine.

Weld'ing-ma-chine'. One for uniting the edges of plates previously bent, so as to lap within a chamber when they are exposed to a gas-flame, and from which they pass to the rolls or hammer which completes the joint.

In Fig. 7146, *A* is a sectional and *B* an end view of a machine for welding plates, patented by W. S. Sutherland of Liverpool, England. It consists of carriage *a*, on which the tube *b* to be welded is placed, supported on rollers *o o*. The furnace *c* is of peculiar construction, carried by the arm *d*, which, in the example, also carries the adjustable anvil *e*; *d'* is an air supply-pipe. Above the anvil is the hammer *f*, worked by an eccentric on the shaft *g*, the eccentric being driven by a band *h* on a pulley *i*. In some cases the furnace is carried by chains, so as to be raised and lowered easily. There is an arrangement for

adjusting the hammer to suit various thicknesses of plates. The edges to be welded are heated in the furnace, and the tube is then run under the hammer and partially revolved, to bring the joint directly between the hammer and anvil

Weld'ing-swage. A block or fulling-tool for assisting the closure of a welded joint. See SWAGE.

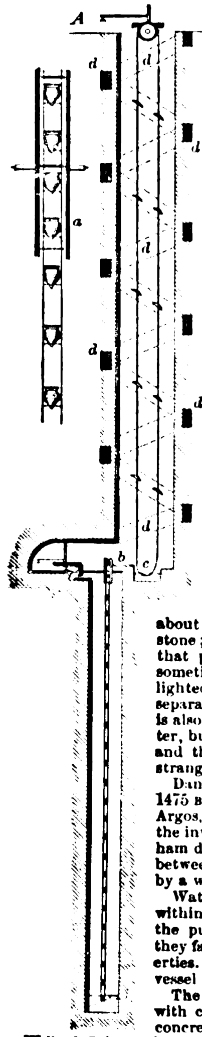
Well. 1. A shaft dug or bored in the ground to obtain water. Lately, some of the deepest have been in search of brine and oil. See ARTESIAN WELL.

The wells of Beersheba, dug by Abraham and re-dug by Isaac, are yet in existence. There are two large ones and five smaller ones. The larger of the two is 12¼ feet across, and 44½ feet to the water. The curbstones of the wells, around the mouth, are worn into deep furrows by the ropes of centuries. The remains of a town are in the neighborhood, but no habitations, shrubs, or trees. The generations of Abimelech, the sons of Samuel who "turned aside after filthy lucre" and "took bribes," the idolaters of the time of Amos, the returned Jews under Nehemiah, the Christians of the time of Jerome, have passed away, but have left these holes in the ground for an enduring record.

Jacob's well at Sychar — the ancient Shechem — has been visited by travelers in all ages and has been minutely described. It is 9 feet in diameter, and 105 feet deep, made entirely through rock. When visited by Maundrel it contained 15 feet of water

The well of Joseph, at Cairo, is the most remarkable work of its kind on record.

Fig. 7147.



Well of Cairo.

A (Fig. 7147) is a section of this well. Its age and the name of its designer are unknown; by the common people it is generally ascribed to the patriarch Joseph; some formerly believed it to be the work of genii, while other authorities attribute its construction to the Saladin of the Crusades, whose real name was *Yussuf*, or Joseph; and still others to a vizier named Joseph, 800 years ago.

It is excavated in the solid rock, with a section of 18 × 24 feet to the depth of 165 feet, where an enlarged chamber *b* is formed, in which is cut a reservoir for the water brought up from below; from this point another shaft, not in the same vertical line with the upper one, is sunk to a farther depth of 130 feet, when a bed of gravel is reached, from which the water is obtained. The whole depth is 297 feet.

Water is raised from the lower well by means of a chain of pots *a* — the *na ura* of the Arabs (see NORIA) — operated by the power of horses or oxen turning wheels within the chamber *b*, and is emptied into the reservoir *c*, whence it is drawn up to the mouth of the well by a second chain of pots raised by animals at the surface. To enable the animals and their attendants to reach the chamber *b*, a winding passage *d d*, 6 feet 4 inches wide and 7 feet 2 inches high, is cut in the rock, surrounding the well and separated from it by a partition of about 6 inches in thickness left in the solid stone; this passage has so gentle a slope, that persons mounted on asses or mules sometimes ride down it; it is faintly lighted by windows cut through the thin separating wall. In the lower shaft, a path is also cut down to the bottom of the water, but as there is no partition between it and the well, its descent is dangerous to strangers.

Danaus, who came from Egypt about 1475 B. C., may have introduced wells into Argos, but he is scarcely to be credited with the invention, as recorded by Pliny. Abraham dug wells 1892 B. C., and the interview between his servant and Rebecca took place by a well of water about 1857 B. C.

Water was scarce in Attica. Neighbors within 4 furlongs were allowed to come to the public wells if after digging 60 feet they failed to find water on their own properties. They might fill at the public well a vessel of 6 gallons twice a day.

The Roman wells were *steined*, or walled, with concrete, to prevent filtration. The concrete was made of pure, rough sand, broken flint, and lime. The proportions in the mortar were: pure sand, 5; lime, 2 parts. The flints were combined in the mass, lining the sides and bottom of the excavation.

Contrary to some of the suggestions of writers on this subject, we do not suppose that *boring* for water was practiced in the patriarchal times in the countries bordering on the Mediterranean, but think it probable that they were dug and quarried, as the text of Genesis and the appearance of the ancient wells would indicate.

The Chinese mode of boring wells has been practiced in that country from time immemorial, and is thus described by the Abbé Imbert, a French missionary: —

"There exist in the province of Ou-Tong-Kiao many thousand wells, in a space of ten leagues long by five broad. Each well costs about one thousand and some hundred taels (the tael is worth 6*s.* 3*d.*). These wells are from 1,500 to 1,800 feet deep, and of a diameter of from 5 to 6 inches.

"To bore them, they commence by placing in the earth a wooden tube of 3 to 4 inches diameter, surmounted by a stone curb pierced by an orifice of 5 to 6 inches. Then a trepan, weighing 300 or 400 pounds, is allowed to play. A man, mounted upon a scaffold, depresses a lever which raises the trepan 2 feet high, and lets it fall by its own weight; the trepan is attached to the lever by a cord of rattan, to which a strip of wood is fixed; a man seated near the cord seizes this strip at each elevation of the lever, and gives it a half-turn, so that the trepan, in falling, may take a different direction. The workmen are changed every six hours, and the work goes on night and day. They are sometimes three years in boring these wells to the depth necessary to reach the springs they are intended to attain."

See ARTESIAN WELL.

In Europe, the province of Artois has been noted for its bored wells since early in the twelfth century, and one is shown at Lillers which is believed to have been bored in 1126. See ARTESIAN WELL.

The arms of Modena, several hundreds of years back, were a pair of well-boring augers; and a professor of medicine of that city wrote, in 1691, a treatise on "physics," which explained the mode of boring for water.

The first notice of boring in England was not for the purposes of a well, but to ascertain the solidity of the foundation of St. Paul's, a number of crypts and structures having successively stood upon the same spot, and it was difficult to determine how much of the slight eminence was débris and how much reliable for supporting the ponderous building Sir Christopher Wren designed to erect.

Toward the end of the last century, the practice of boring was not uncommon in England, and a number of artesian wells were obtained, one especially in London, which was dug and bored 260 feet.

Gas from bored wells is now used extensively in and near Pittsburgh, in heating furnaces. See also GAS, page 244.

The Burns gas-well, on the Duffy farm, 35 miles from Pittsburgh, emits 1,000,000 cubic feet of gas per hour, weighing 58¼ tons. The gas is $C^4 8^6$, or 80 per cent of carbon and 20 of hydrogen. The pressure of gas is 200 pounds to the square inch. The delivery of gas is 1,408 tons per day, or 1,126 tons carbon, 282 tons hydrogen, equal to 1,250 tons anthracite coal, or the charcoal made from 5,000 cords of wood; estimated to be equal to the wood obtained by clearing 125 acres of forest, sufficient in smelting iron ores to make 700 tons of pig-iron daily. See "Galaxy," January, 1876.

One of the deepest, if not the very deepest, bore-hole which was ever sunk, is 24 miles south of Berlin, near the village of Sperenberg, where a small hill, composed of gypsum, crops out in the diluvial plane of Brandenburg. The presence of gypsum so near the capital caused the Prussian mining authorities to search there for rock-salt, and, in 1867, a bore-hole of 15¾-inch diameter was begun at that place, in the gypsum rock itself. This rock was sunk through for 273½ feet, when antrydrite or antrydric sulphate of lime was met with, which, however, after a depth of only 5 feet, gave place to rock-salt, which was struck quite pure at a depth of 284 feet from the surface. The bore-hole was continued, and at the end of 1868 it had reached 956 feet, and had still an inner diameter of 12¼ inches, after three sets of iron tubes had been inserted. Since the beginning of 1869 boring commenced with steam-power, and by the end of that year the bore-hole was sunk to 2,527 feet, by the end of 1870 to 3,479 feet, and in 1871 it was stopped at a depth of not less than 4,052 feet Rhenish, or 4,170 feet English, from the surface, which is the greatest depth that has ever yet been reached. The strata of rock-salt is 3,768 Rhenish feet.

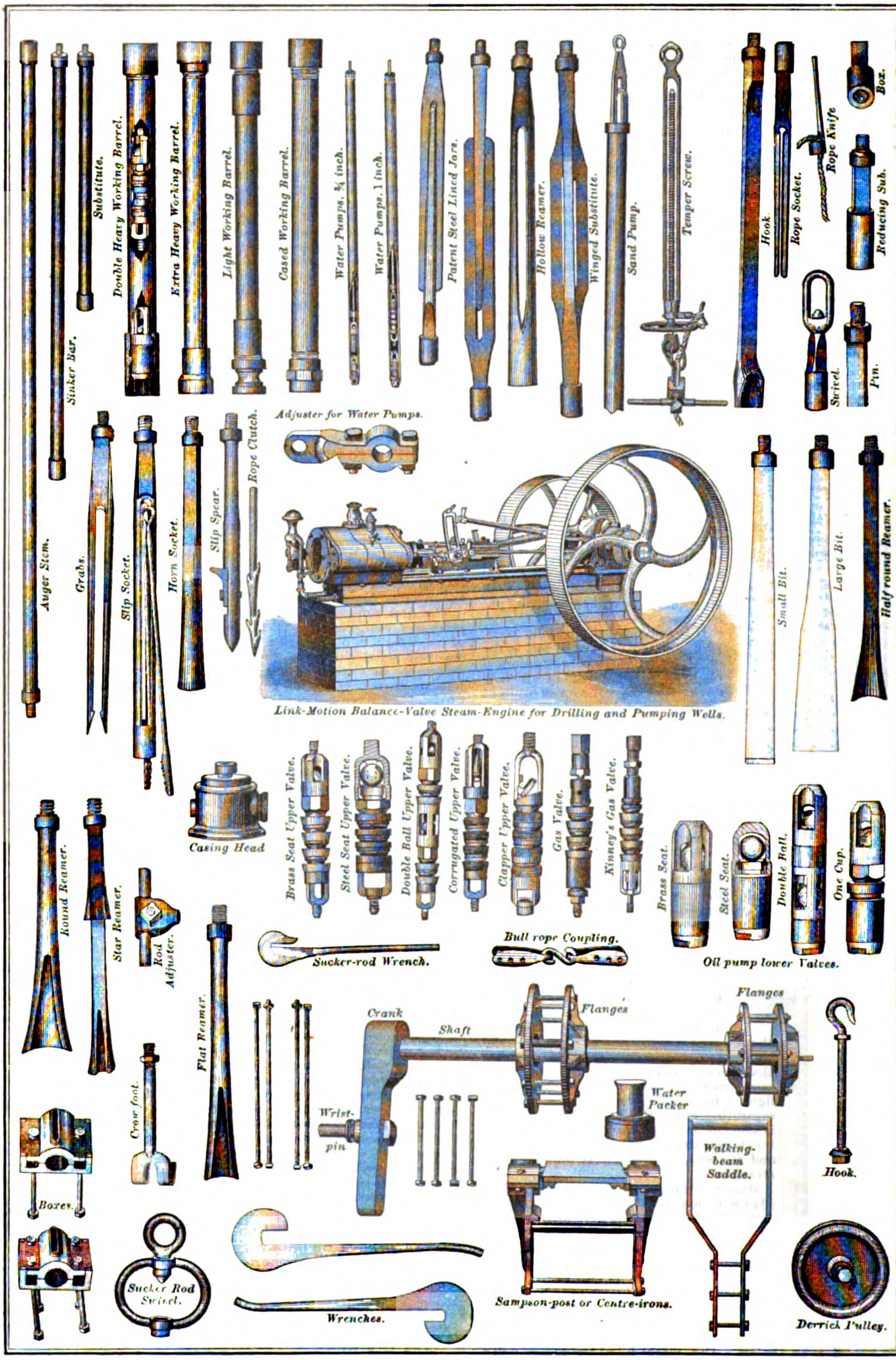
2. (*Mining.*) The lower part of a furnace, into which the water falls.

3. (*Nautical.*) *a.* A boarded inclosure for the pump-stocks.

b. A portion of a vessel's hold open to the sea, for keeping live fish.

4. A deep cavity in a building, occupied by the stairs.

Well-bor'ing Jar. The *jar*, or slide-joint, is the invention of Oeuyenhausen. See Plate LXXIV.



TOOLS AND IMPLEMENTS FOR DRILLING AND PUMPING OIL OR ARTESIAN WELLS.

PLATE LXXIV. (*Gibbs and Sterrett, Corry and Titusville, Pa.*) *See page 2759.*

It consists of two parts able to slide upon each other for a distance of about 1 foot, and so arranged that during the descent one becomes detached from the other. The upper part is balanced by the counterpoise. When the boring-tool is allowed to descend after it has been raised for the purpose of getting the blow, it will strike the bottom simply with a weight equal to that of the lower portion, and the upper portion will descend gently through the distance of 1 foot until it rests upon the collar. Should it be required to bore without percussion, the slide-joint is suppressed, and a common rod substituted; in that case also the lighter and weaker rods are replaced by stout bars able to resist an effort of torsion.

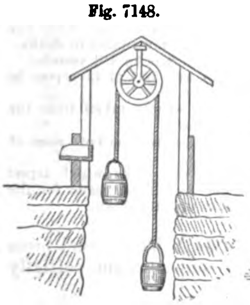
Well-bor'ing Tools. *Well-rig* is the term applied to the whole *plant* for well-boring, consisting of the *derrick*, its engine and operative parts, and the various tools, such as drills, reamers, sucker-rods, grabs, and adjusters; its casing-pipes, pump-rods, valves, casing-heads, swivels, couplings, and wrenches.

Plate LXXIV., opposite, shows a Gibbs and Sterrett (Titusville and Corry, Pennsylvania) full rig, the names of the parts being attached to them for facility of reference.

Well-buck'et El'e-va'tor. A common mode of elevating water is by reciprocating buckets, which are fastened to the ends of a chain plying over a wheel above in alternate directions. The empty one in descending forms a partial counterbalance for the ascending bucket of water.

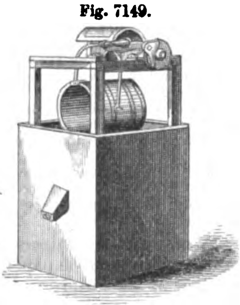
Fig. 7149 shows an arrangement by which the lip of the elevated bucket is engaged so as to tip the bucket and spill the contents into a trough, which has a discharge-spout on the outside of the curb.

Fig. 7148.



Reciprocating Buckets.

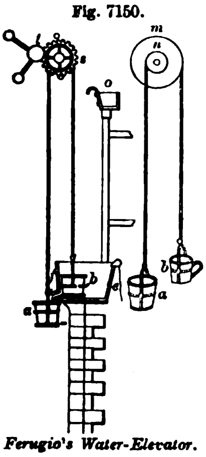
Fig. 7149.



Bucket-Tipping Arrangement.

An automatic reciprocation of two buckets having varying capacities when full and weights when empty was invented by Gironimo Ferugio at Rome, in 1616.

Fig. 7150.

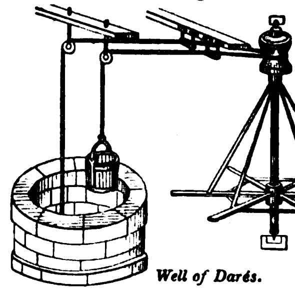


Ferugio's Water-Elevator.

The bucket *a* is larger than the bucket *b*, and consequently holds more, giving *a* the preponderance over *b* when full. When empty, *b* weighs more than *a*, being purposely weighted, giving *b* the preponderance when it descends for another load from the cistern. The tank *e* is constantly supplied with water, which as constantly escapes by the spout *f*. The water escaping from the cistern *e* into bucket *a* depresses the same and raises a smaller quantity of water in the bucket *b* to the elevated cistern *o*. On the middle hoop of the bucket *b* is an ear which catches the hook on the edge of the cistern *o*, so as to tilt the contents of the bucket into the cistern. The lower hoop of the bucket *a* has also an ear, which, at the bottom of the descent, catches upon a hook and tilts its contents. The buckets being emptied, the preponderance of weight is in favor of *b*, which descends, raising the bucket *a* to be again filled, and plunging itself in the cistern *e* to receive another supply.

The toothed wheel *s* engages a pinion *t* to insure regularity of motion, by means of a fly-wheel on the pinion-shaft. When the fall of the bucket *a* is less than the elevation of the bucket *b*, a wheel and axle *m n* are employed, with a corresponding increase in the capacity of *b* in the proportion of the radii of *m n*.

Fig. 7151.



Well of Darés.

At Darés, near Dieppe, the garrison was supplied with water from a deep well by means of buckets raised alternately by a rope passing around a drum on a vertical axis rotated by 6 men, who each exerted a force of 25 pounds upon the ends of the levers, and raised 13 cubic feet of water at a haul.

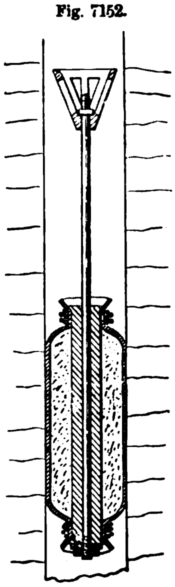
The Anglo-Saxons used the chain and wheel; the pivoted and weighted well-pole; two buckets on a chain with a wheel; buckets with iron hoops. See also SHADOOF; SWEEP; etc.

Well-drill. A tool for boring wells. See WELL-BORING TOOLS; ARTESIAN WELLS; etc.

Well-hole. A hollow newel in a staircase.

Well-pack'ing. A bag of flaxseed — known as a *seed-bag* — or some other material placed around a well-tube in an oil-well to isolate the oil-bearing strata from water above or below.

Fig. 7152.



Seed-Bag.

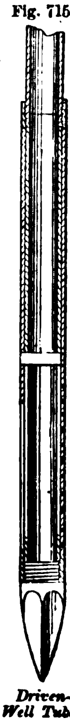
Well-stair'case. A winding staircase built around a hollow newel.

Well-tube. The driven-well, invented by Colonel Nelson W. Green, 76th Regiment New York Volunteers, at Cortland, N. Y., 1862. Used by the British army in Abyssinia. See TUBE-WELL.

Colonel E. L. Drake of New York, subsequently of Titusville, Pa., drove his oil-tubes to the rock, after which he bored. The practice of sinking fresh-water wells by this method has now become common in sections adapted to this mode.

Fig. 7153 shows one in which the inner tube — which prevented the passage of gravel or sand through the holes in the outer one while driving — is subsequently drawn up to expose the holes.

Fig. 7153.



Driven-Well Tube.

Well-tube Fil'ter. A strainer on a driven-well tube to keep back gravel. The illustration (Fig. 7154) has a strainer made by a coil of wire.

In Fig. 7155, the tube is shod with a conical plug, and the lower portion is perforated and lined with wire gauze.

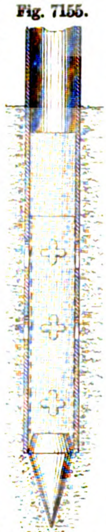
Well-tube Point. An auger or spear point at the bottom end of a perforated tube for a driven well (Fig. 7156).

Welt. A strip forming an additional thickness laid over a seam or joint, or placed in an angle to

Fig. 7154.

Filter for Well-Tubes.

Fig. 7155.



Tube Filter and Point.

strengthen it. Applied to a form of back-strip which covers a flush joint. See CARVEL-BUILD.

A joint or fold.

A border or edging.

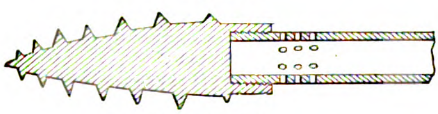
2. (*Shoemaking.*) A strip of leather around the shoe, between the *upper* and the *sole*.

3. (*Sheet-iron Work.*) A strip riveted to two contiguous portions which form a but-joint. As contradistinguished from a *lap* or *turned* joint.

4. (*Knitting-machine.*) A flap of work (as a heel-piece) disengaged laterally and knitted separately from the main body, and subsequently joined thereto by re-engagement of loops or by hand-knitting.

Welt-cut′ter. (*Shoemaking.*) A machine to cut the notches in the edge of the welt to permit it to be bent around and laid smoothly at the toe. The motion is by a treadle; this depresses the angular cutter, which is again raised by a spring.

Fig. 7156.



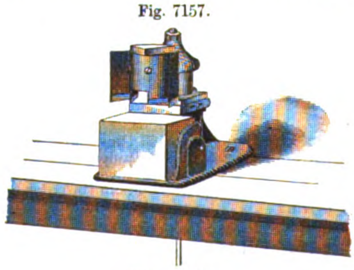
Well-Tube Point.

Welt-guide. (*Sewing-machine.*) An attachment for presenting the welt in the machine so as to be sewn by the needle to the other portion or portions of the boot or shoe. See SEWING-MACHINE ATTACHMENTS, G. W. Gregory, Boston, Mass.

Welt-knife. (*Shoemaking.*) A knife used to trim the welts of shoes and boots.

Welt-ma-chine′. (*Shoemaking.*) A machine to cut leather, cloth, etc., into a series of parallel strips, to be used as welts in side-seaming. The

Fig. 7157.

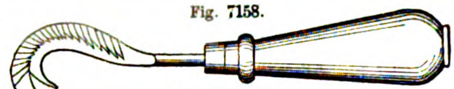


Welt-Cutter.

material is passed into the machine irrespective of its width, the end-knife separating the portion not cut into strips before it can be carried against the standard.

Welt-trim′mer. A cutting-tool for trimming the welts of shoes. The figure shows one composed of a beveled blade having a cutting edge, a guard, and a rasp on it, and provided with a shank and handle.

Fig. 7158.



Welt-Trimmer.

Wet-dock. In contradistinction to dry-dock, in which a vessel is placed for repairs, the water being pumped out.

A tidal or shipping-dock.

In the basin the water is maintained at such a hight as to float the vessels therein at all times. The dock is connected by a lock with the navigable waters, and the gates maintain the level of water in the basin irrespective of the hight or fluctuations of the water outside. The operation of locking a vessel in or out, except at flood-tide, when the outside and inside levels may be the same, is similar to the process of locking canal-boats. See LOCK-CANAL, page 1341.

The docks of Liverpool are the most extensive in the world. The wet-docks are 37 in number, having an area of 167.517 acres. The dry basins are 7 in number, with an area of 20 185 acres. The whole dock-water space is 235 acres, on the Liverpool side of the river. The graving docks are numerous, and the lineal yards of quay space amount to 19,195 yards.

Most of the docks have their own entrances to the Mersey, and the whole chain of docks are connected independently of the river. They also have inland canal and railway connections.

The dock-water space of Birkenhead, on the opposite side of the Mersey, is 153 acres.

The docks of London cover an area of 227 acres; 154 acres being on the Middlesex side, and the remainder on the Surrey side.

The tonnage of London is three times that of Liverpool, but the Thames has spacious and convenient moorings, while the shipping of the Mersey is necessarily accommodated in docks.

The moorings of the Thames afford berths for 461 vessels.

The number of vessels passing in and out of Liverpool in 1860 was 48,317; equal to 132 per day.

The docks of Liverpool are inclosed spaces taken from the river Mersey, the area afterward dug out.

The London docks are excavated in the land on both sides of the river.

The Bristol docks are made by walls and locks, which arrest the water of the river Avon, a new cut being made for the river, and for the passage of vessels up and down.

See list under DOCK.

Wet-press. (*Paper-making.*) The second press in which hand-made paper is compacted and partially drained of its water.

The sheets from the mold are laid in alternation with felt in the first press and subjected to pressure, 144 sheets of paper and the same of felt forming a *post*, which is the amount pressed at one time.

When a second *post* is ready, the first is removed from the press, taken apart, and the sheets made into a compact pile without the felts. Several of these piles are formed into one larger one which is placed in the *wet-press* for a final pressure.

The sheets from the wet-press are dried in bunches across strings, in the loft or drying-room.

Wet′ting-ma-chine′. A machine for damping paper for printers' use.

Whale-boat. A clinker-built boat, sharp at both ends, generally from 20 to 28 feet in length, and rather deep for its width; it pulls four or six oars and is steered by an oar; the ends have a considerable sheer.

Patent No. 73,484, of 1868, is for a whale-boat chock.

Whale′bone. Preferably called *baleen*, as the term *bone* is neither pertinent nor appropriate.

A horny substance occurring in long, thin plates, fringed at the edges and acting as a strainer to detain the whale's food when he ejects the water which he has swallowed with the medusæ and small fry which constitute his food. The principal source of whalebone is the *right whale*, so called, the *Balæna mysticetus* or *australis*. Some 300 of these plates are found in the mouth of an adult whale, and vary from 10 to 15 feet in length. The *baleen* is prepared by boiling and dyeing black.

Machines are made for cutting and splitting baleen. The following patents may be consulted: —

No. 70,545	1867.	No. 121,520	1871.
91,047	1869.	145,539	1873.
96,220	1869.	145,770	1873.
105,498	1871.		

Patent 20,299 is for an artificial whalebone.

Time has passed since the people of England reveled in whale meat. The whale was, however, eaten by the Saxons, and, when men were lucky enough to get it, it appeared at table late in the fifteenth century. In 1246, Henry III. directed the sheriff of London to purchase 100 pieces of whale for his table. Whales found on the coast were perquisites of royalty; they were cut up and sent to the king's kitchen in carts. Edward II. gave a reward of 20 shillings to three mariners who caught a whale near London Bridge. Those found on the banks of the Thames were claimed by the lord mayor, and added to the civic feast. Pieces of whale were often purchased in the thirteenth century for the table of the Countess of Leicester. England was supplied with this choice dainty by the fishermen of Normandy, who made it an article of commerce. The Normans had various ways of cooking it; sometimes it was roasted and brought to the table on a spit, but the usual way was to boil it and serve it with peas. Epicures looked out for a slice from the tongue or the tail. The grampus or sea-wolf was also highly esteemed, but, of all the blubber dainties, the porpoise was deemed the most savory. The Saxons called it sea-swine, and the ecclesiastics of the Middle Ages *porco-marino*. Porpoises were purchased for the table of Henry III. in 1246.

Whal'ing-im'ple-ments. See HARPOON; BOMB-LANCE.

Patents No. 3,290, of 1843, and 9,478, of 1852, are for machines for cutting blubber.

No. 8,843, of 1852, is an electric whaling-apparatus.

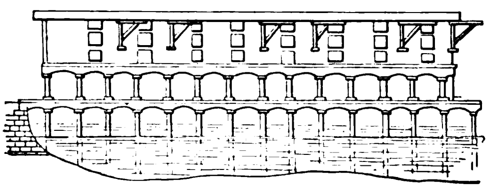
No. 35,476, of 1862, is for raising sunken whales. They have a disagreeable habit of sinking when the life is out of them, especially if the harpoons or lances have penetrated the carcass so that it collapses.

Whang. Tough leather adapted for strings, thongs, belt-lacing, etc. It is of calf-hide commonly, but better still is the tanned hide of a dog, ground hog, or raccoon.

Wharf. A landing-place for cargoes. A *quay* or *mole*.

Fig. 7159 is an elevation of a pier, wharf, and warehouse; the pier having an open way beneath it for the flow of the water, being constructed on iron columns, and the wharf having a

Fig. 7159.

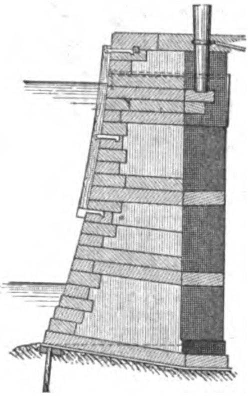


Hyde's Pier, Wharf, and Warehouses.

cart-way around it to facilitate loading and unloading vessels, and the delivery of freight from the warehouse.

Fig. 7160 shows the application of iron to pier and bulkhead work. The hollow piers of metallic tubular sections are so formed that each tube or section is locked between two tubes or sections when arranged in lines or angles to form the pier of any desired shape, according to its location. The tubes, when two or more sections are set in place, are filled with cement, to exclude water. A chamber is formed partly in each tube, which, when two tubes are united, registers throughout the entire length of the tubes, and is filled with wood, plaster, or cement, to prevent the passage of water between them when in position. Lateral openings, protected by glass, in the separate sections, admit light to rooms in the interior of the pier.

Fig. 7161.

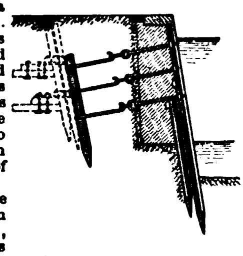


Sectional View of Retaining-Wall.

Fig. 7161 is a sectional view of a retaining-wall employed for wharves in some English tidal harbors. The masonry is laid on a timber platform, the front of which is protected by sheet piling. The face of the wall is curved, to permit vessels to lay closer alongside, and is protected by perpendicular oaken fenders, secured by iron ties.

Fig. 7162 is a section of a wharf at Blackwall, London. The front is formed by a series of iron piles 7 feet apart, backed by shorter sheeting-piles, and anchored to other series of piles farther in shore. The spaces over the sheeting-piles are closed by iron plates bolted to the main piles and to each other, and backed by a wall of concrete.

Fig. 7162.



Section of Wharf at Blackwall, London.

Plate LXXV. is a view of the contemplated improvements on the river-front, New York City, showing the new system of piers and bulkheads.

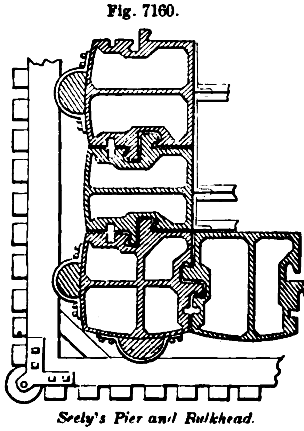
Wharf'ing. (*Hydraulic Engineering.*) A mode of facing sea-walls and embankments by means of driving upright planks in the manner of sheet-piles, the joints being backed by other planks, and the whole secured by land-ties and tightly driven earth in the rear.

Wheat-drill. A machine for sowing wheat and other grain in rows. Each hoe in the series opens a furrow, and the grain is led in by a rubber tube, which conducts the seed from the hopper.

The improved drills of the present day have hoppers attached for sowing grass-seed or fertilizers, and some have arrangements for sowing grain or corn broadcast.

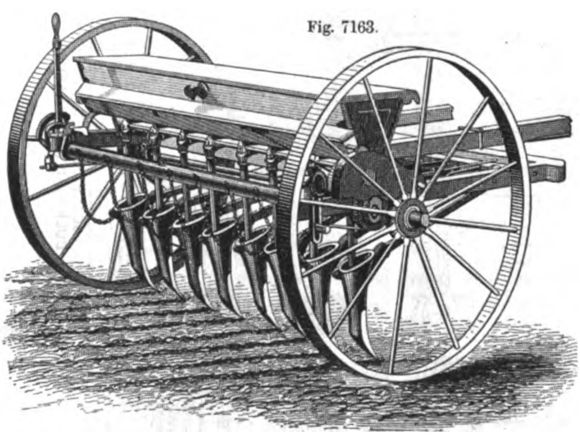
Fig. 7163 is a perspective view of Mast's wheat-drill (Springfield, O.). Fig. 7164 shows the *force-feed* wheel, one of which

Fig. 7160.



Seely's Pier and Bulkhead.

Fig. 7163.



Wheat-Drill ("Buckeye").

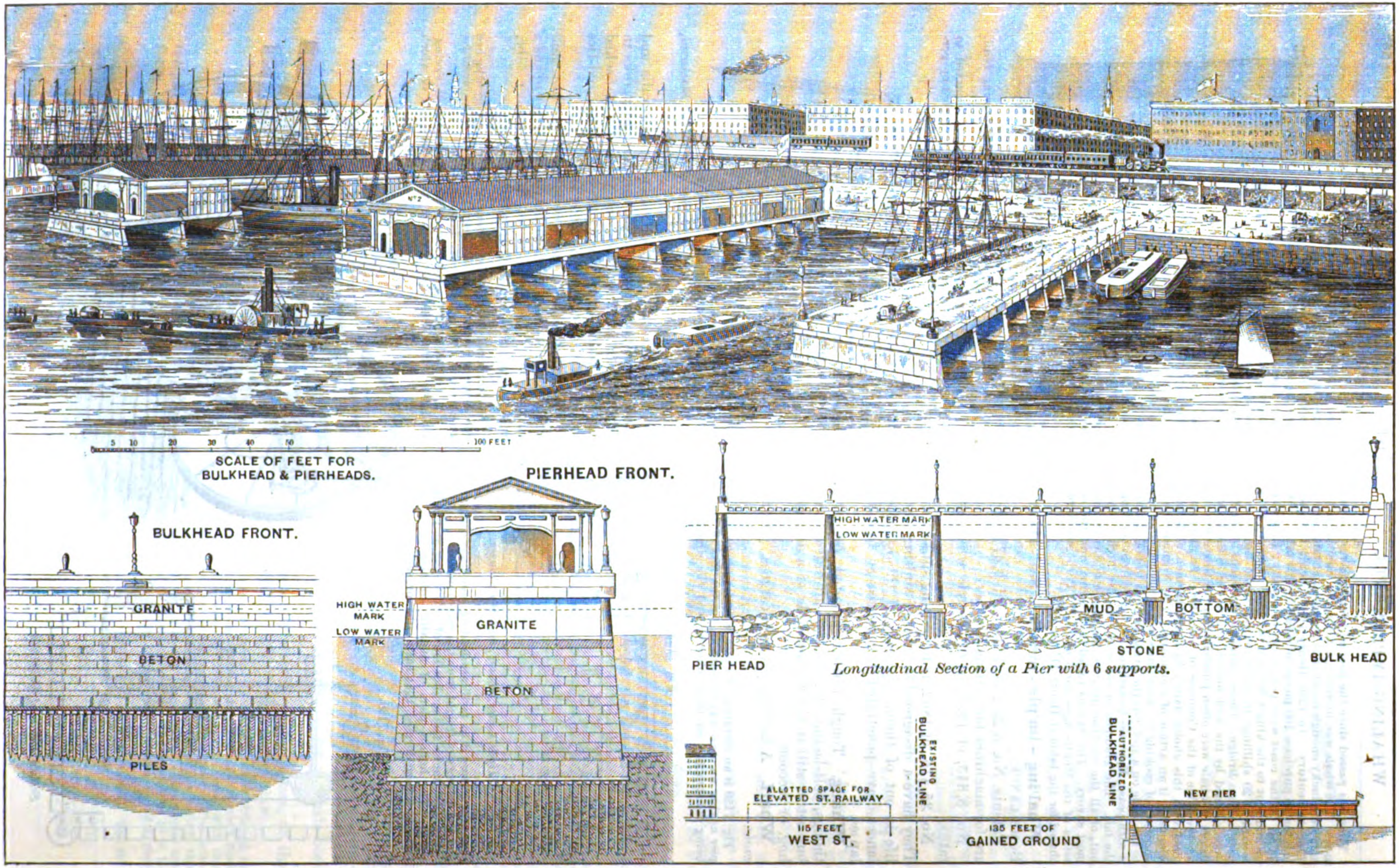


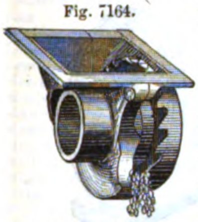
PLATE LXXV.

PROPOSED WHARFAGE, PIERS, AND IMPROVED HARBOR-FRONT FOR THE CITY OF NEW YORK.

See page 2761.

is placed on the bottom of the hopper above each spout, to insure the feed and not depend upon the gravity of the grain. The feed is regulated from ½ bushel of wheat to 3 bushels of oats, without change of gears, by means of an adjustable rotary disk in the feed-cup, so arranged that all the feeders are set at once by merely moving the indicator at the end of the hopper.

Fig. 7164.

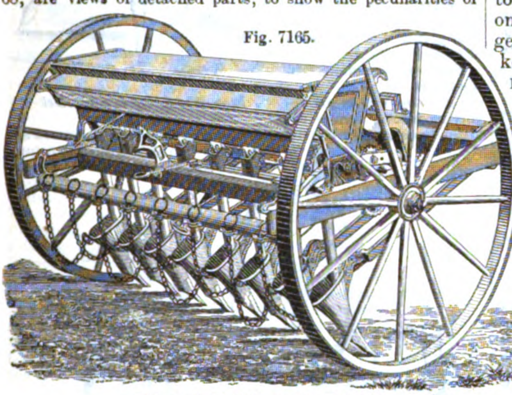


"Buckeye" Drill Force-Feed.

The hoes may be shifted from a double to a single bank, or *vice versa;* the feeders are thrown out of gear when the hoes are raised from the ground. A grass-seed hopper is placed on the rear, and a guano-sower may be attached to drill the fertilizer along with the grain. A spring hoe is used in rocky or rooty ground, to allow the hoe to spring back and avoid breaking.

Fig. 7165 is Kuhn's wheat-drill (Dayton, O.), and Figs. 7166-68, are views of detached parts, to show the peculiarities of the machine. The hoe-shifter is moved by a lever in the rear, to throw the hoes into single or double rank, one half of the drag-bars being attached to a movable frame, and the others to the frame of the machine. The zigzag feed-wheels working beneath the hopper, each above its own leader-spout, drive the grain from the feed-cup right and left, each oblique plate coming into action as its predecessor goes out of action, the rate of revolution determining the quantity sown. The drill ceases to sow when the hoes are lifted. Cog-wheels are used to change the quantity: these are bolted in a cone, and the changes controlled by a lever. The change is made by pressing on a lever to which the cone is attached, which raises it out of gear, and moving the wheel on the shaft right or left into any of the wheels of the cone. The rear end of the shifting lever moves over a notched plate where figures indicate what each wheel will sow.

Fig. 7165.

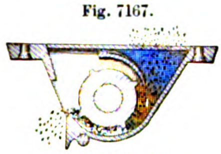


Wheat-Drill ("Farmer's Friend").

Fig. 7166.

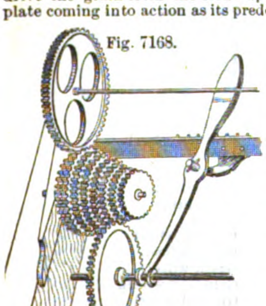
Force-Feed Wheel Delivering Grain.

Fig. 7167.



Section of Force-Feed Wheel.

Fig. 7168.



Cone-Gearing.

The machine has grass, fertilizer, and broadcast attachments. The latter consists of corrugated pans that are put under the feed-cup in place of the rubber tubes, and scatter the grain evenly in front of hoes which harrow it in.

Wheat-hull'er. A machine for decorticating wheat.

In the illustration (Fig. 7169), the rough-surfaced cone rotates reversely in the rotating conical screening-cylinder. The grain to be hulled or scoured is fed in between the core and cylinder. The cleanings are drawn by the forced current of air created by the suction-fan, while the clean grain is discharged by the endless screw.

It resembles in a degree the *hominy-machine*, being employed to take the skin from the grain.

Wheel. A circular frame turning on an axle.

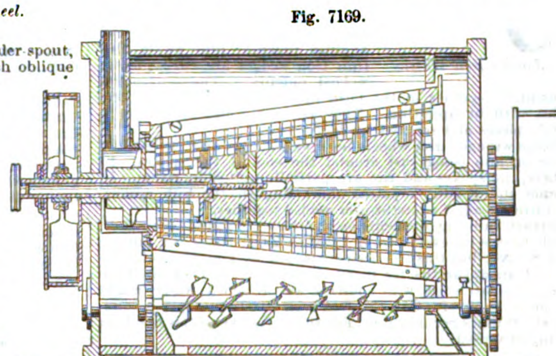
A wheel is distinguished from a roller by this feature, that the former has an axle upon which stress is imposed. The agricultural roller may seem to contradict this definition, but the discrepancy is only apparent. The axle is merely a pair of gudgeons by which the roller is hauled. An axle to keep a roller in place as it revolves is seen in BEARINGS, Fig. 619, page 259. The patentable peculiarities of wheels usually concern their special parts. See HUB, Fig. 2601, page 1139. See also SPOKE; FELLY; RIM; TIRE; BOX; SPINDLE; AXLE; etc. See list under VEHICLE, parts of.

The essential feature of a wheel is rotation, partial or entire. Its motion may be *intermittent*, *oscillatory*, or *continuous*. Its form may be *circular* or otherwise; its contour, *regular* or *irregular*. Its function may be to *transmit* motion or to *modify* it. Its application may necessitate *cogs* of a given form, or it may be *smooth*, its surface being free from contact with other portions of the machine. It may be hollow, for the *conveyance* or *measurement* of fluids; or it may be the means of *propulsion* of said fluids; or, conversely, it may be *propelled* by them. It may form a support, and, by rotation, be made effective in assisting transportation.

1. (*Vehicle.*) Wheeled carriages were comparatively rare in ancient times, excepting war-chariots. Of these many are cited; in the army of Jabin, under the command of Sisera, there were 900 chariots of iron. Solomon had 1,400 chariots. The wheels were not like the clumsy contrivances of barbarous modern nations, but more like our own. "The axle-trees of the wheels were joined to the base; and the hight of a wheel was a cubit and half a cubit" (perhaps 30 inches), "and the work of the wheels was like the work of a chariot-wheel; their axle-trees, and their naves, and their fellies, and their spokes were all molten" (bronze). (1 Kings vii. 32, 33.) The references to wheels in the Bible are frequent.

Homer mentions wheels with eight spokes. The ancient Egyptian wheels had usually, perhaps always, either four or six. Homer also mentions, as constituting a wheel, the wooden fellies, the spokes, the nave, and the metallic hoop or tire.

Fig. 7169.



Machine for Hulling and Scouring Wheat.

The Egyptian monuments also show all these, besides the linch-pin that holds the wheel on the axle, and the metallic bands that strengthened the connection of the spokes and fellies. The wheels were not over two to three feet high. See CART; CHARIOT.

In the Abbott collection of Egyptian antiquities, now in the possession of the Historical Society of New York City, are a wheel and tire and other portions of a chariot, found in a mummy-pit near Dashour. The wheel has six spokes, like those so frequently occurring in the paintings and sculptures. The hub of the wheel is a long wooden sleeve to run upon the axle, and was strengthened by bronze hub-bands, now missing, but shown clearly in colors in contemporary paintings. The inner ends of the spokes are tenoned into the hub, and the outer ends into the fellies. The latter are six in number, and their ends are slanted off obliquely so as to make a lap-joint. On the outside of all is a wooden tire, now detached, and made of bent pieces, which meet with butt joints. There is little doubt that the junction of the fellies with the spokes, and of the parts of the tire, were strengthened by bronze clips.

In a European museum, at Berlin or Florence, is a Scythian war-chariot, which was brought, as a trophy probably, to Egypt in ancient times. (See CHARIOT, Fig. 1253, page 528.) In some of the large French folios on Egyptology it is represented on a scale which allows its construction to be observed. The wheel has a bronze sleeve around the hub, studded on its periphery with bronze sockets, which receive the inner ends of the spokes. The outer ends of the spokes are tenoned into the wooden rim, and strengthened at the intersections with bronze clips or straps, which formed bands around the rim, and were secured by bronze nails. See the folios of Lepsius, Champollion, Rosellini. See also Denon's "Description de l'Egypte" in the Congressional and Astor libraries.

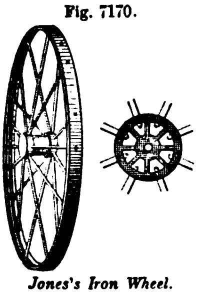
It may be mentioned that the chariot-horses of Egypt were *yoked* to the pole of the chariot, and pulled thereby. (See SADDLE, Fig. 4512, page 2009.) Traces were seldom used. Occasionally they had one trace on the side of the horse next to the tongue. It is not certain, even in this case, but that it was only a mode of coupling back the yoke to the pole, near the chariot. The yoke was secured by a vertical pin, which passed through the yoke and tongue.

The wheels of the ancient *plaustrum*, a farm cart or wagon, were of cross section of a tree-trunk, or of boards nailed together to form a circular disk. Such are still used in Greece.

The usual carriages of the ancients had two wheels, but four-wheeled carriages are shown in the Theban paintings and elsewhere, and are carefully described by Herodotus. (See CART, page 485.) The *ferate orbes* of Virgil are wheels shod with iron. Persius, Martial, and others call the tire *canthus*. Pliny ascribes the invention of four-wheeled wagons to the Phrygians. (See Fig. 1253, page 528.) At Portici are the remains of a Roman chariot-wheel; a band of iron forged out of a single piece, about 48 inches in diameter, nearly 2" broad and 1" thick. A portion of the nave has been preserved, which is bound with iron, and this again by a bronze plate secured by bronze nails.

The common iron wheel of England has cast-iron hub (*nave*) and rim, and wrought-iron spokes. The rim has holes flaring to the outside, so as to hold the ends of the spokes, which have conical heads to fit the openings. The inner ends of the spokes pass through the outer rim of the hub, and are secured by nuts. The insertion of the spokes in circles near the ends of the hubs gives them an extended base or bearing, and strengthens the wheel against lateral strain.

Fig. 7170.



Jones's Iron Wheel.

The tires of wrought-iron wheels for locomotives and railway-carriages were formerly bent to form, being previously cut off with ridges in the center, so as in meeting to form two angular notches, into which two thin iron wedges are subsequently welded radially. The four parts thus unite together in the form of a cross, and make a firm joint without upsetting. They are now rolled or welded in single pieces and secured by bolts.

Some wrought-iron wheels have welded tire and spokes, the nave or hub being cast around the end of the spokes. In others, the spokes and tire are partially united by rivets. In Bourne and Bradley's patent wheel (English) the hub, spokes, and tire are all of wrought-iron welded together.

Savart, in his experiments on the theory of sound (acoustics), made wheels to revolve from 1,000 to 2,000 times per minute (see SIREN); but this has been surpassed by Foucault, who invented an apparatus for measuring the velocity of light, to which a small wheel with a mirror was attached, which might be made to revolve 600, 800, and even 1,000 times per second, or 60,000 times per minute. For such great velocities bands or strings are used.

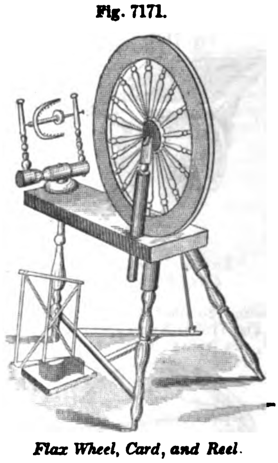
2. (*Spinning.*) A hand-machine for twisting rovings or yarn. A SPINNING-WHEEL. It differs in form with the material and purpose. The use is described under SPINNING.

Figs. 7171, 7172, 7173, show respectively a flax wheel, card, and reel; a *wool-wheel;* and a *knot-reel* for skeining off *knots* of a given length from the cops on the spindles.

3. (*Nautical.*) An instrument by which the rudder is moved. A *tiller*-wheel. See STEERING-WHEEL.

4. (*Pyrotechnics.*) *Wheel-cases* are strong tubes made like rocket-cases, and filled with a composition which burns more slowly than rocket-filling.

Fig. 7171.



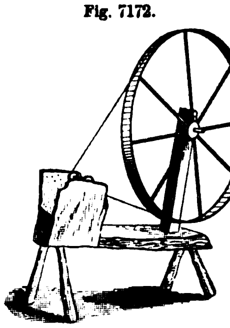
Flax Wheel, Card, and Reel.

They are placed on the edges of revolving wheels, in the direction of the plane of their framework, in order to impart a rotary motion, at the same time giving out long rays of sparkling light.

Sun-cases are similar to the above.

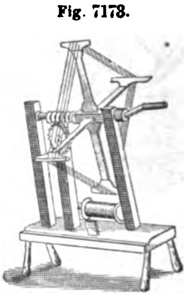
Catherine-wheels are revolving wheels, whose rotation is caused by the flame escaping from a series of cases arranged so as to form a continuous spiral.

Fig. 7172.



"Old-Time" Wool-Wheel.

Fig. 7173.



Knot-Reel.

See under the following heads: —

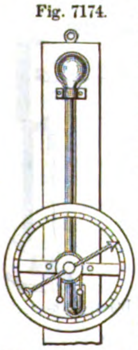
Aero-hydro dynamic wheel.
Angular wheel.
Annular wheel.
Anti-friction wheel.
Back-frame wheel.
Balance-wheel.
Band-wheel.
Barker's wheel.
Bastard wheel.
Bevel-wheel.
Brake-wheel.
Breast-wheel.
Brush-wheel.
Bucket-wheel.
Buff-wheel.
Burring-wheel.
Cam-wheel.
Canting-wheel.
Car-wheel.
Carriage-wheel.
Caster-wheel.
Center-wheel.
Center-discharge wheel.
Chain-wheel.
Change-wheel.
Chapelet-wheel.
Circumferentor.
Click-wheel.
Cloth-wheel.
Cog-wheel.
Conical wheel.
Contrate-wheel.
Count-wheel.
Crank-wheel.
Crown-wheel.
Current-wheel.
Cylinder-wheel.
Danaide.
Dash-wheel.
Dial-wheel.
Disk-wheel.
Double-gear wheel.
Downward-discharge wheel.
Driver.
Driving-wheel.
Drum.
Eccentric.
Eccentric wheel.
Edge-wheel.
Elliptical wheel.
Emery-wheel.
Emery-vulcanite wheel.
Epicycloidal wheel.
Escape-wheel.
Face-wheel.
Fan-wheel.
Feed-wheel.
Fifth wheel.
Flash-wheel.
Flush-wheel.
Flutter-wheel.
Fly.
Fly-wheel.
Follower.
Friction-wheel.
Fuzee.
Gage-wheel.
Gear-wheel.
Gin-wheel.
Glazer.
Glazing-wheel.
Going-wheel.
Grain-wheel.
Grinding-wheel.
Ground-wheel.
Grooved wheel.
Hand-wheel.
Heart-wheel.
Horizontal water-wheel.
Idle wheel.
Intermittent wheel.
Internal wheel.

Irregular wheel.
Lantern-wheel.
Lap.
Lapidary's wheel.
Leader.
Leading-wheel.
Mangle-wheel.
Master-wheel.
Match-wheel.
Measuring-wheel.
Meter-wheel.
Mill-wheel.
Minute-wheel.
Miter-wheel.
Mortise-wheel.
Multiple-wheel.
Multiplying-wheel.
Mutilated wheel.
Non-circular wheel.
Noria.
Odometer.
Outrigger.
Overshot-wheel.
Paddle-wheel.
Pendulum-wheel.
Persian wheel.
Pinion.
Pin-wheel.
Pitch-back wheel.
Pitch-wheel.
Planet-wheel.
Plate-wheel.
Plow-wheel.
Polishing-wheel.
Potter's wheel.
Pot-wheel.
Printing-wheel.
Propeller-wheel.
Pulley-wheel.
Racket-wheel.
Rag-wheel.
Ratchet-wheel.
Reaction-wheel
Rowel.
Scape-wheel.
Scoop-wheel.
Screw-wheel.
Scroll-wheel.
Sector-wheel.
Segment-wheel.
Skew-wheel.
Skew-bevel wheel.
Slicer.
Slosh-wheel.
Snail-wheel.
Speed-cones.
Spider.
Spike-wheel.
Spinning-wheel.
Spiral wheel.
Sprocket-wheel.
Spur-wheel.
Star-wheel.
Starting-wheel.
Steam-wheel.
Steering-wheel.
Stepped-wheel.
Stitch-wheel.
Stream-wheel.
Sun and planet wheels.
Swash-plate.
Swing-wheel.
Tappet-wheel.
Tempering-wheel.
Tide-wheel.
Tiller-wheel.
Tobacco-wheel.
Traction-wheel.
Trammel-wheel.
Tread-wheel.
Troll-plate.
Truckle.
Trundle-wheel.
Tub-wheel
Turbine-wheel.
Tympanum.
Undershot-wheel.
Urchin.
Variable-wheel.
Volute-wheel.
Wabbler.
Walking-wheel.
Wallower.
Warning-wheel.
Water-wheel.
Waved wheel.
Web-wheel.
Wheel and axle.
Wheel-annealing furnace.
Wheel-barometer.
Wheelbarrow.
Wheel-chair.
Wheel-cotter.
Wheel-cultivator.
Wheel-cutting machine.
Wheel-jack.
Wheel-lathe.
Wheel-lock.
Wheel-pit.
Wheel-plow.
Wheel-press.
Whim.
Whirling-table.
Wind-wheel.
Wiper.
Wire-wheel.
Worm-wheel.

Wheel and Ax′le. This is cited as one of the mechanical powers. It is an application of the lever, in which the action is continuous. See WELL-BUCKET ELEVATOR.

Rejecting the consideration of friction, the power and effect are proportioned to the radii of the respective barrels. 1 pound on the cord which passes over the wheel of 4 feet radius will balance 8 pounds on the end of the cord which is wound on the axle having a radius of 6 inches. A small weight or power may be applied on the rope running over the wheel, moving at relatively high speed, to raise, at a proportionately slow speed, a heavy weight on the rope which winds upon the axle; or, conversely, a heavy weight or relatively great power on the axle-rope may raise with speed a light weight attached to the wheel-rope.

Fig. 7174.



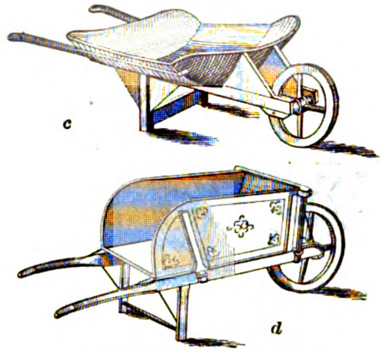
Wheel-Barometer.

Wheel-an-neal′ing Fur′nace. A furnace constructed for annealing cast-iron car-wheels. See Figs. 243–246, page 113.

Wheel-ba-rom′e-ter. One in which the fluctuations of the hight of the mercurial column are conveyed by float and cord to an axis on which is a pointer traversing a graduated circle. See BAROMETER.

Wheel′bar-row. There are many varieties of wheelbarrows. The most efficient implement for removing excavated earth, as in railway-grading, is the barrow with a scoop-shaped bed (*c*). It has a small wheel, widely diverging handles, and is adapted to dump on either side.

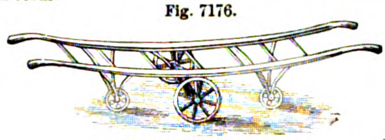
Fig. 7175.



Grading and Garden Barrows.

The *garden*-barrow (*d*), with removable sides, is more convenient about a farm or garden for the multitudinous uses which occur.

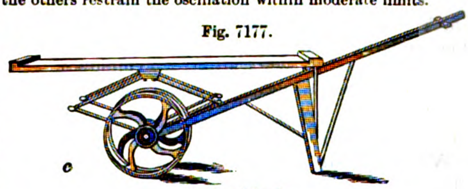
Fig. 7176.



Express-Wheelbarrow.

The express-wheelbarrow (Fig. 7176) is a superior form of the warehouse-barrow, adapted to carry heavy loads on a floor. The load may be balanced on the middle pair of wheels, and the others restrain the oscillation within moderate limits.

Fig. 7177.

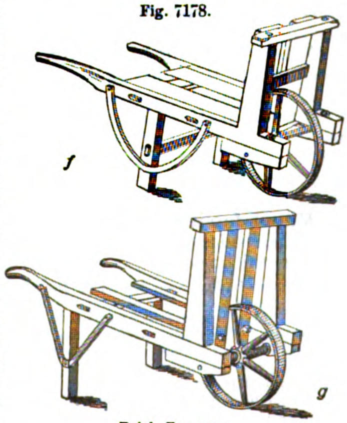


Spring-Truck.

f (Fig. 7178) is a green-brick barrow.
g, a dry-brick barrow.
h, Fig (7179) a dumping-barrow.
a and *b* (Fig. 7180) are varieties of barrows for porterage and wheeling long stuff.

M. le Duc corrects an error that has prevailed in France with regard to the invention of this useful little vehicle. It has been attributed to M. Dupin, who, it has been claimed, devised it in 1669. M. le Duc says he found mention of them in the thirteenth, fourteenth, and fifteenth century MSS., and gives an illustration taken from a vignette of a MS. of the thirteenth century, of a man propelling a wheelbarrow, the form of which differs but slightly from those now in use.

Fig. 7178.



Brick-Barrows.

The Chinese wheelbarrow has but one wheel, but it is large, and placed in the center of the

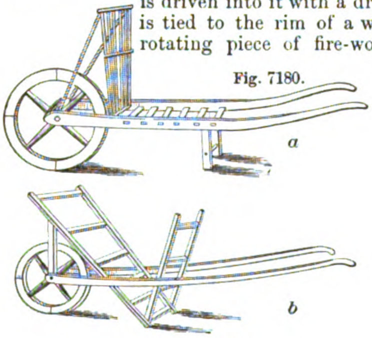
bed of the vehicle; the entire load rests on the central wheel. In Shanghai, thousands of these vehicles ply for hire. The usual load is two persons, who sit on a wooden platform on each side of the wheel, resting one arm each upon the framework which rises above the top of the wheel, and planting one foot in a stirrup made of rope.

Fig. 7179.

Dumping-Barrow.

Wheel-case. (*Pyrotechnics.*) A stout paper case, similar to a rocket-case or sun-case. It is filled with composition, which is driven into it with a drift, and is tied to the rim of a wheel or rotating piece of fire-works, to

Fig. 7180.



Wheelbarrows.

which it imparts a circular motion, at the same time emitting brilliant trains of fire. (See WHEEL, 4.) The following compositions are employed: —

Brilliant; 1 niter, 1 sulphur, 16 mealed powder, 7 cast-iron filings.
Chinese; 2 niter, 1 sulphur, 16 mealed powder, 4 charcoal.
White; 6 niter, 7 sulphur, 16 mealed powder.

Wheel-chair. A *bath-chair*, or invalid chair.

The *chiramaxium* or *gestatoria sella* of the ancients. A small carriage for one person, drawn by slaves.
In the Middle Ages the lame used chairs on casters.

Wheel-col'ter. A sharp-edged wheel running in advance of the breast of the plow, to cut the sod or weeds in the line of the furrow. It has long been used in the fen-lands of England. See Fig. 1391, page 596.

Wheel-cul'ti-va-tor. One traveling on wheels during its work. See figures, page 657.

Wheel-cut'ting Ma-chine'. Invented by Dr. Hooke for cutting the cog-wheels of watches, about 1655. See page 960. See GEAR-CUTTER, Fig. 2205.

Wheel-draft. In steam-boilers, when the current of smoke and hot-air is continued round and round in the same direction. In contradistinction to a *direct*, a *reverting*, or a *split* (i. e. divided) *draft*. Usual in the *wagon* boilers.

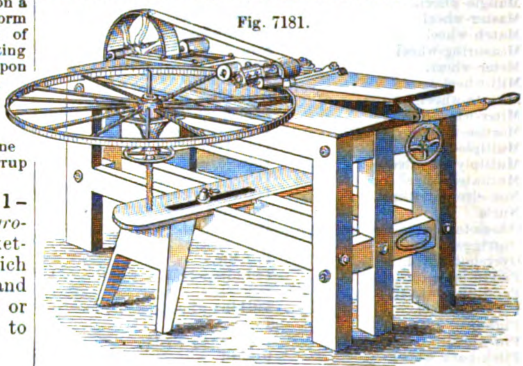
Wheel-fac'ing Ma-chine'. A machine for facing the sides of wheels, reducing the fellies to a uniform thickness, and beveling them if desired.

The fellies, having been driven on the spokes, the hub of the wheel is placed in a self-centering chuck, which is raised and lowered, by a screw and hand-wheel, to give the desired bevel to the side. The table carrying the chuck is adjustable for wheels of different diameters. The cutter-head frame and table, to which pressure rollers are attached, are elevated by a lever when a wheel is to be placed under the cutters or taken out. The cutter-head and rolls have minute adjustment by means of a hand-wheel and screw.

Wheel-fin'ish-ing Ma-chine'. A machine-tool for planing off the inside of the tires of locomotive-wheels. It may be called a curvilinear slotting-machine, the tool being mounted on a holder at the end of a vibrating lever.

The other end of this lever is slotted and fitted with a sliding block, into which the pin of a disk-crank enters. As the crank-

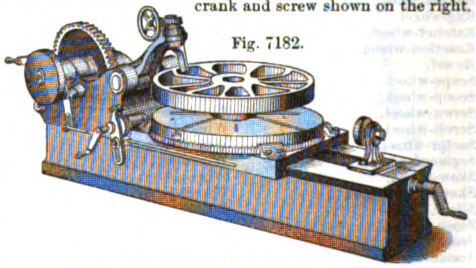
Fig. 7181.



Wheel-Facing Machine.

disk revolves with its upper edge approaching the fulcrum of the lever, the tool-holder receives a slow downward and a quick return stroke. The point of the tool describes an arc of a circle struck from the center of the vibration of the lever, thereby producing a convex form on the inside of the tire. The wheel bed-plate is revolved by automatic mechanism somewhat similar to the devices ordinarily employed in planing-machines. Provision is made for wheels of any diameter, by means of the crank and screw shown on the right.

Fig. 7182.

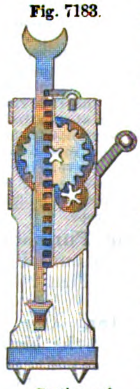


Webb's Wheel-Finishing Machine (English).

Wheel-guard Plate. (*Ordnance.*) An iron plate on each side of the stock of a field or siege gun-carriage to prevent its being chafed by the wheels when turning. Used also on carriages.

Wheel-jack. 1. The *lifting-bar* is a cogged rack operated by a pinion and hand-crank through the intervention of gearing, by which the power is multiplied. See also LIFTING-JACK.

Fig. 7183.

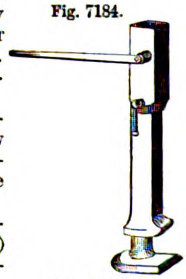


Section of Wheel-Jack.

2. A lifting-jack with a low toe, to catch beneath the tire of a wheel.

The illustration (Fig. 7184) shows a hydraulic jack thus adapted. See also LIFTING-JACK, and list under JACK.

Fig. 7184.

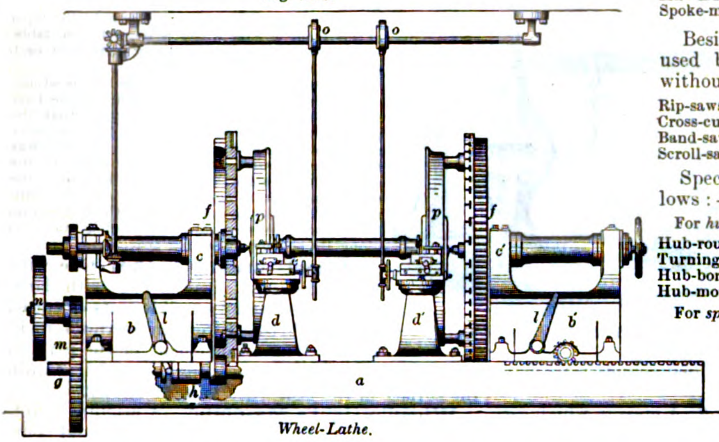


Wheel-Jack.

Wheel-lathe. A lathe for turning railway-wheels and other large work.

a (Fig. 7185), base-plate.
b b', standards for carrying head-stocks, *b* being permanent

Fig. 7185.



Wheel-Lathe.

and *b'* movable on the base-plate by means of a rack and pinion.

c, fast, and *c'*, movable head-stock, the center in which can be moved out any distance as in an ordinary puppet-head.

d d, standards for carrying slide-rests.

e e, compound slide-rests.

f f, large face-plates, with extra wheels at back.

g, longitudinal shaft.

h, one of two pinions keyed on shaft *g*, and gearing into the external wheels *f f*.

l, clutches for disconnecting the pinions from the external wheels.

m, spur-gearing at end of lathe.

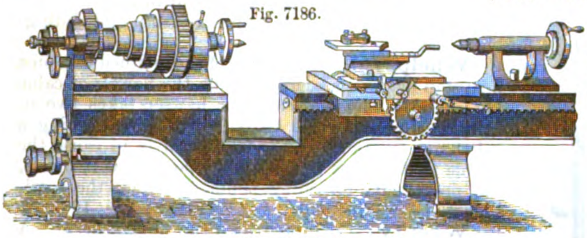
n, strap-pulley.

o o, apparatus for giving self-acting motion to the two compound slide-rests.

p p, wheels to be turned.

Fig. 7186 is called a *gap-bed* lathe, having a cavity in the bed enabling objects to be turned the diameter of which is greater than the distance between the center and the sheers.

Fig. 7186.



Gap-Bed Lathe.

Wheel-lock. 1. (*Fire-arms.*) A form of lock for fire-arms which superseded the old matchlock, whereby the piece was touched off by a match or port-fire.

The wheel-lock was invented in Italy early in the sixteenth century; it was moved by a chain and wound up like a watch to prepare it for use. The wheel, originally, was not fixed in the gun, but was fitted in a groove when ready for firing; at other times being carried in a bag. It consisted of a furrowed wheel of steel, whose friction against a piece of sulphuret of iron was made to communicate fire by sparks to the priming. See GUN-LOCK.

2. (*Locksmithing.*) A form of lock having a series of wheels or disks with letters around their edges. The interior arrangements of the lock were such as to prevent the bolt being shot until a series of letters were in line, forming a combination known only to the owner and maker. See LETTER-LOCK.

3. A wagon-lock, to retard the revolution of the wheels in descending a hill.

Wheel-ma-chin'er-y. It is but of late years that the making of carriage and wagon wheels has been so systematized as to call for specific machines for the various operations. These may be classed as, —

Hub-machines.
Spoke-machines.
Felly-machines.
Wheel-makers.

Besides these, the following are used by wheel-makers, with or without special adaptation: —

Rip-saws.
Cross-cut saws.
Band-saws.
Scroll-saws.
Surfacing-planers.
Boring-machines.
Turning-lathes.
Tenoning-machines.

Special machines are as follows: —

For *hubs*: —

Hub-rougher.
Turning-lathe.
Hub-boring machine.
Hub-mortising machine.

For *spokes*: —

Center-sawing machine.
Spoke-lathe.
Spoke-tenoning machine.
Spoke-throating machine.
Spoke-sizing machine.
Tenon-truing machine.
Sand-belt machine.
Oval tenon forming-machine.

For *fellies*: —

Bevel felly-planing machine.
Inside and face planer.
Felly cutting-off saw.
Felly-rounder.
Felly-boring machine.
Felly-doweling machine.

For *setting up and finishing wheels*: —

Spoke-driving machine.
Wheel-facing machine.
Wheel-screwing machine.

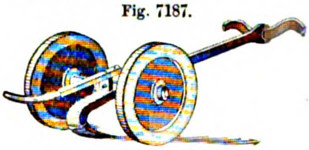
Wheel-mold'ing Ma-chine. (*Founding.*) A machine for making the mold for gear-wheels by repeating a section of a few cogs around the perimeter. See Fig. 3202, page 1468.

Wheel-pit. A walled hole for the heavy fly-wheel of a train of rolls, etc.

Wheel-plow. 1. A plow supported in part by a wheel or wheels as a gage of depth. See Figs. 3823–3825, pages 1745, 1746.

2. A plow with a wheel in the space between the landside and mold-board, and reducing the friction of the plow by bearing the weight. See *f*, Fig. 3823; see also B and C, Fig. 3825, page 1746.

Fig. 7187.

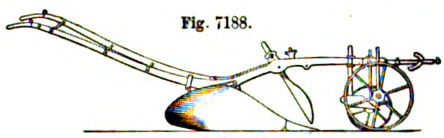


Roman Plow.

A Roman wheel-plow is illustrated in the accompanying cut, and needs no particular description.

Busby's wheel-plow (English) received the Council Medal in its class at the London Exhibition of 1851. It is mentioned in an English treatise as the best specimen of a plow that is manufactured. It has land and furrow wheels, a skim colter, and is principally or altogether of iron.

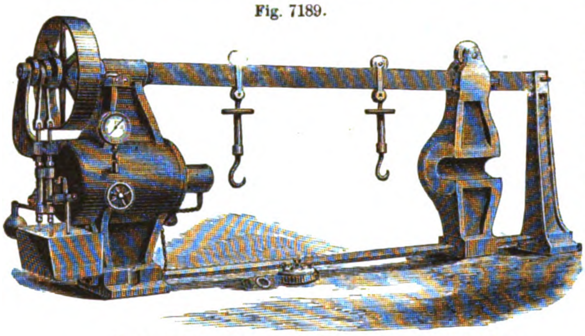
Fig. 7188.



Busby's Wheel-Plow.

Wheel-press. 1. A hydrostatic press for forcing car-wheels on to their axles and removing them. The axle is suspended from the hooks, and one end passed through the groove in the slotted post, which resists the thrust of the ram, and is held at any desired position by a key or otherwise. The ram is operated by a double-acting pump, and may be

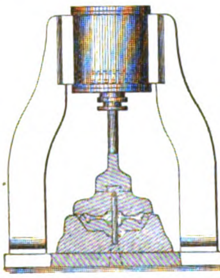
Fig. 7189.



Hydraulic Car-Wheel Press (N. Y. Steam-Engine Co.).

worked up to a pressure of 5,000 pounds per square inch.

Fig. 7190.



Wheel-Molding Press.

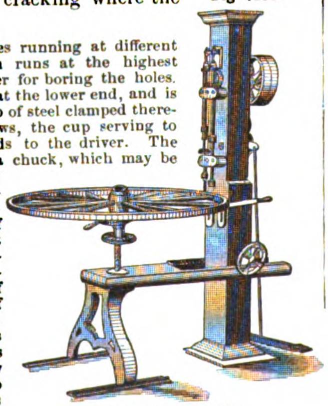
2. A press in which car-wheels are molded. The *drag* is suspended from the piston of a hydraulic press, and is forced down upon the *cope*. A central spindle makes a tapering hole in the nave, and acts as a guide.

Wheel-quar′ter-ing Ma-chine′. A machine for quartering locomotive driving-wheels on their axles, that is, boring the wrist-pin holes at 90° distance apart. See QUARTERING-MACHINE, page 1842, Fig. 4067.

Wheel-rope. (*Nautical.*) One connecting the steering-wheel with the tiller.

Wheel-screw′ing Ma-chine′. A machine for boring the holes and fixing the screws in the rims or fellies of wheels to prevent them from splitting or cracking where the spokes enter.

Fig. 7191.



Wheel-Screwing Machine.

It has two spindles running at different speeds. That which runs at the highest speed carries an auger for boring the holes. The other is cupped at the lower end, and is split to receive a strip of steel clamped therein to drive the screws, the cup serving to guide the screw-heads to the driver. The wheels are held in a chuck, which may be raised or lowered by a screw and hand-wheel to suit different lengths of hubs, and brought to or from the machine to accommodate different sizes of wheels by means of a rack and pinion. The belt which drives the boring-spindle is slack enough to allow the spindle to stop when the foot is taken off the treadle. The other spindle runs constantly with the countershaft.

Wheel-spok′ing Ma-chine′. A machine for driving spokes symmetrically. See SPOKE; SPOKE-MACHINES; etc.

Wheel-spoke Plan′ing-ma-chine′. A machine-tool for planing the faces of spokes of locomotive-wheels.

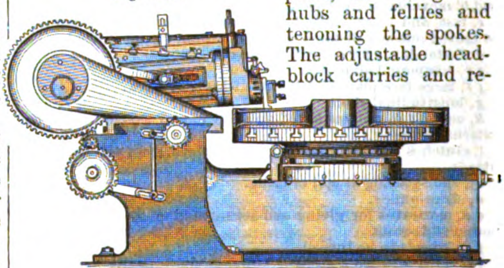
The tool traverses at an angle from the horizontal, allowing for the increased thickness of metal near the hub. The tool-holder is at the outer end of a reciprocating ram, which works on guides formed on a plate adjustable at any angle, so as to conform to the taper of the spoke. The wheel is dogged to a table, which has a circular adjustment to present each spoke in turn to the planer-tool.

The tool-holder at the end of the ram is adjustable vertically, and is provided with a toothed arc actuated by a worm, and so arranged that the point of the tool can be made to traverse automatically on the arc of a circle. In this way the desired rounded form can be given to the edges of the spokes. The motion is given to the ram by a crank of adjustable throw in the ordinary way, and the carriage on which the ram is mounted is also capable of being traversed along its bed by self-acting gear.

Wheel-turn′ing Lathe. One with two very solid head-stocks with large face-plates, and two slide-rests operated by a ratchet-feed from an overhead rock-shaft. The arrangement of the parts is such that the pressure in cutting always falls within the surface of the bed. See WHEEL-LATHE.

Wheel′wright's Ma-chine′. A machine adaptable to several purposes, as boring the hubs and fellies and tenoning the spokes. The adjustable head-block carries and revolves the auger. The stuff is held in place and fed to the operating-tool by a spring-clamp and sliding-carriage.

Fig. 7192.



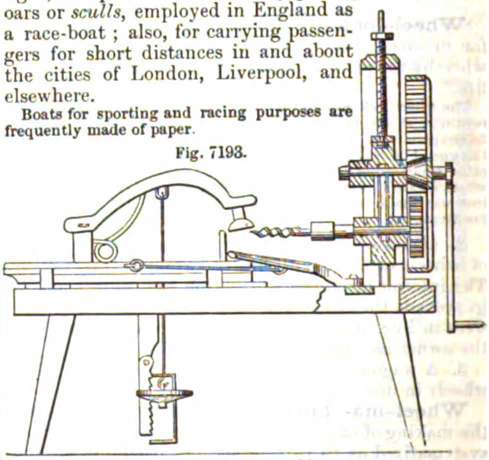
Wheel-Spoke Planing-Machine.

Whelp. (*Nautical.*) One of the inclined bars on a capstan or windlass, upon which the hawser or cable is wound. The messenger or hawser takes two or three turns round the barrel, the whelps forming a skeleton frustum; the conical form is to cause the cable to *fleet* back to the smaller portion as it winds, to prevent its becoming jammed against the pawl-head at the large end. See CAPSTAN, Fig. 1083.

Wher′ry. Corrupted from the Roman *horia.* A light, sharp-built boat, usually pulling one pair of oars or *sculls*, employed in England as a race-boat; also, for carrying passengers for short distances in and about the cities of London, Liverpool, and elsewhere.

Boats for sporting and racing purposes are frequently made of paper.

Fig. 7193.



Wheelwright's Machine.

The following is a description of one constructed for Walter Brown, the celebrated oarsman, after the Waters patent, from a model of his own. This boat is 31½ feet long, 12 inches wide, and weighs but 22 pounds. The lightest wooden boat ever built of similar dimensions weighed 41 pounds. The most singular part of the matter is that the boat is more than four times stronger than one of wood. All of it, save where the sculler sits, is gas-tight, so that in the event of a race sufficient gas may be taken into it to reduce its weight to 8 pounds. The displacement of water by such a craft will be very much less than that of a wooden boat, and the same exertion will propel it proportionately faster. Its strength is also a great advantage.

Whet'stone. A piece of stone, usually a rectangular slab, used for sharpening cutlery or tools. Scythe-stones are, however, bellied, and taper toward the ends.

Many varieties of stone, especially of the slaty kinds, are more or less perfectly adapted for the purpose. Some, however, are peculiarly suited for imparting a fine edge to tools, command a high price, and are generally used in the workshop as oil-stones See OIL-STONE; HONE; GRINDING and POLISHING.

The best known locality in the country for whetstone or *novaculite* is about two miles from the hot springs in Arkansas. It is quarried in blocks from two to four feet square, or in irregular masses which are afterward split into slabs. This is generally known as Ouichita-stone.

Another variety, termed white-stone, is also derived from the Arkansas quarry. It is of much finer grain than the preceding kind, and is used by jewelers, engravers, and surgical-instrument makers for sharpening their implements; and also for sewing-machine needles.

Another variety, known as Hindostan stone, is derived from a quarry in Orange County, Indiana.

"In ancient times," says Pliny (*d.* A. D. 79), "the only whetstones known were those of Crete and other places beyond sea, and they only used oil to sharpen the scythe with [and a file probably]. For this purpose the mower moved along, with a horn to hold the oil fastened to his thigh. Italy has since furnished us with whetstones which are used with water and give an edge to the iron quite equal to that imparted by the file; these water-whetstones, however, turn green very quickly."

Laconia was also famous for its oil-stones.

A celebrated deposit which exists near Constantinople has been quarried for centuries, and furnishes the well-known *Turkey oil-stones*.

An ancient hone found in a British barrow was a blue-gray stone 3″ by 1″, and ¼″ thick.

Whetstones for farmers', mechanic's, and domestic use are ground on a horizontal wooden wheel studded with scraps of nail-plate. Sand and water are used for smoothing them. The wood wears more rapidly than the iron, and leaves the latter somewhat salient. It is said to exceed a cast-iron plate in effectiveness, three to one.

Whet'ter. A sharpener; as a whetstone, hone, rifle, steel, strap, etc. See list under GRINDING and POLISHING, page 1017.

Whif'fle-tree. A bar to which the traces of an animal's harness are connected, and whereby the vehicle is drawn. A *whippletree.* The terms *single, double,* and *treble tree* are more convenient, and expressive of their capacity. See SINGLE-TREE; DOUBLE-TREE; TREBLE-TREE.

Whim. (*Mining.*) A large winding-wheel for the rope of a mine-shaft. See WHIN.

Whim'ble. (*Mining.*) A hollow instrument for cleaning the rubbish out of a bore-hole. *Wimble.*

Whim-rope. (*Mining.*) A rope by which the kibble is attached to the winding-engine or whim.

Whim'sey. 1. (*Mining.*) An engine used to draw up coals; the term is particularly applied to the old atmospheric engines.

2. A small warehouse-crane for lifting goods to the upper stories.

Whim-shaft. (*Mining.*) The shaft by which the stuff is drawn out of a mine.

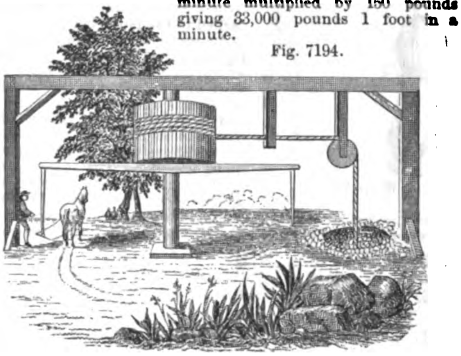
Whin. (*Mining.*) *a.* Any very hard stone.

b. Sometimes written *whim.* A hoisting-device operated by horse-power to wind a rope and draw a kibble or bucket from a mine.

The rope is passed over a pulley and around a drum on a vertical shaft provided with a cross-bar, to which a pair of traces is connected.

To exercise the best effect, the track should not be less than 24 feet in diameter, and the horse should walk at the rate of 2½ miles per hour. Exerting a force of 150 pounds at that rate for 8 hours is equal to a horse-power, — the speed 220 feet in a minute multiplied by 150 pounds giving 33,000 pounds 1 foot in a minute.

Fig. 7194.



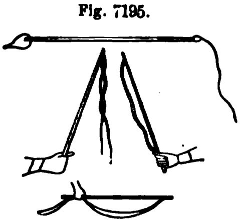
Whin.

Whip. 1. (*Saddlery.*) An instrument used for driving horses and other animals, or for correction; commonly consisting of a handle, a thong of plaited leather, and a lash of plaited hemp or other fiber. Frequently, however, the handle and thong are in one, forming a tapering flexible rod; riding-whips are made in this way.

The device is very ancient, being referred to in Proverbs xxvi. 8, and Nahum iii. 2. "The noise of a whip, and the noise of the rattling of the wheels, and of the prancing horses, and of the jumping chariots." It was in use, however, long before this.

The Egyptian whip consisted of a short, round wooden handle, and a single or double thong about 2 feet in length, twisted or plaited. A loop was attached, so that it could be swung from the left wrist while the archer was using his bow. Short, knotted whips, much resembling our riding-whips and the postilions' whips of the last and the early part of the present century, are also shown in the paintings of Thebes.

Fig. 7195.



Egyptian Whips (from Thebes).

The whips of the ancients generally had knots or bronze or leaden (*plumbatum*) balls on the lashes to render them more severe. The priests of Cybele punished themselves with whips on whose lashes were the *astragali* bones of kids. Greek whips were of leathern thongs, twisted cords of hog's bristles, or sinews of oxen. The *scorpio* was a whip with iron spurs. The Anglo-Saxon whip for prisoners was three-lashed. Switches were used for soldiers.

Eel-skins were used to flog school-boys by the Romans and Anglo-Saxons.

The ancient Scythian whip resembled the *nogaik* of the modern Cossacks. It had a short handle and a single lash, with a round flat piece of leather at the end. The taskmasters of Egypt and Persia hurried up their workmen with whips. Xerxes lashed the laborers who dug the canal across the isthmus of Athos; and his soldiers were hurried by whips across the Hellespont bridge, during the 7 days and nights which they occupied in crossing between Abydos and a rocky point in the Hellespontine Chersonese. The bridge was about 1¼ miles long.

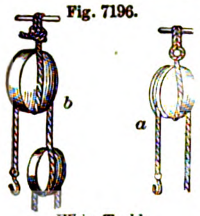
The artillery-driver's whip has an interior stock of raw hide covered with India-rubber cloth, over which is sewed an outer covering of leather. A loop is attached at the but for suspension. A lash of thread is attached to the small end.

Fancy whips are made with handles composed of a central core of whalebone stiffened and filled out with rattan; this is inclosed in rubber cloth and covered with rubber cement, over which strands of cotton, silk, or gut are braided by machinery.

2. (*Nautical.*) *a.* A form of hoisting-tackle. A single whip (*a*, Fig. 7196) is the most simple purchase in use. It is made by reeving a rope through a single block.

If the fall of the rope of a single whip be spliced round the block of another whip, it becomes *whip on whip* (*b*) or *whip and runner.* Thus two single blocks afford the same purchase as a tackle having a double and a single block, with much less friction. For other varieties of purchase, see TACKLE.

Fig. 7196.



Whip-Tackle.

In unloading colliers in the Thames, the bucket of coal is raised by a *whip*, a number of cords attached to the fall being grasped by as many men, who mount a wide ladder, and after two or three hauls at the rope, jump to the deck and *whip* up the bucket to the landing, where it is dumped.

A modified form of this whip is one in which the fall is attached to a platform which slides up and down a ladder. The man ascends the ladder, steps on to the platform, which descends with his weight and raises the cask or chest. It is rigged where a large number of pieces of the same size are to be raised, as salt or coffee in bags, flour in barrels, tea in chests.

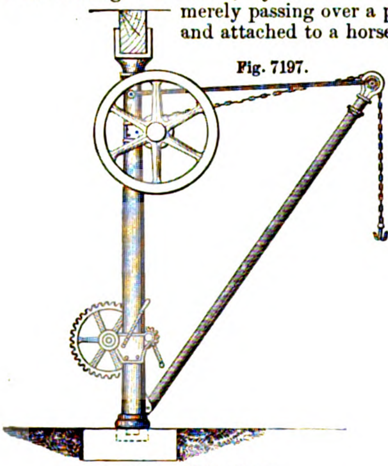
b. A flag used for signaling.

3. The arm of a windmill, on which a sail is extended.

4. To sew over and over, as the two selvages of stuffs stitched together. As we say, *whip* them together merely; or *whip* them down.

Whip and Der'ry. (*Mining.*) An arrangement for raising the kibble, by means of a rope merely passing over a pulley and attached to a horse.

Fig. 7197.

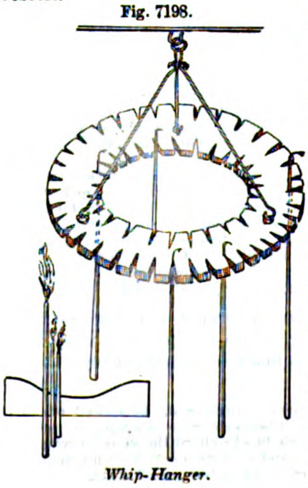


Pillar or Whip Crane.

Whip-braid'ing Ma-chine'. See BRAIDING-MACHINE, Fig. 867.

Whip-crane. A crane of simple construction for *whipping* or quickly hoisting goods in unloading vessels.

Fig. 7198.



Whip-Hanger.

Fig. 7197 is a crane made with either iron or timber pillar and jib, and especially adapted for docks, warehouses, railway-stations, and all places where light and heavy weights have to be lifted alternately. It has three motions,—quick, medium, and slow. Light weights may be lifted at a quick speed by pulling directly at the rope; for medium weights the handle is put on the rope-barrel shaft, and for heavy loads on the pinion-shaft. The speeds are rapidly changed, and the crane is made to swing completely round.

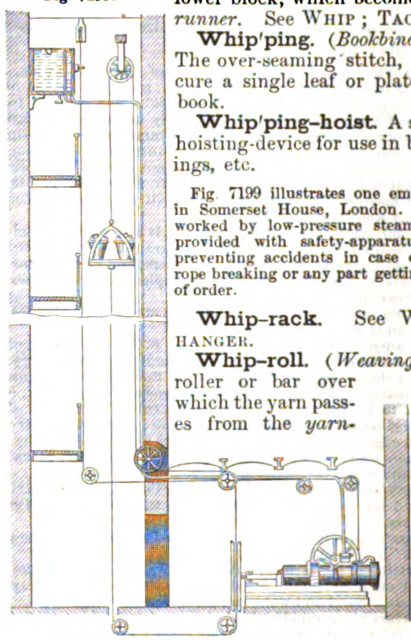
The crane has an efficient break, and is made secure to a beam at the top. See also CRANE, Fig. 1505, page 642, *et seq.*

Whip-hang'er. An annular rim or bracket provided with notches, into which the ends of the suspended whips fit.

Whip-net. A simple form of network fabric produced in the loom by a systematic crossing of the warps.

Whip on Whip. (*Nautical.*) A tackle consisting of two single blocks and falls; the fall of the upper block is spliced round the lower block, which becomes the *runner*. See WHIP; TACKLE.

Fig. 7199.



Whipping-Hoist (Somerset House, London).

Whip'ping. (*Bookbinding.*) The over-seaming stitch, to secure a single leaf or plate in a book.

Whip'ping-hoist. A steam hoisting-device for use in buildings, etc.

Fig. 7199 illustrates one employed in Somerset House, London. It is worked by low-pressure steam, and provided with safety-apparatus for preventing accidents in case of the rope breaking or any part getting out of order.

Whip-rack. See WHIP-HANGER.

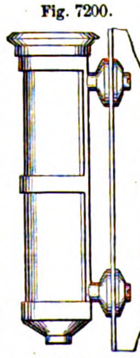
Whip-roll. (*Weaving.*) A roller or bar over which the yarn passes from the *yarn-beam* to the *reed*; by the pressure on the whip-roll, devices are brought into operation by which the rate of *let-off* is adjusted to the speed with which the weaving proceeds. See LET-OFF.

Whip-saw. A thin, narrow saw-blade strained in a frame, and used as a compass-saw in following curved lines. Of this class are the *buhl-saw* and *piercing-saw*.

Whip-sock'et. A pocket on the edge of the dash-board, to hold the whip.

Whip up-on' Whip. (*Nautical.*) One whip applied to the fall of another. See WHIP.

Fig. 7200.



Whip-Socket.

Whirl. 1. A reel by which a strand of hemp or a gut is twisted in the process of manufacture.

2. A set of three spindles with hooks for yarn, and driven by a strap. A *rope-winch.*

Whirl'er. 1. One of the rotating hooks on which the end of a bunch

Fig. 7201.

Whirling-Table.

of hempen fibers is secured, and by which it is twisted into yarn as the man recedes backward from it, paying out the hemp as he goes. See ROPE-MAKING.

2. A revolving top, invented by Troughton, to serve as an artificial horizon.

Whirl'i-gig. A frame with wooden horses or seats on which persons are whirled around as an amusement. In the Middle Ages disorderly persons were punished by confinement in a cage which revolved on a pivot and made them sick.

Whirl'ing-ta'ble. (*Pottery.*) A horizontal disk rotating in a horizontal plane and carrying a plaster mold, whose surface is the counterpart of the inside of the plate, saucer, cup, or other circular object, while the outer surface of the object is formed by the templet, which is lowered upon and gaged for the thickness of the ware (Fig. 7201).

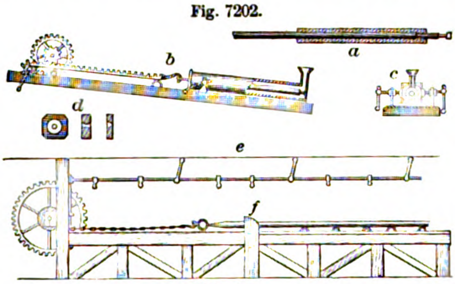
The templet *a* moves in or out upon an arm *b* according to the radial dimensions of the ware to be molded, and descends in a groove to a distance regulated by a stop in correspondence to the desired thickness of the ware. The molds are made of plaster, and as they readily absorb moisture, they are kept in a drying-room, from whence they are brought by a boy as required.

The plate-maker cuts off a piece of clay with a wire, and flattens it out by a plaster-mallet called a *batter*, while the clay rests upon a slab of wet plaster called a *batting-block*. A boy brings a plaster-mold from the drying-room, places it on the whirling-table, and then takes his position at the driving-crank. The man places the clay on the mold which forms the inside of the vessel, and when motion is imparted to the table the templet *a* is brought down and gives the required thickness and configuration to the ware. The mold and the ware are then removed to the drying-room, where, in a few hours, the plate is sufficiently dry to be removed from the mold. The latter is left to dry for a while longer, to remove the moisture contracted from the clay.

Whir'tle. A perforated steel plate through which pipe or wire is drawn to reduce its diameter.

Fig. 7202 illustrates a mode of forming lead-pipe. *a* is a section of the mold in which the rough tube is cast upon a treblet serving as a core. This is placed in an inclined position, as at

Fig. 7202.



Whirtles.

b, the pouring being done at the lower end. The core is enlarged at the lower end, so that when the other is made fast to the rack and the gear operated, the pipe is drawn with it through the whirtle *c* is a section illustrating the plan of clamping the mold. *d* are a plan and two sections of a whirtle. *e* is a drawing-machine in which a chain, winding upon a shaft rotated by gearing operated from the engine, is engaged to the treblet, drawing it over rollers through the whirtle at *f*. The whirtles are made rounded on one side to allow the more ready exit and entry of the pipe. They are of various sizes, the pipe being drawn through the larger ones first, and afterward through the smaller, of the gradually decreasing series, until reduced to the proper size.

Whisk. 1. A small besom of broom-corn.

2. An egg-beater.

3. A cooper's plane.

Whisk'er. (*Nautical.*) Projecting booms at the bows, to spread the guys of the jib-boom.

Whis'ket. 1. A small lathe, used for turning wooden pins. It has a hollow chuck, which holds the pin while turning.

2. A *basket*.

Whis'key. Corrupted from *kibitka*, or *britschka*. See BRITZSKA.

Whis'per-ing-gal'ler-y. One of circular plan, in which a faint sound conveyed around the interior wall may be readily heard, while the same is inaudible elsewhere in the interior.

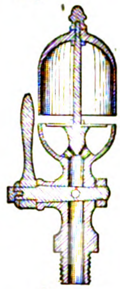
Fig. 7203.

Whisk.

Fig. 7204.

Police Duplex Calls, with Guard.

Fig. 7205.



Steam-Whistle.

Mentioned by Seneca, and well known to the ancients.

Whis'tle. 1. A shrill-toned wind-instrument, used as a child's toy. Larger instruments of the kind are employed as alarms and for signaling.

Fig. 7204 is a duplex whistle, for policemen, street-railroad car-starters, etc. It has two tubes of different lengths and consequent pitch.

The only musical instruments exhumed from the prehistoric deposits are whistles and pipes: one of the former obtained in a cavern of the Department of Dordogne in France is the first digital phalanx of a reindeer, with a cylindrical smooth-drilled hole. It yet yields a shrill sound when blown into. Several whistles made of the eye-teeth of dogs, with holes drilled near the roots, have been found in the cave of Lombrive, Department of Ariège. These are contemporary with the remains of the rhinoceros, reindeer, mammoth, hyena, bear, and cave-lion. A pipe with three finger-holes, made from a fragment of stag-horn, was found in the vicinity of Poitiers.

An ivory whistle a foot long has been found in a British barrow. It is engraved in Grose.

The railway-signal code of the United States is, —

1 whistle, "down brakes."
2 whistles, "off brakes."
3 whistles, "back up."
Continued whistles, "danger."
Rapid short whistles, "cattle-alarm."
A sweeping parting of the hands on the level of the eye, "go ahead."
Downward motion of the hands with extended arm, "stop."

Fig. 7206.

Whistles.

2. The steam-whistle was invented in 1826 by Adrian Stephens, Plymouth, England.

It is attached to a pipe connected with the boiler. On turning a cock the steam enters the lower part of the case, and, striking against a thin-edged circular deflecting plate, is directed through an annular opening against the beveled rim of a hemispherical or elongated brass cup, and passes out between the upper and lower cups.

A (Fig. 7206) is Johnston's self-acting alarm-whistle. The rod *a* is adjustable in the tubular stem *b* of the ball, to suit the desired low-water level in the boiler. When the water falls below the fixed point, the descent of the ball opens a valve connected with the rod *a*, allowing steam to escape and sound the whistle.

B shows the device attached to a Cornish boiler.

See also LOW-WATER ALARM.

Porteous's whistle, for a railway or marine signal, consists of a single mouthpiece and a number of whistles of different tones arranged in the barrel. By the introduction of one discordant note, an extremely shrill vibra-

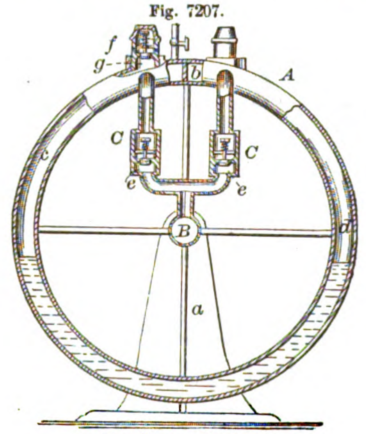
tion is produced, its peculiar dissonance rendering it distinctly audible over other sounds. (See also CALLIOPE.) The whistle, patent No. 46,910, March 21, 1865, gives also a variable sound.

Wood's railway-whistle (English patent, May 22, 1841) is attached to the blast-pipe to give a constant intermittent whistle during foggy weather.

Fig. 7207 is a fog-alarm whistle, acting by the pulsation of water as the vessel sways, driving air out of an orifice.

The annular pipe *A* is divided into two chambers by a partition *b*. It is partially filled with liquid, and an oscillating motion is imparted to it, producing alternately a partial vacuum in each of the chambers *c d*, which is filled by air entering through downwardly opening valves *g*, one for each chamber. The return oscillation, causing the liquid to rise,

Fig. 7207.



Fog-Alarm Whistle.

compresses the air, forcing it to pass through one of the downwardly opening valves *e e* in the pipes *C C*, whence it is discharged through the hollow trunnion *B* into a chamber to which the whistle is connected. See also FOG-ALARM, Fig. 2056, page 898.

Patent No. 13,639, January 21, 1868, is also for a whistle, operated by compressed air by means of a piston and hand-lever.

White. The white pigments of commerce are principally obtained from lead, but preparations of baryta and zinc are also used; the former as an adulteration, the latter as a substitute.

White-lead is the carbonate of lead, produced from the metal. See WHITE-LEAD.

Venice white is a mixture of equal parts of white-lead and sulphate of baryta.

Hamburg white is lead, 1; baryta, 2 parts.

Dutch white has lead, 1; baryta, 3 parts.

Clichy white is pure carbonate of lead.

Kremnitz white, *krems white*, and *silver white* are synonyms of *white-lead*.

Zinc-white, an oxide of zinc. See ZINC-WHITE.

White Brass. An alloy of copper and zinc, with sufficient of the latter, or of nickel, lead, etc., to give it a white color.

	Copper.	Zinc.	Nickel.	Iron.
Tutenag	50	31	19	..
German white copper........	88	..	8.75	..
Sorel's white brass (1840) ...	10	80	..	10
Packfong	5	7	7	
Chinese packfong............	40.4	25.4	31.6	2.6
				Cadmium.
Parisian white metal	69.8	5.5	19.8	4.7

White-cloud Il-lu'mi-na'tor. (*Optics.*) A reflector to illuminate a microscopic object with a subdued white light, such as is obtained from a bright *white cloud*. In place of a plane mirror, a surface of pounded glass or plaster of Paris is used.

White Cop'per. An alloy forming an imitation of silver: copper, 16; zinc, 1; with arsenic added in a small quantity, to whiten.

Known also as *white tombac* (Malay, *tambaga*, copper) or as *blanched copper*. See MOCK-SILVER; WHITE BRASS.

White-lead. Carbonate of lead (PbO, CO_2). A dense white powder, insoluble in water, but easily dissolved in dilute nitric or acetic acid; extensively employed in painting.

The dissolving of lead in vinegar to make a pigment was known to the ancients.

Various methods have been and are used in its manufacture.

By the Dutch process, generally employed in England, where the manufacture was introduced about 1780, metallic lead cast in star or circular shaped gratings 6 or 8 inches in diameter is placed in pots containing strong acetic acid, over, but not in contact with, the acid. The pots are imbedded in a mixture of new and spent tan, and are covered with boards, over which is another layer of pots also imbedded in tan, and so on until a stack is built up some 20 to 25 feet in hight. The process is conducted within a covered chamber.

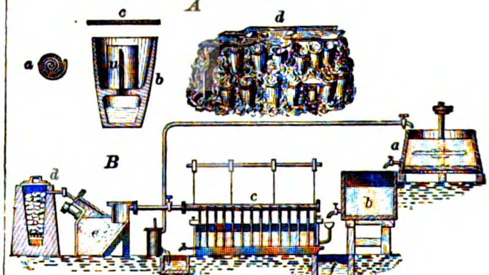
A double reaction takes place in consequence of the heat generated by the fermenting tan; the volatilized acetic acid changes the metal into an acetate, which is converted into a carbonate by combination with the carbonic-acid gas evolved by the tan. The process occupies from 4 to 6 weeks.

In France, pits lined with masonry are constructed for the purpose. Stable-manure is employed as the fermenting material. A similar plan is adopted in Holland, Belgium, and some parts of Germany. *a* (Fig. 7208, *A*) is a plate of cast-lead rolled into spiral form; this is placed on an annular ledge in the pot *b*, so as not to be in direct contact with the acetic acid, and the pot is covered with a leaden plate *c*; the stock of pots is arranged as shown at *d*.

It is of great importance that the lead should be pure. consequently sheet-lead is not used, cast-metal only being employed. Any iron gives the pigment a tawny hue; and if silver be present, it becomes dingy when exposed to the light.

Lead prepared in this way is afterward subjected to the action of a crushing-mill, and then passed through a separator, by which any remaining unconverted or "blue" lead is removed. It is then ground in water, run through troughs arranged to arrest any metallic particles which may still remain; passed into tanks, where it is precipitated; and, finally, dried in large pans previous to being mixed with oil.

Fig. 7208.



White-Lead Pits and Process.

In the improved method, as practiced in England, the lead is first converted into litharge, which is mixed with a small proportion of the acetate of lead, and then subjected to the action of carbonic-acid gas, derived from the combustion of coke. In France, the process of Thénard and Roard is employed. Litharge is dissolved in acetic acid, forming a solution of basic acetate of lead, through which a current of carbonic-acid gas is passed.

B is the apparatus employed at the works at Clichy. *a*, tub, provided with a stirrer, in which the litharge is dissolved; the acetate is drawn off into the tank *b*, where the impurities settle, and is then allowed to flow into the tubular decomposition-vessel *c*, where carbonic-acid gas from the kiln *d*, filled with chalk 2½, coke 1 part, is, after passing through the purifier *e*, conducted by the tubes to points near the bottom of the liquid; when the process is complete, the supernatant neutral acetate of lead is drawn off, and the white-lead, in the form of a semi-fluid magma, passes into *f*.

Sulphate of baryta is extensively used for the adulteration of white-lead. This substance is nearly as heavy as the lead, and is perfectly white, but not so brilliant. It has not the body of white-lead, but is not so easily affected in color by noxious gases, white-lead being soon discolored by sulphureted hydrogen gas.

The carbonate of zinc is a good substitute. See ZINC.

For other processes, see English patents: —

11,521, of 1847, Charles R. Lothman. Vapors produced in the process of brewing and air are introduced into the lead-chambers.

12,246, of 1848, Thomas Richardson. Finely divided metallic lead is treated with acetic acid, steam, and hot air, in trays lined with slate flags, at a temperature of 90° to 100° F.

12,724, of 1849, J. E. D. Rodgers. Lead is cast into sheets, which are doubled, and hung on frames. Troughs on the floor of the chamber are charged with malt, sugar, etc. Steam is admitted, through dilute acetic acid, in other troughs.

3,091, of 1857, Edwin Hills. Lead ore, roasted to drive off the sulphurous gases which are used for making sulphuric acid, is formed into stacks, and acetic-acid vapor introduced at their bases.

1,411, of 1858, Brown and Young. Carbonic-acid gas is passed through nitrate of lead, in solution. The carbonate thus formed is lixiviated with lime-water.

88, of 1860, George Robinson. Chloride of lead is mixed with carbonate of ammonia.

1,288, of 1860, William Baker. Uses salts of acetic acid instead of the acid itself.

642, of 1861, J. A. Phillips. The carbonic acid is expelled from lead ores by a dull red heat, and they are boiled in a strong solution of neutral acetate of lead; a current of carbonic-acid gas then causes a precipitate.

2,427, of 1865, Peter Spence. Ore prepared as above is treated with a carbonate, then with caustic soda, and, lastly, with carbonic-acid gas.

1,465, of 1867, William R. Lake. Chloride of sodium and oxide of lead are heated, forming oxychloride of lead; the pasty mass is treated with carbonic-acid gas.

1,278, of 1867, A. M. Clark. Metallic lead is moistened with the spray of acidulated water, and then treated with carbonic-acid gas, under pressure; the process is completed by treatment with chlorine and carbonic-acid gas.

List of United States Patents for White-Lead.

No.	Name and Date.	No.	Name and Date.
——	Holland, Mar. 18, '36.	66,139.	Fell * *et al.*, June 25, '67.
——	Clark,† ‡ Dec. 4, '28.	66,140.	Fell * *et al.*, June 25, '67.
95.	Richards, Dec. 2, '36	67,992.	Lewis, Aug. 20, '67.
160.	Phillips, April 17, '37.	70,990.	Gattman,* Nov. 19, '67.
264.	Ripley, July 11, '37.	77,818.	Jacobi, May 12, '68.
767.	Cumberland, June 7, '38.	80,168.	Hannen,† July 21, '68.
994.	Holland, Nov. 3, '38.	83,357.	Bartlett, Oct. 27, '68.
1,115.	Button *et al.*, April 10, '39.	85,796.	Dale *et al.*,§ Jan. 12, '69.
1,231.	Clark, July 11, '39.	86,835.	Hannen,* Feb. 9, '69.
1,424.	Clark, Dec. 5, '39.	89,074.	Reakirt, Apr. 20, '69.
1,535.	Trovills, Mar. 31, '40.	91,267.	Repetti, June 15, '69.
1,744.	Gardner, Aug. 28, '40.	91,466.	Mayer, June 15, '69.
1,804.	Cory, Oct. 8, '40.	92,816.	Gattman, July 20, '69.
3,232.	Gardner, Aug. 26, '43.	94,214.	Jacobi, Aug. 31, '69.
8,292.	Pattison, Aug. 12, '51.	95,075.	Bradley, Sept. 21, '69.
12,616.	Baker, April 3, '55.	95,097.	Dwelle, Sept. 21, '69.
13,657.	Rowland, Oct. 9, '55.	95,201.	Cuddy, Sept. 28, '69.
13,961.	Schwabe, Dec. 18, '55.	97,365.	Dale *et al.*, Nov. 30, '69.
18,244.	Hannen, Sept. 22, '57.	97,936.	Lewis *et al.*, Dec. 14, '69.
19,771.	Hannen, Mar. 30, '58.	104,434.	Cuddy *et al.*, June 21, '70.
20,731.	Rowland, June 29, '58.	105,431.	Cuddy, July 19, '70.
22,036.	Smith, Nov. 9, '58.	108,433.	Bartlett, Oct. 18, '70.
22,679.	Smith, Jan. 18, '59.	108,571.	Dwelle, Oct. 25, '70.
23,815.	Albert, May 3, '59.	109.125.	Hatfield, Nov. 8, '70.
25,106.	Erdmann, August 16, '59.	112,606.	Lewis, March 14, '71.
29,665.	Brumlen, Aug. 21, '60.	112,607.	Lewis, March 14, '71.
30,521.	Mayer, Oct. 23, '60.	112,608.	Lewis, March 14, '71.
31,224.	Brumlen, Jan. 29, '61.	113,014.	Brumlen, Mar. 28, '71.
33,337.	Cary, Sept. 24, '61.	114,405.	Burridge, May 2, '71.
38,283.	Cobley, Apr. 28, '63.	116,604.	Lewis, July 4, '71.
42,407.	Rowland, Apr. 19, '64.	118,794.	Davison, Sept. 12, '71.
45,587.	Coggeshall *et al.*, Dec. 27, '64.	120,556.	Wheeler, Oct. 31, '71.
46,706.	Archer *et al.*, March 7, '65.	120,916.	Wadsworth, Nov. 14, '71.
48,099.	Rowland, June 6, '65.	122,404.	Pollock, Jan. 3, '72.
48,243.	Baker, June 13, '65.	125,153.	Whiting, April 2, '72.
51,018.	Chadwick, Nov. 21, '65.	127,395.	Wheeler, May 28, '72.
52,144.	Delafield, Jan. 23, '66.	136,446.	Meylert, Mar. 4, '73.
53,093.	Spence, March 6, '66.	137,474.	Osgood, April 1, '73.
53,583.	Delafield, Apr. 3, '66.	140,721.	Milner, July 8, '73.
55,249.	Delafield, June 5, '66.	142,199.	Bœhne, Aug. 26, '73.
56,685.	Fell *et al.*, J'ly 24, '66.	142,419.	Tolle, Sept. 2, '73.
59,135.	Overmann, Oct. 23, '66.	145,713.	Armstrong, Dec. 23, '73.
59,901.	Fell * *et al.*, Nov. 20, '66.	148,862.	Tuttle *et al.*, Mar. 24, '74.
59,902.	Fell *et al.*, Nov. 20, '66.	151,165.	Sevin, May 19, '74.
62,097.	Van Der Weyde,* Feb. 12, '67.	151,497.	Meylert, June 2, '74.
62,130.	Hannen, Feb. 19, '67.	151,799.	Rueger, June 9, '74.
64,763.	Hannen, May 14, '67.	154,643.	Brumlen, Sept. 1, '74.
66,137.	Fell *et al.*, June 25, '67.	155,539.	Morse, Sept. 29, '74.
66,138.	Fell *et al.*, June 25, '67.		

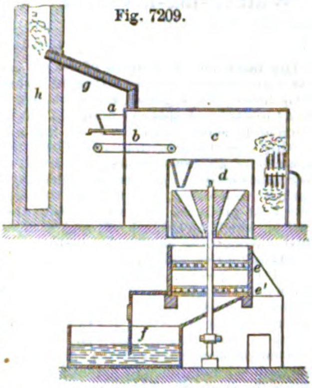
* Antedated. ‡ Extended.
† Reissued. § Patented in England.

See also ZINC-WHITE.

White-lead Mill. A mill for grinding white-lead, either in a dry or moist condition.

Fig. 7209 illustrates an apparatus invented by MM. Hameline and Besançon, in which the production of flying dust, injurious to the health of the workmen, is reduced to a minimum. The dried cakes of lead are placed in a hopper *a*, from whence they fall upon an endless band *b* within the chamber *c*, by which they are carried to the mill *d*, where they are pulverized. The powder falls upon a sieve, over which is a series of brushes connected to and revolving with the mill-spindle. The larger particles are conveyed off through a channel *e*, while those which pass through the meshes fall on to a second sieve with brushes, the larger particles, as before, being discharged through a channel *e'* at the side, while the finer ones pass through and fall upon an incline, by which they are conducted into a vessel *f*, which may contain oil, or where they may be collected in the dry state. The chamber *c* has at its upper part a pipe *g* opening into the shaft *h*, which carries off such dust as is not condensed by means of steam-jets *i* entering the chamber.

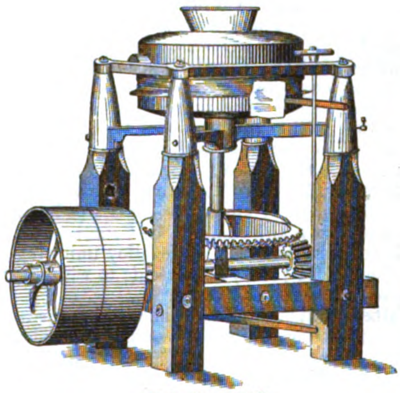
Fig. 7209.



White-Lead Mill.

Fig. 7210 illustrates a mill for grinding white-lead in oil or water. The pigment having been sufficiently moistened and mixed is fed through the hopper at the top, and is thoroughly comminuted and incorporated with the oil by the grinding action of two grooved disks, the upper one of which is rotated by gearing driven by belt and pulley and the lower one stationary. The spindle of the upper disk is stepped in a lever which is adjustable by a screw-rod and hand-wheel to vary the distance between the faces of the two disks, so as to regulate the fineness of the product.

Fig. 7210.



White-Lead Mill.

White-leath'er. Leather tanned with alum and salt, which does not discolor the hide or give it the brown appearance due to tanning by oak-bark or other ooze. See TAWING.

White-line. 1. (*Printing.*) A blank space between lines of types.

2. (*Nautical.*) An *untarred* cord or rope.

White-mal'le-a-ble Al'loy. See list under ALLOY. Specifically the list in 2d column, page 63.

White-met'al. A term usually applied to an alloy in which zinc, tin, nickel, or lead is in such quantity as to give it a white color, if white be a color, as it is for all reasonable purposes of description. See list, 2d column, page 63.

Whit'en-ing. (*Leather-manufacture.*) The process of cleaning hides at the beam, by passing a knife with a fine edge lightly over the flesh side, to bring it to the clean and fit condition for *waxing*.

Whit'en-ing-ma-chine'. A machine for removing the red skin or cuticle from the grain of rice after the outer husk has been hulled off.

The machine has a stone of coarse grit fixed on a spindle, like a grindstone, and revolving in a sheet-iron case, punched with holes like a grater, the protuberances of the apertures being inward. A space of about 1 inch intervenes between the stone and the case, and the latter has a door on the periphery, at which the rice is introduced. The stone is rotated by a band, at a rate of 250 revolutions per minute, and the case is allowed to rotate slowly. The rice is rubbed by the stone, the grains against each other, and against the asperities of the casing. The heat produced by friction swells the grain and bursts the cuticle, which is rubbed off, and escapes, in the form of red dust, through the holes in the casing.

Ewbank's rice-polishing or whitening machine (English patent, 1819) specifies a pair of concentric cylinders, the outer one fixed, and the revolving inner one covered with sheep-skin, with the wool outward. The rice is rubbed between the two, and the cuticle is thereby rubbed off and the grain polished.

Shiel's whitening-machine (English patent) consists of two wooden runners, covered with sheep-skin, with the woolen and the flesh sides of the skin exposed to the rice, which passes between the runners. The wool intervening between the leather and the wood gives a certain elasticity to the rubbing surfaces.

Whit'en-ing-stone. A fine-grained stone used by cutters.

White Pat'terns. (*Dyeing.*) In the India bandanna handkerchiefs the white spots are produced by covering them with sealing-wax and tying up tightly to protect them from the action of the dye. European manufacturers employ a *resist* or *discharge* for the same purpose, citric or tartaric acids being largely used for the latter object. The yellowish tinge which the white spots acquired during the subsequent washing was formerly provided against by mixing cow-dung with the water; the phosphates of lime and soda mixed are now, however, used to produce the same result.

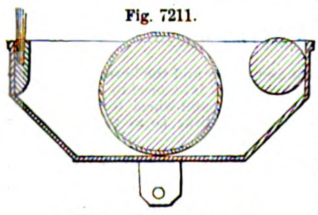
White-rub'ber. Caoutchouc mixed with such quantity of any white pigment as to give a dead white color to it. The ingredients are added in combination with sulphur, so as to make a white vulcanite when heat is applied. Oxide of tin, chalk, whiting, etc. See IVORY, ARTIFICIAL.

White-stuff. (*Gilding.*) A composition of size and whiting used by gilders to cover woodwork on which gold-leaf is to be laid. See GILDING.

White Tom'bac. A white alloy imitating silver. Copper, 14; zinc, 1. Arsenic to whiten. See MOCK-SILVER.

White'wash. A milk of lime used for painting walls. Its extreme whiteness is sometimes moderated by a little black or other color. An addition of size renders it more durable.

Fig. 7211.



Whitewashing-Apparatus.

White-wash'-ing-ap'pa-ra'-tus. A reservoir with roller and brush for whitening walls and ceilings.

The bibulous larger roller distributes the wash from the reservoir upon the ceiling; the smaller roller acts as a guide, and the brush precedes to remove dust.

Whit'tle. An old name for the clasp-knife.

"A Sheffield whittle." — CHAUCER.

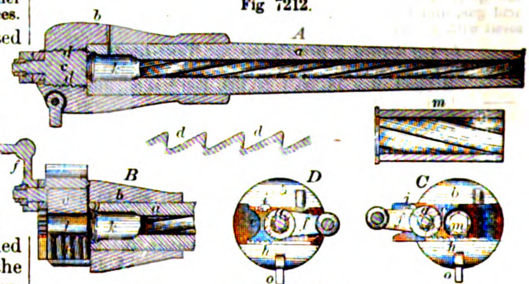
Whit'worth Gun. (*Ordnance.*) A kind of rifle invented by Mr. Whitworth of Manchester, England. The bore is hexagonal in section and has a very rapid twist. The projectiles are very elongated in form and adapted to closely fit the bore, studs and expansible rings being dispensed with. Cannon and small arms, both muzzle and breech-loading, are constructed on this principle, the breech-loading form, however, being generally adopted.

Fig. 7212 illustrates one of the latest of Mr. Whitworth's improvements. The gun is of cast-steel, compressed while still in a fluid state, whereby the tensile strength is greatly increased.

A is a vertical, *B* a horizontal section, *C D* end elevations showing the breech in open and closed positions respectively.

The barrel *a* is strengthened by a reinforce band *b*; in large guns more than one of these bands may be employed. The central part of the rear end of the reinforce is cut away, forming a groove in which the breech-block *c* slides. The faces of this opening have a series of parallel grooves *d*, adapted to receive a corresponding series of teeth *e e* on the breech-block, and by which it is held when pushed home in position for firing. These grooves are very slightly inclined to the axis of the bore, so that as the breech-block is moved into this position it is drawn up close to the face of the breech. The movement is effected by a lever *f*, connected by interlocking projections with a pinion *g*, which gears with a rack *h* at the bottom of the breech-opening; a pawl *i* dropping into a notch in the pinion *g* serves to hold it in place, but may be lifted to permit its removal. The cartridge-chamber *k* is of larger diameter than

Fig 7212.



Whitworth Gun.

the bore of the gun, and is somewhat enlarged at its base; to facilitate the insertion of the cartridge a groove *l* or a circular opening, corresponding in diameter to the cartridge, is also made in the breech-block; this opening receives a shot-guide *m* having an aperture through which the projectile is passed in loading, and by which it is directed into the bore; when in place this guide is removed and the cartridge inserted; to facilitate this the rear end of the bore is very slightly enlarged. By turning the lever *f* the breech-block is then slid into firing position and the gun is ready for discharge. The interlocking projections on the lever and the pinion *g* having a certain amount of play allow the lever to act as a hammer to more effectually start the breech-block at the commencement of this and of the return movement. A steel gas-check *n* is provided to prevent escape of gas at the breech. It will be observed that the grooves *d* are undercut to prevent any tendency on the threads of the breech-block to separate the two parts of the reinforce-band which serve as guides. *o* is the upper end of the elevating screw-link.

The nine-pounder field-gun on this plan is made from a solid ingot of steel, no reinforce-band being employed. Its length is 6 feet 2 inches; weight, 8¼ cwt.; external diameter at the breech, 10¼ inches; muzzle, 4¼ inches; diameter of major axis of bore, 2.72 inches; of minor axis, 2.47 inches; charge of powder, 2¼ pounds.

The rifling has a twist of 1 in 55 calibers, and the ordinary projectiles are 3½ diameters in length, and are fired as cast, without being trimmed up. The carriage is also of steel, weighing 10 cwt.

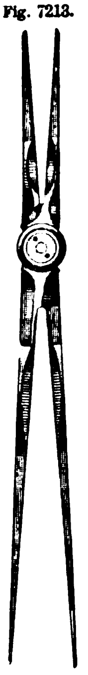
Steel shot having their sides smoothly dressed up are frequently employed with the Whitworth gun, which is peculiarly adapted for firing solid shot, though hollow projectiles are also used

Small arms rifled on this plan are better suited for hard metal than leaden projectiles; with the former great penetration and accuracy are attainable.

Whole. (*Mining.*) Where the coal has not been worked.

Whole-and-Half Com'pass. A proportional compass having two pairs of legs, one pair twice the length of the others, so that their respective reaches are as 2 to 1. A kind of *reducing* or *enlarging* compass. The Herculaneum cabinet shows a pair of

Fig. 7213.



Whole-and-Half Compass.

such, and the same may be seen in Ficoroni, "Gem. Liter.," tab. 6, 4to, 1757. Such are also seen in the Pompeiian collection. Also known as a *bisecting-compass*.

Whorl'er. A potter's whirling-table, on which he shapes circular articles.

Wick. A bundle of fibers to lead oil to the flame, where the oil is evolved as gas to maintain combustion. It acts by capillary attraction, and usually consists of a bundle of soft-spun cotton threads. Though the wick is usually charred, it is not a necessary condition. Some of the lighthouse lamps are made to overflow at the wick-tube, keeping so constant and profuse a supply that the wick is scarcely affected.

Small tubes of glass or bundles of wire have been used as wicks; asbestus was used by the ancients, and is yet used by the moderns. Gordon's English patent, many years since, described wicks composed of glass, metallic wire, or asbestus in fine filaments, formed into small bundles and bound spirally with wire or wrapped in wire-gauze. The liquid is conveyed by capillary attraction in the fine interstices between the parallel filaments to the flame.

Inventors have not entirely neglected the subject, as the following will indicate: —

Leslie, October 26, 1858. A wick composed of a single yarn, double-looped.

Wortendyke, April 26, 1859. A lamp-wick composed of strands that have received a preparatory twist in one direction are then spun in a contrary direction with and coiled upon a thread, and are then twisted together.

Weeden, January 1, 1861. A wick composed of a single strand in a series of single loops.

McKee, December 23, 1862. A lamp-wick made out of pulp, and felted or hardened together, instead of being woven, plaited, or twisted, and this whether the pulp be incased in an outer protection or not.

Connelly, January 6, 1863. The wick consists of an outside case or wrapper of linen, muslin, or other suitable substance, folded lengthwise over a filling of loose raw cotton, cotton-yarn, paper, pulp, or other substance possessing sufficient capillarity, the joint of the outside case or wrapper being secured by a narrow strip of thin muslin or other material pasted upon one side of the wick, where the edges of the wrapper meet.

White, August 28, 1863. A roving of unspun cotton, flax, jute, or other vegetable fiber, covered with a coating of gluten, by being passed through a vessel containing a solution of gluten, from whence it is passed to a tube to bring it to the proper shape, and afterward dried.

Larcher, July 7, 1863. At the upper end of a common wick is a section of asbestus, which is fed by the ordinary wick, without waste of material.

Meucci, February 28, 1865. A lamp-wick made of paper pulp, and strengthened by means of bobbinet or other similar material.

Furlong and Long, April 4, 1865. The wick is saturated with a mixture of alum, graphite, and water, to render it nearly incombustible.

Noyes, December 19, 1865. The wick is made of closely woven fiber, inclosing loose longitudinal fibers to lead the oil.

Le Count and Chard, February 27, 1866. The wick is made of wool or woolen cloth.

Topliff, June 19, 1866. The lamp-wick is treated with alum and gum, to preserve it from combustion.

Le Count, October 30, 1866. Cotton threads run longitudinally through the wick, to increase its conducting power.

Hoard, November 20, 1866 The wick is made of paper pulp.

Martine, March 5, 1867. The wick has a core of wood, twine, or some firm substance that will consume with the wick; the addition gives stiffness to the wick, and enables the teeth of the elevating wheel to operate upon it more effectively

Count Rumford invented the flat wick of soft cotton woven for the purpose, of the right width.

Argand of Geneva invented the tubular wick and the lamp named after him, which was the first lamp requiring a wick of that character.

The modification of the Argand, invented by Fresnel, for lighthouse purposes, has 4 concentric wicks, the outer one 3½ inches in diameter.

L'Ange invented the lamp-chimney, adding it to the tubular wick and central air-tube of Argand.

The mosque of Cordova was lighted by oil-lamps and wax-candles, in the time of Al-Mansur. 75 pounds of cotton were consumed each month of Ramadhan. The number of brazen chandeliers was 280; the cups for oil, 7,425. The annual consumption of oil, 125 kintars (12,500 pounds). The wax-candles for Ramadhan, 300 pounds, with 75 pounds of cotton yarn for wick. The largest chandelier had 1,854 cups for lights. The four large ones were only lighted on special occasions, and burnt nightly 175 pounds of oil. — MAKKARI'S (Arabic) *History of the Mohammedan Dynasties of Spain.*

Wick'et. 1. A gate, formed like a butterfly-valve, in the chute of a water-wheel, to graduate the amount of water passing to the wheel. It has a central spindle with a wing on each side.

2. A small gate for foot-passengers.

3. A half-high door.

Wick-trim'mer. A shears for trimming wicks. It has usually a shelf on one blade to hold the portion cut off.

Wide-gage. In England, the gage of the Great Western Railway, 7 feet.

Our broad-gage is such as the Erie. See RAILWAY-GAGE.

Wig. A false head of hair; the hair is fastened into a fabric or false scalp.

Some very fanciful and well-constructed wigs are found in the tombs of Egypt. The people, especially those of quality, were shaved regularly, except in time of mourning. Several wigs have been preserved, and are now in the museums of London and Berlin.

The Egyptians wore false beards on the chin, the kind and style being determined by rank and condition.

Xenophon stated that the Persian monarchs wore wigs. It is probable that the splendid tresses and beards of the Assyrian monarchs and magnates, as seen in the sculptures of Nimroud, were artificial.

Tertullian cautioned his wig-wearing auditors to beware of wearing dead peoples' hair. Clemens of Alexandria declared that the episcopal blessing stayed in the wig and would not percolate through to the scalp.

The Greeks and Romans used false hair, and likewise hair-powder. Hannibal wore what may be called a wig; that of the Emperor Commodus was anointed with grease, powdered with gold-dust, and scented. The fashion was again set by St. Louis on his return bald-headed from the crusades. Henry III. of France had a skull-cap covered with false hair. In Louis XIV.'s reign wigs were fashionable. Hair was then woven into a linen cloth, and likewise into fringes, which were used under the name of *Milan points*. These fringes or laces were sewed in rows to plain caps, which were made of thin sheep-skin, and this head-dress was the French *perruque*, the German *parucke*, the English *periwig;* whence the term *wig*. One form consisted of three-thread tresses which were sewed to ribbons; these were then stretched out and sewed together on blocks cut into the shape of the head. Frizzing the wigs was introduced by one Ervais

Periwigs first worn in England about 1590. Judges wore full-bottomed wigs 1674.

"I bought two periwigs, one whereof cost me £3 and the other 40 *s.*" — PEPYS, 1663.

The *peruke* was an Italian device, first worn at the French court, 1620; introduced into England, 1660.

Louis XIV., to hide his shoulders, which were not matches, introduced the long wig, and then no gentleman of quality at court could wear his own hair.

Wig'an. An open, canvas-like fabric, used as a stiffening in the lower ends of the legs of pantaloons, and as a skirt-protector on the lower inside surface which drags on the pavement. It is sometimes sold in strips, fluted, and attached to a band.

Wig-block. A shaped piece of wood for fitting a wig upon.

Wig'ging. See WIGAN.

Wig'wag. (*Watch-making.*) A rubbing-instrument used upon and driven by the lathe, being reciprocated longitudinally by crank attachment to some wheel of the lathe.

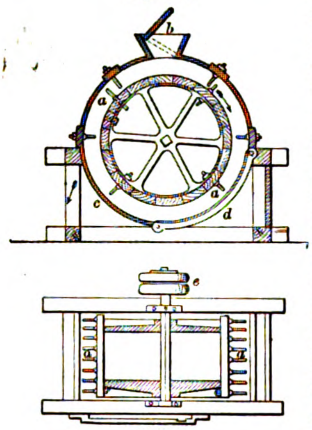
Wil'low. See WILLOWING-MACHINE.

Wil'low-er. See WILLOWING-MACHINE.

Wil'low-ing-ma-chine'. 1. (*Flax.*) A set of revolving bars for removing the pith and other refuse from flax, hemp, etc.

2. (*Cotton.*) A machine for cleaning cotton, similar to the *opening-machine*, and more particularly adapted for cotton of long fiber and full of impurities.

Fig. 7214.



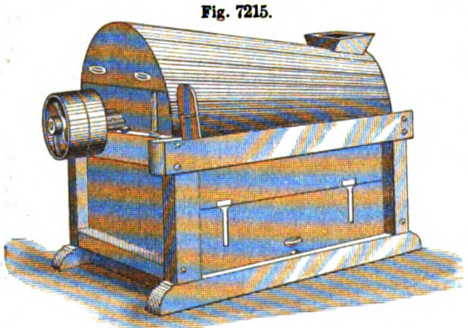
Willow.

The spikes *a a* are less numerous but much longer than those of the *opener*, the spikes of the drum passing between those in the cover.

The machine is fed through the hopper *b*, and the cotton is taken out through the door *c*, while the impurities pass through the grid *d*. The drum, which is driven by means of the fast and loose pulleys *e* at the rate of 300 revolutions per minute, can prepare 150-200 pounds of cotton per hour. Each charge consists of about 1¼ pounds, and the duration of each operation is about 25 seconds.

Fig. 7215 consists of a casing containing a conical beam studded with spikes, which pass between other spikes in the casing. The cotton is put in at one end of the machine, and being caught by the spikes, the flocks are pulled apart and the dirt shaken out while it is being gradually carried forward to the place of discharge. Sand and

Fig. 7215.



Willower.

heavier impurities fall through a grating at the bottom, while the dust and lighter matters are driven off by a fan and pass through wired openings into a chute. Called also *twilly*, *shake-willy*, *willow*, *willy*, *willey*, *devil*, *opening-machine*. See also COTTON-CLEANING MACHINE.

The term *willow* is said to have been derived from the fact that in the early forms of the machine a cylindrical willow cage was used. It is more than probable that the term is derived from the willow-wands wherewith the cotton was beaten, to loosen it and eject the impurities, before the invention of machinery for the purpose. The finer varieties of cotton are yet *batted* with rods while resting on an elastic grated table; the felting-material for hats is similarly treated; and cow-hair to mix with plastering-mortar is also beaten with rods to separate and loosen the tussocks.

The willowing in the series of operations on ordinary cotton is followed by the batting-machine, in which *scutching*, *blowing*, and *lapping* are employed, to rid the cotton of remaining impurities, and bring it to a light downy condition, fit for presentation to the *carding-machine*, which lays the fibers parallel, in readiness for the operations of *drawing* and *twisting*.

3. (*Wool-manufacture.*) A large wooden cylinder having strong iron spikes about 3 feet long projecting from its periphery, and arranged in a spiral direction around it.

The cylinder is inclosed in a wooden case, and the wool is supplied to it by an endless apron and feeding rollers. The wool as it passes between the rollers is exposed to the action of the spiked cylinder, whose teeth tear apart the fibers of the wool, making it light and open, at the same time allowing dust and dirt to fall through a grating beneath. This is preliminary to the *picking* and *burring*. See WILLOWING-MACHINE; WILLOWER.

Wil'low-peel'er. A device or a machine for stripping the bark from willow wands.

A crotch with sharp edges is effective upon the wand which is drawn through it, the bark being loose upon the wood.

Machines are also made for the purpose. See patents Nos.

62,629	21,740
58,747	40,252
84,324	34,201
29,535	70,288

Wil'low-strip'per. See WILLOW-PEELER.

Wil'ly. A machine having a spiked cylinder for tearing open the locks of wool before the *picking*, *burring*, *oiling*, and *carding* processes. A *devil*. See WILLOWING-MACHINE.

Wil'son-snaf'fle. (*Manege.*) A jointed mouth-ring bit, the check-rings of which are loose and made in the usual manner; upon the mouth-piece there are two loose rings, into which the check-straps of the bridle are buckled.

Wil'ton-car'pet. A carpet made like Brussels, excepting that the wire is flattened instead of being round, and has a groove along the upper surface, which acts as a director for the knife by which the loops are cut and the wire liberated.

The Wilton-carpet is called *Moquette* by the French. By increasing the size of the wire, the carpet can be increased in

Fig. 7216.

Pile-Fabric.

thickness or quality. The quality of Wilton or Brussels is estimated by the number of wires to the inch. The usual number is 9 for Brussels, 10 for Wilton. After weaving, the nap is sheared. See BRUSSELS-CARPET.

Wim'ble. The old-fashioned name of the *gimlet*, then of the brace. A brace, used by marble-workers in drilling holes.

Fig. 7217.

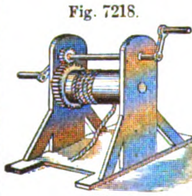
Wimble.

Wince. A form of washing-machine used by calico-printers and dyers. See WINCING-MACHINE.

Win'cey. (*Fabric.*) *Linsey-woolsey.*

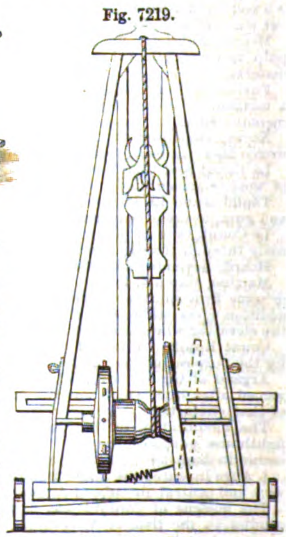
Winch. The most simple form of hoisting-machine, consisting of a roller on which the rope is wound, the turning-power being a crank.

Fig. 7218.



Winch.

Fig. 7219.



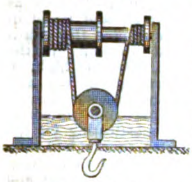
Fence-Post Driver.

It has many modifications in respect of its adaptation to cranes and derricks. Increased power is obtained by placing a large spur-wheel on the roller-shaft and turning it by a pinion on the crank-shaft.

When on a movable frame, with drum and gearing, and adapted for hauling in the fall of the hoisting-tackle of *derricks*, etc., it is called a CRAB (which see).

In Fig. 7219 the rope-

Fig. 7220.



Chinese Windlass.

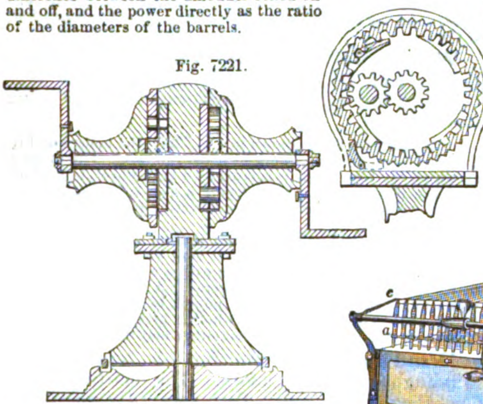
drum is turned by a spoke-wheel instead of by crank.

Fig. 7220 is a differential windlass.

In the differential windlass the rope winds upon the larger part of the barrel and unwinds from the smaller one, the elevation of the pulley being equal to half the difference between the amount coiled on and the amount payed off.

Dispense with the pulley, place the power on the rope of the larger barrel, and the load on that from the smaller barrel, and we have the ordinary *wheel and axle;* the elevation of the load being equal to the difference between the amounts coiled on and off, and the power directly as the ratio of the diameters of the barrels.

Fig. 7221.



Winch-Capstan.

We are not to infer that Satan saw the cars in motion, nor that Milton believed the modern theory, that mankind proceeded from several independent centers.

This would be granting the whole question, that the almond-eyed man of Cathay was scudding over the plains in pursuit of business or pleasure while Adam and Eve were yet disporting in Eden.

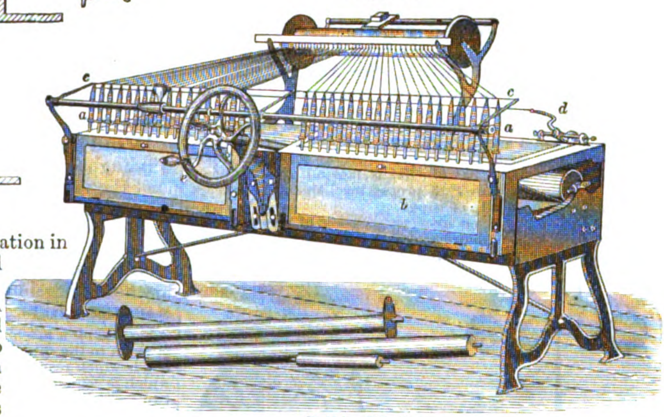
One form of the wind-car has sails like a windmill, which rotate an axle and impart motion to the driving-wheels. Such are described in old works on physics, published centuries ago.

The Chinese wind-wheelbarrow is drawn by a donkey, and when the wind is fair a sail is set. The wheel turns in the middle of a wooden frame, sustained by iron bars. Upon the frame are hung all kinds of utensils. The donkey is generally mounted by the paterfamilias, the son and heir walks behind, while the mother and younger ones ride on the vehicle. See also KITE, page 1230.

Wind-chest. (*Music.*) An air-tight box in an organ or other wind-instrument played by keys, into which the air is received from the *wind-trunk*, and from which air is admitted by valve-ways through the channels of the *sound-board*, to the air-ducts communicating with the respective pipes.

Wind-cut′ter. (*Music.*) In an organ-pipe, the lip or edge against which the issuing sheet of air impinges. The vibration thereby imparted is communicated to the column of air in the pipe, producing a musical note whose *pitch* is determined by the length of the pipe; the quality of the tone by the size of the pipe, and the material of which it is made.

Fig. 7222.



Bobbin-Winder.

Winch-cap′stan. A combination in which winch-heads are arranged on top of the capstan.

Winc′ing-ma-chine′. A wince is a reel (see WINCH) placed over the division-wall between two pits, so as to draw the cloth from either, discharging it into the other, according as the handle is turned.

It is used by dyers and calico-printers in steeping or washing cloth. The *wincing-machine* is a succession of winces over which the cloth passes continuously over reels dipping into tanks placed in succession and holding a mordant, a dye, soap-suds, solution of bleaching-powder, a chemical solution of any kind, or water, as the case may be. The tanks are *wince-pots.* See WASHING-MACHINE, Figs. 7062, 7063.

Wind′age. (*Ordnance.*) The difference between the bore of the gun and the diameter of the shot fired therefrom. It varies from .15 inches to .9 inches for spherical projectiles.

Rifled guns are intended to avoid windage, various kinds of packing and sabots being used to fill up the space around the projectile.

Wind-bar′row. See WIND-CAR.

Wind-beam. Formerly, a cross-beam used in the principals of roofs, occupying the situation of the collar in modern king-post roofs.

Wind-bore. (*Mining.*) The pump at the bottom of a set of pumps.

Wind-car. One driven wholly or partially by the wind. The Chinese have sails on barrows, to be used when the wind is favorable. Wind-cars are also used on the plains of Tartary, if we may believe the poets.

Milton alludes to the wind-driven cars of the Chinese, as traversing the table-land of Asia: —

> "But in his way lights on the barren plains
> Of Sericana, where Chineses drive
> With sails and wind their cany wagons light."
> *Paradise Lost.*

Wind′er. (*Fiber.*) 1. A machine for winding yarn on spools. There are various forms for filling spools or bobbins from skeins, balls, cops, reels, or beams: the bobbin horizontal or inclined.

Fig. 7222 is a machine for winding from a beam on to upright bobbins *a* on skewers rotated by gearing within the box *b*. Two *fallers c d* are used, one for building up the cop, the other for tension. In the figure the machine is shown as hand-driven by the wheel *e* in the rear.

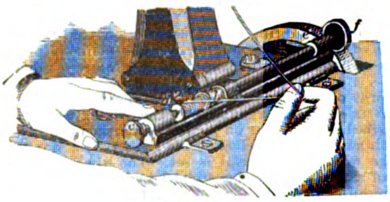
2. An apparatus for winding silk on to bobbins.

Each hank is extended upon a light, six-sided reel called a *swift*, a number of which are arranged side by side upon an axis on either side of the frame. The bobbins, one for each swift, are similarly arranged above, and the filaments being attached to the bobbins these are set in motion, causing the swifts to turn around and deliver the silk. The fibers pass through guides to which a traversing motion is imparted so that the silk is laid evenly on the bobbins.

3. A machine for winding bobbins for sewing-machine shuttles.

In Fig. 7223 is shown the thread passing off from the spool of thread on the machine; *b* is the bobbin-winder; *a* is the bobbin in process of being wound; *c* is the head on the adjustable spindle-center that holds the bobbin, and is pulled out by this head in order to get the bobbin between it and the spindle;

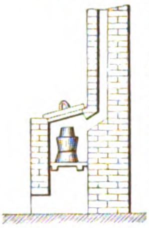
Fig. 7223.



Bobbin-Winder.

d is the point of the bobbin which should be oiled when it is being wound; *e* is the balance or fly wheel on the machine; and *f* is the bobbin-winder wheel.

Fig. 7224.



Wind-Furnace.

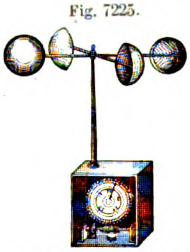
Wind-fur'nace. A furnace in which a strong heat is obtained without the use of bellows, by means of a powerful draft, dependent on a narrow flue or chimney of considerable elevation. Such furnaces are employed in chemical laboratories, and in smelting the more refractory metals.

Wind-gage. An instrument for measuring the force or velocity of the wind. See ANEMOMETER.

Dr. Robinson's is now more generally used, perhaps, than any other. It consists of four hemispherical cups attached to the ends of equal horizontal arms, which turn freely on a vertical axis. The axis carries an endless screw, which, by means of interposed gearing, rotates a hand or hands moving around one or several dials, or it is caused, by proper mechanism, to leave a record on an endless strip of paper.

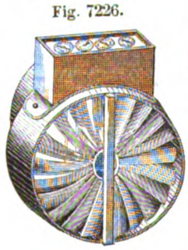
Williams's wind-gage, or air-meter, consists of a rotary vane *a*, surrounded by a cylindrical casing; the axis of the vane-wheel carries an endless screw, which, by suitable gearing,

Fig. 7225.



Robinson's Wind-Gage.

Fig. 7226.



Anemometer.

actuates the pointers on a series of dials; the gearing may be so adjusted as to cause the pointers to mark the number of revolutions of the wheel, the absolute velocity of the wind, or the quantity of air passing through the cylinder in a given time, in which latter case it becomes a meter.

In Professor Coffin's wind-gage each motion of the vane directed a minute but constant stream of dry sand into some one of 32 stationary hoppers, corresponding in position to as many points of the compass. The weight of sand found in the several receptacles below each hopper showed the length of time that the vane had pointed in that direction. In the observatory erected on the Greylock peak, 4,000 feet high, of Saddle Mountain, the instrument was arranged to run and register for three months in winter, when the peak was inaccessible. In this interval the clock-work faithfully did its entire duty. The anemometer was changed by substituting for the stream of sand a series of cards half an inch square, laid consecutively on a moving band that deposited one of them every fifteen minutes. Each card being inscribed with the day and hour it represented, when the receptacle marked "North," for example, was examined, all the cards found in it indicated the exact quarter-hour in the past three months when the wind was from that direction. In 1872 a similar instrument was constructed for the observatory of the Argentine Confederation, at Cordova.

Wind-hole. (*Mining.*) A shaft or sump sunk to convey air.

Wind'ing-en'gine. (*Steam-engine.*) A hoisting steam-engine.

In the portable form (shown in Fig. 7227), the boiler and furnace are contained in an upright plate-iron case. The drum *a* on which the rope winds is rotated by a gear-wheel, into which meshes a pinion on a shaft carrying a disk *b*, having a wrist-pin, to which is attached the connecting-rod of the steam-cylinder *c*.

Fig. 7228 is an English winding-engine, adapted for small mines. The engine is of the usual size, with a Cornish boiler. The ore is raised by a double drum with a wire rope, one kibble being raised while another is lowered. A second shaft has a crank on its end for working the pumps by means of the balance-beam. The pumping and winding arrangements may be thrown in and out of gear, so that either may be worked singly.

Wind'ing-gear. An English term for the winding-machine for mines. The hoisting-engine is of the portable class. Each part of the rope passes over a separate pulley at top of the elevated stage, so that one kibble is being hoisted as the other descends (Fig. 7229).

Wind'ing-ma-chine'. A reel, swift, warping-machine, or similar contrivance. See BALLING-MACHINE; REEL; WINDER; etc.

Fig. 7230 is a machine designed to wind direct from the hank or skein to the shuttle-bobbin. It has 30 spindles, rotated by bands which reach from the spindle-whirls to the long drum *a*, which is common to the whole set. The skeins are laid around two spools *b c*, the lower of which is dependent and keeps the skein distended. The thread of the skeins passes upward to wire eyes *d d*, which are traversed back and forth over the bobbins so as to build up the thread symmetrically upon them.

See also WINCING-MACHINE; WASHING-MACHINE, for machines for winding fabrics through vats.

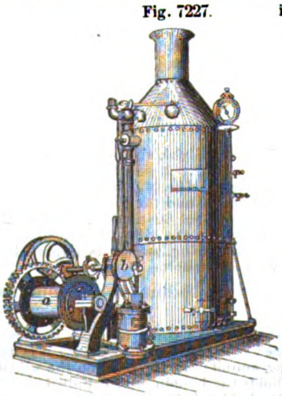
Wind'ing-stairs. Stairs ascending in a spiral line around a solid or open *newel*. See STAIRS.

Stairs are found at Persepolis. They were so gently inclined, and so wide, that horses might ascend them. The Roman stairs were usually narrow, steep, and inconvenient. The newel staircase in the Trajan Column has 3 parts for the newel and 4 for the stairs. The porticos of Pompeii had winding-stairs, with a well, so to call it, of columns, to give light to the staircase, which had no exterior window.

Triangular staircases are found in ancient buildings. Louis Cornaro invented winding-stairs without newel, and Barbaro, a Venetian, the regular geometrical stairs.

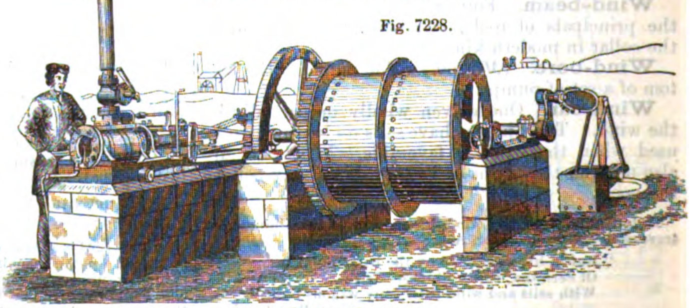
Francis I., at the Castle of Chambré, near Blois, had four staircases to four several rooms, going one over the other, but

Fig. 7227.



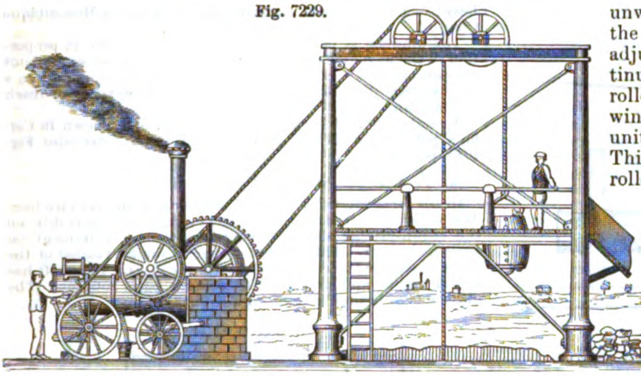
Winding-Engine.

Fig. 7228.



Winding-Engine.

Fig. 7229.



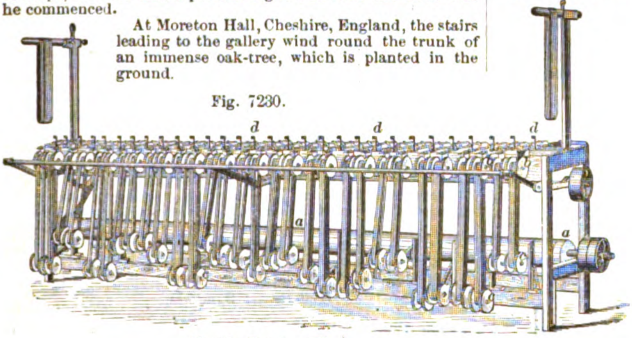
Winding-Gear.

so that persons to and from each traveled their own stairs, though in sight of each other. The northwest tower of Pontefract Church, England, has two circular flights of stairs, winding about the same center, with separate entrances below, and distinct landings above.

The ancient stairs had, to avoid omens, an uneven number of steps, in order that a person might end with the same foot he commenced.

At Moreton Hall, Cheshire, England, the stairs leading to the gallery wind round the trunk of an immense oak-tree, which is planted in the ground.

Fig. 7230.



Shuttle Bobbin-Winder.

Wind'ing-tack'le. A purchase of one fixed three-sheave block, and a movable double or treble block, suspended from a lower-mast head, and used in getting in or off heavy freight, stores, or armament.

Wind-in'stru-ment. A musical instrument in which wind is blown through a tube; in contradistinction to *stringed* and *percussion* (see list of each on pages 1500, 1501).

Wind-instruments are also divided into *with reeds* and *without reeds;* into *metal* and *wood, with* keys or *without* keys.

The organ is almost all-embracing, except that it has a key for each note. (See ORGAN.) See also MELODEON, ACCORDEON, and CONCERTINA, which are keyed, reed wind-instruments on similar principles.

Brass instruments with mouth-pieces are described and shown under HORN, Fig. 2564, page 1122 (which see).

Fig. 7231 shows wind-instruments of wood, with mouth-pieces and keys.

a a', bassoons.	*f*, petite flute, octave flute, or piccolo.
b, cors anglais.	*g*, musette.
c, oboe, or hautbois.	*h*, flageolet.
d, clarinet.	
e, flute.	

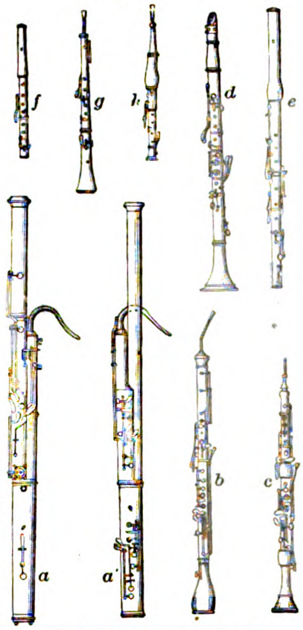
The *octave* fife, or *piccolo*, is a wind-instrument of wood, without keys; the *syrinx* also.

Wind'lass. 1. (*Nautical.*) A large horizontal roller journaled in standards (*cheeks, windlass-bitts*), and rotated by handspikes or other means. It differs from the capstan principally in the horizontality of its axis. The hawser or chain-cable winds in a concave or slightly conical track, round which it makes two or three turns. As it winds up toward the larger end, it occasionally slips back without unwinding materially; this is called the *surge* of the cable, and this self-adjustment enables it to be wound continuously without accumulating on the roller. The surface on which the cable winds is formed of bars (*whelps*), which unite the *drum* with the *ratchet-head.* This is in cases where the windlass-roller is not solid, but consists of *ratchet-heads* (*a a*, Fig. 7232), *drum-heads* (*b b*), and *whelps* (*c c*), built around a *spindle* which is journaled in the *cheeks* (*d d*). The pawls are pivoted in the pawl-bitts *e e*, and sustain the strain while the handspikes are being shifted for a new purchase.

Smaller hoisting-machines, turned by cranks, are *winches*, and some are specially adapted to machines which revolve on their bases, as cranes, derricks, etc. See WINCH.

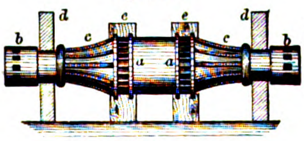
The old-fashioned mode of working a windlass was by spikes, which were placed like spokes in the holes of the drum, requiring that they should be shifted four times during each rotation. To avoid this, a pair of vertically oscillating levers have been attached to the bitt-head, forming *brakes*, like those of a fire-engine. These brakes — one projecting toward each end of the windlass — are connected by rods to pawl-boxes, which are sleeved upon the spindle, and act upon ratchet-heads on the windlass. By making a double system of pawls, that is, placing them on each side of the ratchet on the windlass, each stroke of the brakes may be made effective. The ordinary sustaining pawls pivoted to the *pawl-bitts* are retained, as usual, to prevent the back-lash of the windlass. The cable, or hawser, winds upon the *whelps*, and the *drum*, with its square sockets for the hand-spokes, may be used as accessory to the *brakes*. See Fig. 7233; see also CAPSTAN.

Fig. 7231.



Wind-Instruments of Wood.

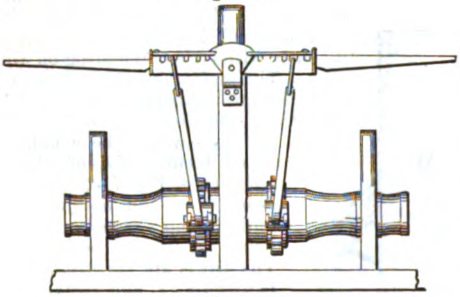
Fig. 7232.



Windlass.

In another form of windlass (Fig. 7234), the ratchet-heads are dispensed with, *purchase-wheels a a* having plain surfaces being employed; these are acted on by *nipping-levers c c*, con-

Fig. 7233.



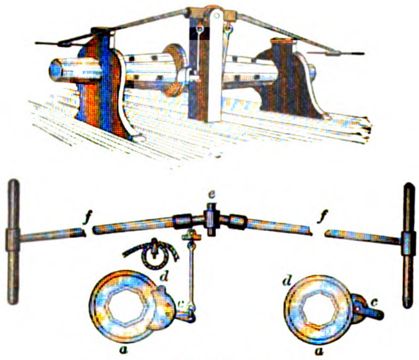
Windlass.

fined to the purchase-wheels by iron rings *d d*, called *travelers*, which in descending move freely round. The nipping-levers are connected by links to the brake-levers, and by biting alternately upon the purchase-wheels heave the windlass round as they ascend; the cross-head *e* of the sway-beam has sockets to receive the brake-levers *f f*, which are bent so as to clear the knees of the bitt-heads.

The windlass still used in the Chinese seas, even for large junks, consists of a roller extending across the vessel from side to side, and turned by spikes, which prevent the unwinding by resting on the deck.

In 1776, when Falconer, the author of the "Shipwreck," wrote his "Marine Dictionary," the windlass in English ships had its gudgeons in windlass-bitts, and was furnished with pawls of wood or iron which fell into notches in the periphery of the windlass. These notches, being eight in number, sus-

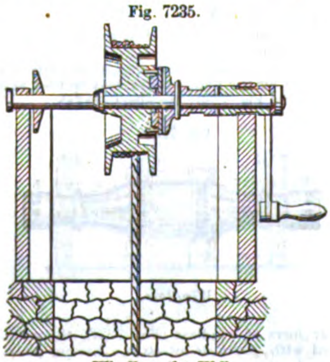
Fig. 7234.



Windlass.

tained the strain on the cable at every seven inches hauled in. Afterwards the "pawl and half-pawl" arrangement was introduced, which sustained the cable at every 3½ inches. William Falconer was the son of a barber, born at Edinburgh, 1730; he published the "Shipwreck," 1762. He was appointed purser of "Aurora" frigate, which sailed from England, September 30, 1769, and after touching at Cape of Good Hope was never

Fig. 7235.



Windlass for Wells.

heard from. Supposed to have foundered in the Mozambique Channel.

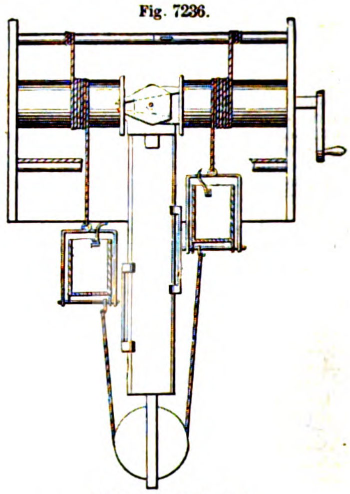
The windlass is more powerful than the capstan, in proportion to the men employed, as a man can exert a power of about 150 pounds on a windlass-handspike, but about 35 pounds on a capstan-bar. A greater number of men, however, can reach the capstan.

A combination of the capstan and windlass is shown in Coffin's patent, No. 59,969, November 27, 1866. See also Fig. 1085, page 457.

2. A well-bucket elevator.

In the form shown in Fig. 7235, the loose drum has a friction-disk which is backed by springs and engages a similar disk on the crown-ratchet sleeve, having longitudinal movement on the winch-shaft. This ratchet engages a similar ratchet of the shaft to remove the collar and engage the disks. The shaft has a spur-ratchet and drop-pawl to prevent back rotation. The disks acts as brakes in lowering the bucket.

Fig. 7236.



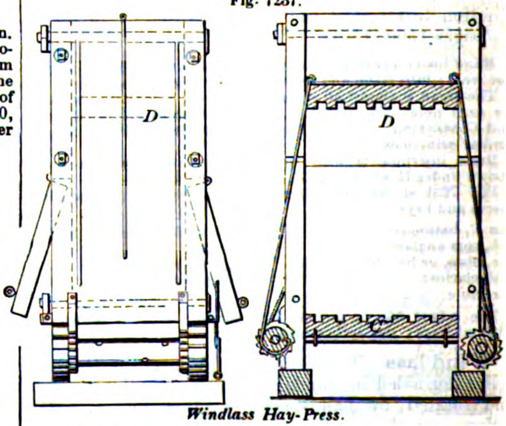
Well-Bucket Windlass.

In Fig. 7236, the buckets are alternately raised and lowered by the continued revolution of the winch in one direction.

3. The differential windlass is shown in Carpenter's "Mechanical Philosophy," London, 1844, page 282.

It is therein credited to Mr. Moore of Bristol. The hand portion of the continuous rope passes over the larger wheel,

Fig. 7237.



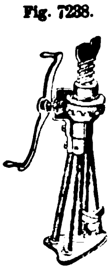
Windlass Hay-Press.

and the weight portion over the smaller wheel, the value in hoisting power being equal to the difference in the radii of the two wheels. It is the same principle as shown in the Chinese windlass, Fig. 1651, page 701, but is a very neat application of the idea. See also Fig. 7220.

Wind'lass Bal'ing-press. One in which the power is brought to bear upon the platen or follower by means of rope and windlass.

In Fig. 7237, the pressure is brought to bear upon the bale by the descent of the follower *D* toward the bed *C*. In discharging the bale, the bottom is hinged at one side and supported on adjustable blocks, so that it may be allowed to fall slightly, taking its pressure from the doors when the holding-bars of the latter are being removed. The sides of the press are sprung out by toggle-levers, to loosen the bale for removal.

Fig. 7238.



Tripod Windlass Screw-Jack.

Wind'lass-jack. A form of lifting-jack having a winch-handle for turning the pinion which gears into the crown-wheel. See also SCREW-JACK.

Wind'mill. A mill in which motion is imparted to mechanism, for grinding grain or for other purposes, by the action of the wind on a series of revolving sails. Commonly met with in flat districts of country or in other situations where water-power is not available.

Pomponius Sabinus states that hand-mills were brought to Rome from Greece, and that one Paulo also introduced windmills for grinding grain. This was a little before the time of Augustus. In the "Spiritalia" of Hero of Alexandria, 150 B. C., we find the description of an organ blown by the agency of a windmill which worked the piston of an air-pump. See ORGAN.

Beckmann, in his "History of Inventions," denies that the Romans had windmills during the period of the Empire. They were not uncommon in Europe at the time of the Crusades. The earlier Roman mills, after the hand-mills, were driven by water either from the aqueducts or by the current of the Tiber. See WATER-WHEEL; CURRENT-WHEEL; MILL; ETC.

They are mentioned in England A. D. 1180, and from the twelfth to the fourteenth centuries notices of them are common.

Mabillon mentions a charter of 1105, A. D., in which a convent in France is allowed to build water and wind mills, *moledina ad ventum*.

Bartolomeo Verdè had a grant of land to build windmills in Venice in 1332. They were in use at Spires in 1373, and at Frankfort in 1442.

In the twelfth century, the Pope decided that the usufructs of water and wind mills were tithable.

It took some time to determine the legal bearings of this question. In the fourteenth century, the prior of the monastery of Augustines, at Windsheim, in the province of Overyssel, was desirous of erecting a windmill. When the lord of Woerst heard of this he forbade it, on the ground that "the wind of Zealand" belonged to him. Appeal was taken to the Bishop of Utrecht, who flew into a towering passion, and declared that no one had power over the wind within his diocese but himself and the Church at Utrecht. He granted letters-patent, and the mill was erected.

It is stated that the first mode adopted to present the vanes towards the wind was to float the mill and turn it in the water, as occasion required.

The next was to put it on a post, and turn the building on this, as an axis. This was called the German method.

The next was to turn the cap, or roof. This was a Dutch invention, in the sixteenth century. See WINDMILL-CAP.

The principal parts of the common windmill consist of an axle, inclined to the horizon at an angle of 8° to 15°, and carrying at its outer end four sail-frames, or *whips*, usually about 40 feet long, consisting of a long tapering bar of wood, with short cross-pieces, whose extremities are connected to each other by a wooden strip. Upon these frames the canvas sails are spread. Reefing arrangements are sometimes provided to diminish the area of the sails during high winds. The whole frame of the mill turns upon a vertical shaft, and, by means of a lever, may be adjusted to cause the sails to present their surfaces directly to the wind.

The inclination of the axis is for the same purpose, it being found by experience that the direction of the wind is somewhat downward, generally forming, in open countries, an angle of about 18° with the surface of the ground. The sails are also advantageously arranged, so as to have a somewhat winding surface, the lower part forming an angle of about 60°, and the upper of about 80°, with the axis, the concavity facing the wind. The breadth of the sails is usually about 1/5 or 1/6 of the length, which varies from 30 to 40 feet, and they are preferably widened toward their outer extremities. Their maximum effect is attained when their outer ends revolve with about 2½ times the velocity of the wind.

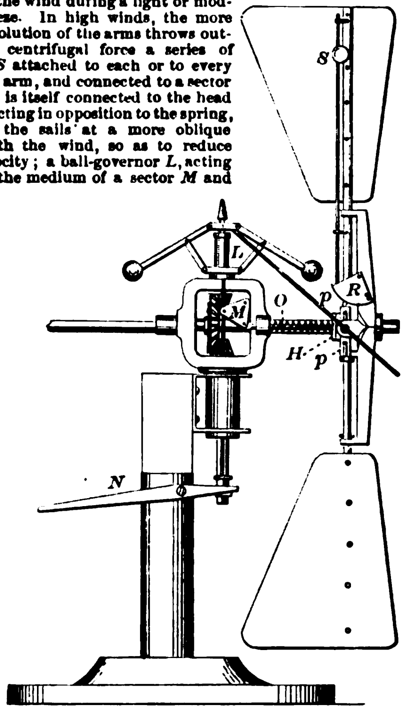
In 1772 Andrew Meikle, of Scotland, invented a plan for automatically adjusting the area of the sails to the force of the wind; and in 1804, Bywater of Nottingham, England, patented a method of rolling up the sails to adjust them in like manner, by means of a weighted lever, which was caused to operate gears, connected by cords to cylinders, on which the sails were wound.

More recent devices of this kind generally aim to effect this adjustment by altering the angle at which the sails are presented to the wind.

In some cases the axis on which the sails rotate is caused to fall in the line of direction of the wind by means of a vane of considerable area attached to the movable framework of the mill.

In Fig. 7239, the sails *D* turn on rods having cranked ends *p* inserted into holes in the sliding-head *H*, which is pushed outward by means of a spring *O* of sufficient tension to present the sails at a proper angle to the wind during a light or moderate breeze. In high winds, the more rapid revolution of the arms throws outward by centrifugal force a series of weights *S* attached to each or to every alternate arm, and connected to a sector *R*, which is itself connected to the head *H*, and, acting in opposition to the spring, presents the sails at a more oblique angle with the wind, so as to reduce their velocity; a ball-governor *L*, acting through the medium of a sector *M* and connecting-rods, is also provided for the same purpose. A lever *N* permits this adjustment to be made by hand.

Fig. 7239.



Feathering-Sails Windmill.

Horizontal windmills, though exerting much less useful effect, may be used where the hight of the vertical sails is objectionable. The usual form consists of a wheel or fly having six sail-beams, near the ends of which are pivoted vanes, which are divided by lines passing through the pivots into two unequal portions. As these revolve, the wind, first acting against the broader side, lays the vane flat against the arm, where it is held by a stop and exposed to the full power of the wind; on proceeding farther, it is taken aback and swings around so as to feather, or present its edge to the wind until it again comes into its former position.

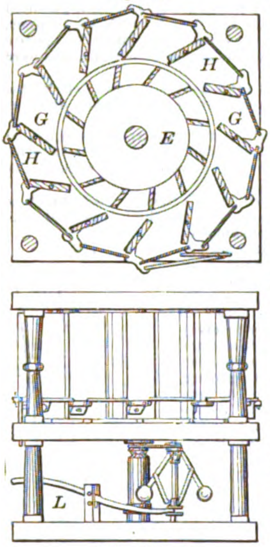
Another plan is to form each sail of pivoted slats, like those of a Venetian blind, so arranged as to open and permit the free passage of the wind as the sail comes up to the wind, but close so as to receive the full effect of the wind when moving in the opposite direction.

Fig 7240 is a horizontal windmill in which an exterior series of shutters *G G* connected by rods *H H* are automatically adjusted to admit more or less air to the interior wheel *E* by means of a ball-governor driven by connection with the wheel and operating a lever *L*.

The ball-governor was first used in windmills, and James Watt borrowed the idea from thence.

In Holland, windmills are employed in driving the scoop-wheels which drain the polders. The mill resembles exteriorly an ordinary windmill, but the upright shaft is carried down to the bottom floor, where a bevel wheel is placed upon it, and another on the shaft of the scoop-wheel to which it communicates the motion. The scoop-wheel has flat blades, arranged to work in a chase which they fit accurately. The wheel in its

Fig. 7240.



Wind-Wheel.

revolutions lifts the water from the lower to the higher level. These wheels are not economically effecttive in lifting to a hight above the center of the axle. See SCOOP-WHEEL.

Holland is said to have 12,000 windmills in operation, averaging eight horse-power each. The annual cost is reputed at $ 4,000,000. When very heavy and continous work, however, is required, steam is the more reliable. It has superseded to a large extent the windmills of the fens and low counties of Eastern England. See also DRAINING-ENGINE, for account of the Haarlem lake-engines in Holland.

Wind'mill-cap. The movable upper story of the wind-wheel which turns to present the sails in the direction of the wind.

Wind'mill-pro-pel'ler. An application of a wind-wheel to the propulsion of a boat.

Win'dow. From the Welch *wyntdor*, wind-door. Originally an opening for ventilation; afterwards an aperture for light, protected by mica, oiled linen, horn, paper, or glass. These articles were probably introduced in the order stated.

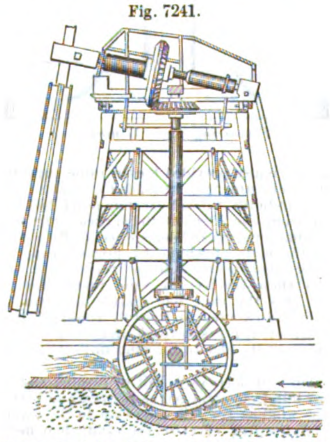
"A window in the ark."

"A place in Cappadocia produced large masses of transparent stones for windows, which were exported." — STRABO.

Pliny mentions horn windows for lanterns, and Tertullian *corneum specula*, horn windows for houses.

Transparent windows were a curiosity in the time of Seneca. Stone and glass windows were introduced into England by Wulfrid, Bishop of Worcester, in 736; or by Benedict Biscopius.

Fig. 7241.



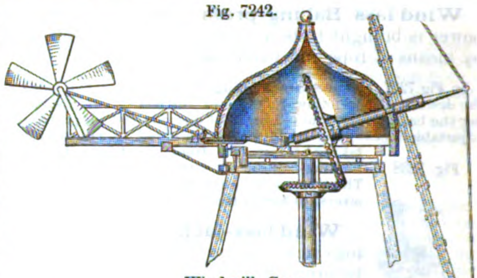
Dutch Draining-Windmill and Scoop-Wheel.

Trefoil openings within triangles are of the time of Edward I. In the reign of Richard II. they were subdivided by upright *mullions*, dividing the window into *lights*. The molding grew more graceful and light in succeeding centuries. It was long before the cloisters were closed with windows, and then not entirely, for spaces were left for access of fresh air.

Windows to the floor are the *valvatæ fenestræ* of Vitruvius.

"The windows of Manila, in the Philippine Islands, have sliding frames fitted with *concha* or plates of semi-transparent oysters, which admit an imperfect light, but are impervious to the sunbeams. I do not recollect to have seen any glass windows in the Philippine." — BOWRING.

Fig. 7242.



Windmill-Cap.

The glazed portion is the *sash*, which slides in a *frame*; the weights are in *casings*. See SASH.

The piece above a window is a *lintel*, below it a *sill*; the sides of the openings are *jambs*; the exposure of the sides between the face of the wall and the sash-frame is the *reveal*.

Windows are of various kinds, — Gothic, mullion, casement.

Bay-windows were invented about the fifteenth century.

Double window; having inner and outer sash, with a body of air between.

Double-hung window; having two sashes, each with its complement of lines, weights, and pulleys.

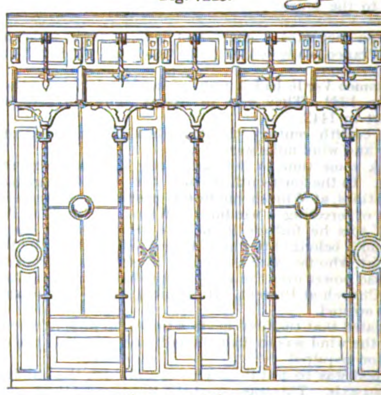
Win'dow-blind. A curtain shade or shutter to close the window against light, or to make it safe against intrusion.

In Fig. 7243, the metallic blind is hinged at top, and is drawn upward by cords to form an awning. Rods hinged to its outer edge are let down to form supports.

Fig. 7244 shows a roller blind made of slats and adapted to close any portion of the window, either above or below the meeting rails of the sashes.

The flexible blind is wound on a roller upon whose journals are wound the side tapes which are connected to the window-

Fig. 7243.



Shutter and Awning.

frame above. One cord supports in its loop and adjusts the hight of the lower roll of the blind; the other cord winds with the upper roll and adjusts its hight by winding it or allowing it to unwind its contents.

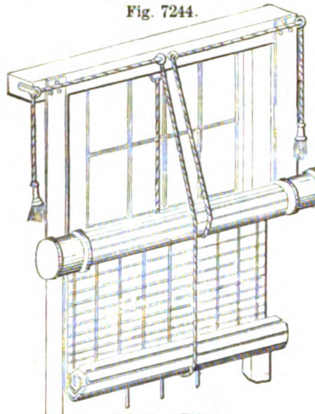
Win'dow-glass. Common window-glass is made into circular disks by the familiar blowing and whirling processes.

The pontil of the glass-blower is dipped into the glass-pot and abstracts therefrom a mass of glass, which is blown into a globular shape. The end being pierced, and the bulb whirled, the opening enlarges until, by centrifugal action, the plastic mass assumes a flat shape. This is the method generally employed in England. The best variety of this is *crown-glass*.

Other window-glass is made in what is called *cylinder* or *sheet glass*. The mass of glass is blown into a cylindrical form, the end cut off, the cylinder split longitudinally and flattened. This is the usual German and Continental process. The glass of the London Exposition building of 1851 was made in this way. See CYLINDER-GLASS.

The best kind of window-glass is that called *plate-glass*. This is poured in a molten condition upon a table, and a heavy roller passed over the fluid mass. The plates are after-

Fig. 7244.



Window-Blind.

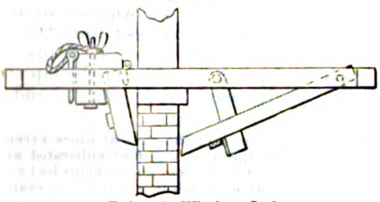
ward ground smooth and polished. See CROWN-GLASS; CYLINDER-GLASS; PLATE-GLASS; and specific index GLASS.

Though known to the Egyptians at a very remote period, glass appears to have been little used for illuminating purposes by the ancients.

Rome had but few glazed windows in the reign of Nero. Its use seems to have gradually become more general during the dark ages, principally, however, in ecclesiastical edifices.

Glass windows were placed in the monastery of Weremouth, A. D. 647. St. Jerome, who wrote early in the fifth century, and Gregory of Tours, who wrote in the sixth century, mention glass windows. The use, however, was not general in the

Fig. 7245.



Painter's Window-Jack.

twelfth century. Henry III. had glass windows in his palace of Woodstock, 1265, and at Westminster. Chaucer mentions them. Scattering mention is made of them in succeeding ages, and they became common in farm-houses about 1600.

The Venetians led the way among European nations, and attained great excellence, both in quality and taste of design; their ware was regarded with admiration, and has been preserved in England among other articles of vertu.

A factory was established in England in 1557, and improved in 1635, about which time pit coal was substituted for wood. In 1670, Venetian artists were introduced into England, and established the art in that country.

Casting glass was invented by Theraut, a Frenchman, in 1688, and was introduced in England, at Prescott, in 1773.

The art of coloring glass was well understood in ancient Egypt, as we observed in reference to the imitation of glass.

Stained glass was originally a mosaic, made up of different pieces, arranged, according to color, to form a design. About 1500, a French artist at Marseilles incorporated colors with the glass, which were baked in. Albert Durer practiced the art.

WINDOW-GLASS.

Thickness and Weight per Square Foot.

No.	Thickness. Inch.	Weight Oz.	No.	Thickness. Inch.	Weight. Oz.
12	.059	12	21	.1	21
13	.063	13	24	.111	24
15	.071	15	26	.125	26
16	.077	16	32	.154	32
17	.083	17	36	.167	36
19	.091	19	42	.2	42

Win'dow-jack. A scaffold for carpenters, painters, or cleaners, enabling them to reach the outside of the window.

The frame has pivoted brace-bars to rest against the outside of the house, and hold-fasts hinged to an adjustable block; these rest against the inside of the window-frame.

Win'dow-lock. A fastening for the meeting rails of sashes.

Win'dow-sash. The frame holding the lights or panes of glass. The sash is held by counterpoise weights and cords running over pulleys in the jambs of the sash-frame, or may be held by spring latches, such as Hammond's, for instance, which enter notches in the edges of the sash.

Win'dow-shade. A blind for windows, usually rolling.

Legg's window-shade (Fig. 7246) is arranged to admit light either from the top or bottom of the window. The curtain is wound upon a roller suspended by webs from spiral springs contained in boxes above. As shown, the roller is drawn down and the curtain hooked below; when released, the roller is raised by the springs, and the curtain may be hoisted in the usual manner by the cord.

Fig. 7246.

Window-Shade.

Fig. 7247.

Window-Tube.

Win'dow-tube. (*Telegraphy.*) An insulating device for introducing line wires into telegraph-offices. It consists of a glass or hard rubber tube of any required length, and having a head at one end which is placed inside the building. The iron wire is fastened to an insulator outside and projects through the tube into the office, for $\frac{1}{4}$ to $\frac{1}{2}$ an inch. A screw-thread is cut on its end, which receives a main line binding-post, and from this the copper office wire is run to any part of the room.

Wind-pump. A pump driven by a wind-wheel.

Wind-sail. A canvas tube is used as a wind-conductor, having its open mouth presented towards the wind, or in the direction of motion, as on board a steamship, where it is used to direct a current of air down into the engine-room to moderate the intense heat and improve the draft of the fires.

The wind-sail is used quite commonly on ships to ventilate and cool the cabins and "tween decks," especially on board vessels in tropical climates, and on board those floating coffins, — *monitors*.

Wind-trunk. (*Music.*) The air-duct which conducts air from the bellows to the wind-chest of an organ or similar instrument.

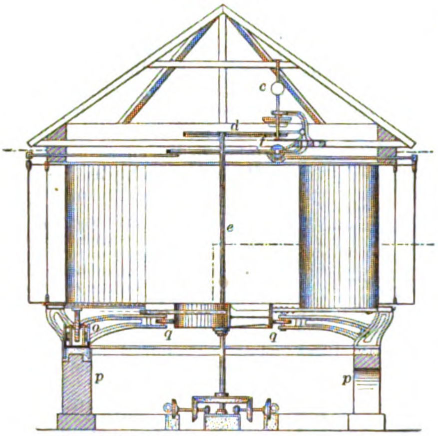
Wind-way. (*Mining.*) A passage for air.

Wind-wheel. A wheel acted upon by the wind and used to communicate power. Among its familiar applications are the windmill, wind-pump, and anemometer. See WINDMILL.

Moerath's wind-wheel, on exhibition at the Paris Exposition of 1867, is of the horizontal class. The air is directed against the curved wings *a a* by guides *b b*, Fig. 7248, and is discharged at the center of the wheel. When the arms have reached a point where the direction of the wind is tangential, the overlapping ends of the guides cut it off and prevent its exercising a retarding action.

To regulate the amount of air admitted to the wheel in proportion to the velocity of the wind, the governor *c* is provided. When the velocity of the weeel is in excess, the gear-wheel *d* on the shaft *e* of the wind-wheel, gearing into the pinion *f* on the governor-shaft, imparts a more rapid rotation to the latter, opening out the governor-balls and raising the doubly conical wheel *g* into contact with the bevel wheels *h h'*; the first of these, through the bevel wheels *i i*, the former on the shaft *j*, passing through the hub of the wheel *k*, acts on the screw *l*, which meshes with a worm-wheel *m* connected by a series of rods *m' m'*, pivoted at each end with the hinged shutters *n n*, and turning wheel *m* from right to left, operates to close the shutters and diminish the area through which the wind can enter, until the speed of the wind-wheel is reduced to the proper running velocity. The wheels *k' k* are idlers, serving merely as bearers for the conical wheel *g*. If the wind lull so that the wind-wheel does not rotate with sufficient velocity, the falling of the governor-balls causes the wheel *g* to come in con-

Fig. 7248.

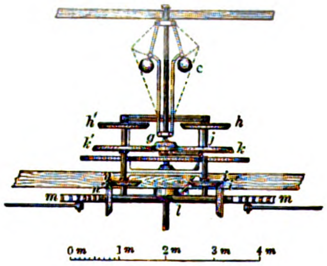


Moerath's Wind-Wheel (Vertical Section).
(Paris Exposition, 1867).

tact with the wheels *k k'*, and the latter through the bevel-gears *n n'* and screw *l* moves the worm-wheel *m* in the reverse direction, widening the distance between the shutters and permitting more air to pass.

The wind-wheel is borne upon rollers *o o*, running on a circular track at top of the foundation *p p*; other rollers *q q* bear-

Fig. 7249.



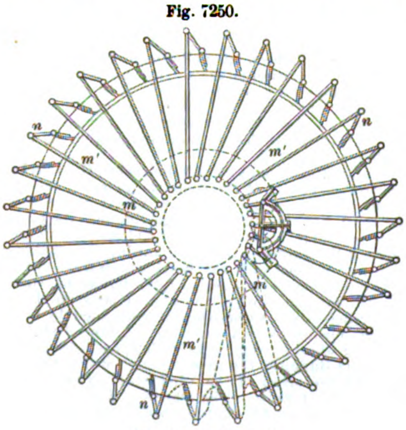
Wind-Wheel (Section).

ing against the circular shell of the air-discharge space prevent tendency to lateral displacement.

Wine-age'ing Ap'pa-ra'tus. A device for treating liquor, to give it, by a speedy process, the same character as is conferred by age.

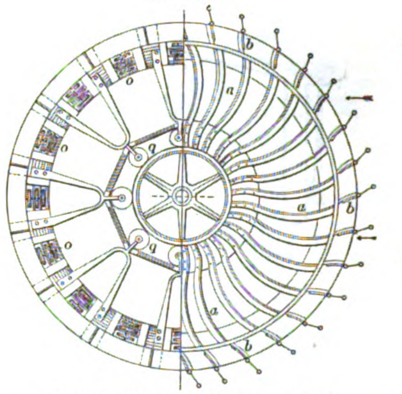
Fig. 7252 is an apparatus for this purpose, in which the liquor is subjected to heat and agitation in a close vessel, the rising

Fig. 7250.



Wind-Wheel (Plan).

Fig. 7251.



Wind-Wheel (Partial Section and Plan).

vapors being condensed and removed. The heat is derived from steam and hot water, and is gradually applied.

Martin, May 21, 1867, uses the combined action of heat, electricity, and attrition for the same purpose.

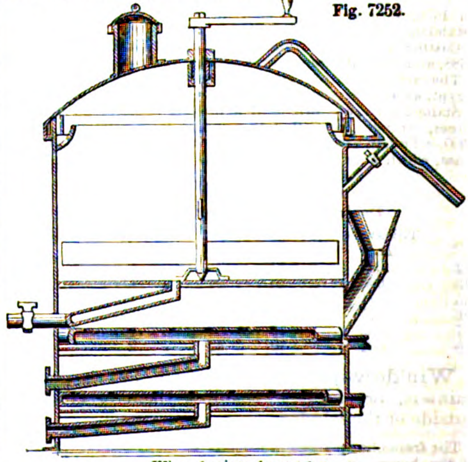
Wine-cool'er. A tub or bath in which bottles of wine are surrounded by ice to render the contents more palatable in warm weather.

Wine-press. Hardly any race of people, however uncivilized, has been discovered which was not possessed of the secret of procuring intoxicating drink of some kind, either the produce of animals, as honey (*metheglin*); mare's milk, fermented by the Tartars, forming the liquor known as *koumiss*, and possessing intoxicating properties; from the ceralia (beer, whisky, arrack), the juice of fruits (wine, grape, apple, and peach brandy), or the sap of trees and plants, namely, maple sap, plaintain, and agave wine.

Little is positively known of the ancient wines except from Pliny, who says that the vine was first cultivated at Rome about 600 B. C., and that the Greeks and Romans had a method of concentrating the wines, either by spontaneous evaporation or boiling, and of reducing them to a sirup or even to a solid cake, in which state they were preserved for many years. Wine two hundred years of age is mentioned by Pliny, its age being considered, as now, a criterion of goodness.

In the time of the Roman Emperor Probus, about the close of the third century, great attention was paid to the cultivation of the vine; it is supposed to have been planted on the banks of the Rhine, the Main, and the Moselle at that time, and to have been introduced into Britain. About the close of the tenth century, wine in considerable quantity and, it is said, of excellent flavor, was produced in England in the counties of Lincoln, Gloucester, and Somerset.

Fig. 7252.



Wine-Ageing Apparatus.

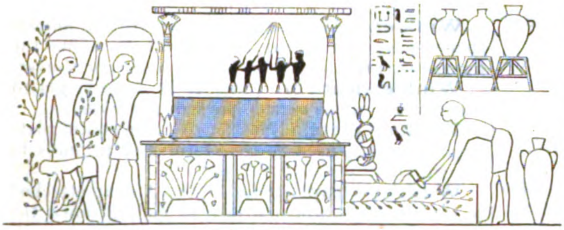
The importation of foreign wines into England commenced soon after the Norman Conquest, and was greatly increased by the acquisition of Guienne, under Henry II.

In the reign of Richard II., Spanish wines were common, and continued to grow in estimation, especially *sack*, which is the produce of the grape of Xeres, in Spain. Holingshed asserts that there were upward of eighty-six different kinds of wine imported from France and other countries into England in the sixteenth century.

On the enthronization of Neville, Archbishop of York, in 1553, upward of one hundred tuns of wine were consumed, and his predecessor is reported to have used, besides other wines, eighty tuns of claret yearly. At this period it was customary for the princes and nobles to bathe in wine.

Dioscorides, Acteus, and others among the ancients were

Fig. 7253.



Grape-Press.

acquainted with means of rendering the acid in spoilt wine imperceptible, and of stopping the fermentation or corruption by litharge. The introduction of sulphite of soda for this purpose is modern.

William, Count of Hennegan, Holland, and Zealand, prohibited the adulteration of wine in 1327, the first prohibition of the kind recorded; and the mixture of litharge with wine was made punishable by death, in the Duchy of Wurtemburg, in the year 1697.

Sulphurous-acid gas, produced by burning brimstone in the cask previous to the introduction of the wine, has a tendency to check fermentation and purify the wine, without imparting to it any deleterious properties.

In France and other wine-producing countries, the old plan of treading out the grapes is still employed. This is performed by men who dance to the sound of music, and is preferred on account of there being no liability to crush the seeds and stalks of the bunches, which would impair the delicacy of the flavor.

Grape culture, for wine-making purposes, was, in this country, long almost exclusively confined to the banks of the Ohio, but is now practiced in localities, such as the shores of the Great Lakes, where it was formerly thought impracticable. Increased care and skill have developed varieties which may be relied on almost as a sure crop in many parts of the great central belt of the United States. California, however, appears destined to be the great wine-producing region of the future; the absence of frosts, and of excessive moisture at any time, giving it advantages not possessed elsewhere.

The gathering of the grapes in the Buena Vista Vineyard, California, is done in October and November. Men, with wooden boxes similar to a claret-box, and holding 50 pounds of grapes each, take a row of vines. They sever the grape-bunches with scissors made for this purpose, fill their boxes, and carry them to a wagon which attends upon every five men. Thirty-five boxes form a load, and a man will fill forty in a day. The boxes are elevated to the third story of the press-house. From a platform on this story the grapes are passed to the hopper of the crusher, which latter consists of two cylinders, 2½ feet long and 12 inches thick. A load is crushed in about six minutes, two men attending to feeding the machine. The grapes are crushed without mashing the seeds, and fall into a box beneath, the juice running through the perforated false bottom and being conducted by spouts to the vats on the basement floor, where the *must* is allowed to settle for six hours, to remove impurities. The crushed grapes are removed to the press-box, which is 6 feet square and 4 feet deep. The follower is moved by an iron screw, 6 feet long and 5 inches in diameter, having a thread of slow pitch, to confer great power. It is said to deliver a pressure of 282,000 pounds. The side-pieces of the box are slipped in, and small intervals occur between each, allowing the escape of the *must*.

The press is filled with alternate layers of crushed grapes and wooden cubes. 6 inches of grapes followed by 3-inch cubes, and so on. It holds about 8,000 pounds of grapes, and the resulting *must* joins that which preceded from the before-mentioned box to the tanks on the ground-floor. The pressing occupies seventy minutes. After settling in the tanks, it goes to the reservoir. It is then pumped into a tank and distributed to the fermenting-vats in the basement. Each of these vats holds 4,000 gallons. In from eight to fifteen days it clears, when the vat is filled with similar wine, and so remains till January. The wine is racked off three times the first year following the vintage, twice the second year, once the third year. It is then potable.

For red wine, the *must* is fermented on the skins.

The resulting stems, seeds, and skins are placed in a vat, covered with water, and fermented. The result is a wine from which brandy is distilled.

Vinegar and raisins are made on the same estate. See Haraszthy on "Grape Culture."

The wine-press of the Bible was a vat, in which the juice was expressed by the feet of men who tramped the fruit therein, staining their legs and garment with the color of the *must*. Says Jacob of Judah: "He washed his garments in wine, and his clothes in the blood of grapes." Says Isaiah: "Wherefore art thou red in thine apparel, and thy garments like one that treadeth in the wine fat." And again: "The treaders shall tread out no wine in *their* presses. I have made their vintage shouting to cease."

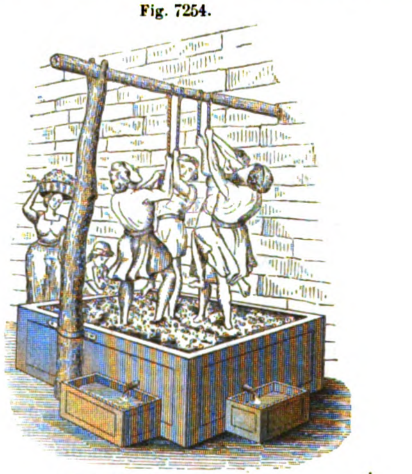
Wine-presses among the ancient Egyptians were of different kinds. One kind was a bag, in which the grapes were put, and squeezed by means of twisting the bag. The accompanying illustration (Fig. 7253) is from a tomb at Beni-Hassan, and is so plain as to require no detailed description. In another illustration, the ends of the bag are twisted in opposite directions by a pole at each end in the hands of two men.

In another illustration, taken from a tomb at Thebes, the various operations of treading the press and removing the *must* to the jars in which it stands to undergo fermentation are shown. After this process it was stored in *amphoræ*, or jars, which were closed with a lid, luted with clay or pitch, sealed, and then placed upright in the cellar.

The Romans had several different modes of expressing the juice. The grapes were crushed beneath a wooden beam, or in a press, the platen (*prelum*) of which was driven down upon the bed (*torcular*) by wedges. Sometimes a lever was used for the purpose; a pair of screws are shown in a Pompeian painting. The oil-presses were of substantially similar construction.

The treading operation was also common and is represented

Fig. 7254.



Syrian Wine-Press (from Kitto).

in a mosaic of a temple of Bacchus at Rome. It is substantially the same as that used in the Syrian wine-press of modern times, shown in the accompanying cut.

Wine-tast'er. A tube for withdrawing liquors from a jar, bottle, or cask. It has a larger opening at the lower end and a smaller one at the top. Being thrust in at the bung-hole of a wine-cask, for instance, it fills to the level of the wine outside of it. The upper end being then stopped by the finger,

Fig. 7255.

Wine-Tasters.

the tube is withdrawn and holds the liquid. A burette will answer for taking a sample from a bottle.

a in the accompanying cut shows a glass wine-taster discovered at Pompeii. The larger end was plunged into the amphora, and the small hole at the upper end stopped by the finger while the utensil was lifted out of the pot of wine.

b is the ordinary *taster* used by wine-merchants and others. Known as a *sampling-tube* or *velinche*. Sometimes called a *thief-tube*.

Wing. 1. A thin broad projection, as the wings of a gudgeon, which keep it from turning in the wooden shaft of which it forms the pivot. See WING-GUDGEON.

2. A vane of a rotating fan.

3. A sail of a windmill.

4. A side projection of a building on one side of the central or main portion.

5. A lateral extension of an abutment. See WING-WALL.

6. (*Fortification.*) The longer side of a crown or horn work uniting it to the main work.

7. The side, displayed portion of a dash-board.

8. A leaf of a gate or double door.

9. (*Plow.*) The laterally extending portion of a plowshare which cuts the bottom of the furrow.

10. (*Milling.*) A strip, commonly of leather, attached to the skirt of the runner to sweep the meal into the spout.

11. (*Shipbuilding.*) *a.* The overhang deck of a steamer before and abaft the paddle-boxes. The *wing-wale* extends from the paddle-beam to the side, and is also called the *sponson-rim*.

b. A passage along the inside of a ship, between the fore-and-aft cock-pits, to give the carpenters access to a leak. See WING-PASSAGE.

12. (*Hydraulic Engineering.*) *a.* An extension endways of a dam, sometimes at an angle with the main portion.

b. A side dam on a river shore to contract the channel. A notable instance of their use is mentioned on page 674, where the depth of water was increased in the channel of Red River to rescue a fleet of gun-boats.

13. A shoulder-knot or small epaulette.

14. One of the sides of the stage in a theater.

Wing and Wing. (*Nautical.*) Said of a *fore-and-aft* vessel going before the wind, with her foresail hauled over to one side, and mainsail to the other side.

Wing-com'pass. A joiner's compass with an arc-shaped piece which passes through the opposite leg, and is clamped by a set-screw.

Wing'er. (*Nautical.*) A smaller water-cask stowed in a vessel's hold where the sides contract fore and aft, and are relatively smaller than those amidships.

Wing-gud'geon. A metallic shaft forming a journal for water or other wheels having wooden axles. The wings are let into the ends of the wood and confined by wrought-iron bands put on hot, which become tight by shrinking.

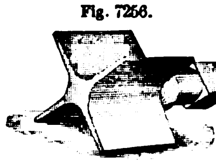
Wing-pas'sage. (*Shipbuilding.*) A passage-way around the cabins of the *orlop-deck* in ships of war, to allow access to the ship's side for repairing during action.

Wing-rail. (*Railway-engineering.*) A *guard-rail* at a switch. See GUARD-RAIL.

Wing-tran'som. (*Shipbuilding.*) A nearly straight and horizontal timber in the stern of a vessel, extending across between the fashion-pieces, in front of the stern-post and near its head. From it spring the timbers of the *counter*, or overhanging portion of the stern. The *wing-transom* is slightly rounded aft and upward, and is the uppermost transom of the stern-frame.

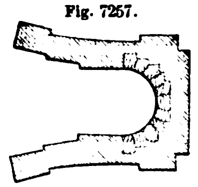
Wing-wall. One of the lateral walls of an abutment which form a support and protection thereto, to prevent the access of water to the rear and act as breast-walls to support the bank.

Fig. 7256.



Wing-Gudgeon.

Fig. 7257.



Wing-Walls.

Wink'er. (*Saddlery.*) A square or shield-shaped piece on each side of the bridle to confine the horse's attention ahead. A *blind, blinder*, or *blinker*.

Wink'er-leath'er. (*Saddlery.*) A heavy glazed leather used as the outside piece of a winker.

Wink'er-plate. (*Saddlery.*) A metallic plate slightly dished, used to give form and firmness to the winker.

Wink'er-strap. (*Saddlery.*) A strap attached to the crown-piece of a bridle, extending down the forehead a few inches, then branching off to each side, having the lower ends attached to the winkers; used to hold the latter in their proper position.

Win'ning. (*Mining.*) *a.* A new opening.

b. A portion of a coal-field to be worked. In British practice there are four systems: —

1. *Pillars* and *rooms*, called *post and stall*, where the pillars left bear such proportion to the coal excavated as is just adequate to the support of the superincumbent strata.

2. Working with *post and stall*, with extra-sized pillars, a part of which are removed when the coal is worked out and the regular working is over.

3. Working with *post and stall*, leaving very heavy pillars, which are all cut away when working backward towards the pit, allowing the ceiling to fall, following the retreating workmen.

4. The *long-way*; driving the gallery to the far end of the projected working, and then working backward, clearing out all the coal (for instance) and allowing the ceiling to cave in.

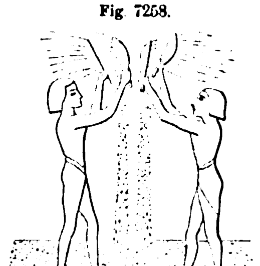
Win'ning-head'way. (*Mining.*) A headway driven to explore and open out a coal-seam.

Win'now-ing-ma-chine'. More often called a fanning-mill by those who *use* it, in this country. A machine in which grain, accompanied by chaff, dirt, cheat, cockle, grass-seeds, dust, straw, and other *foul*, either or all, is subjected to a shaking action on riddles and sieves in succession, the while an artificial blast of wind is driven against it on and through the sieves, and as it falls from one to another.

We derive it from Britain, which obtained it from Holland in 1710. It was introduced into Scotland by Meikle, the father of that Meikle who invented thrashing-machines.

The English word is derived from the idea of making an artificial blast by means of a fan; and the specific mechanical purpose is to separate grain from chaff by a blast of wind acting upon the latter, which is lighter than the grain. The oldest representations that we have of the process of winnowing are in the Egyptian tombs, where men with scoops are throwing the grain up into the air, so that the passing wind may drive off the chaff. The shovel, the sieve, and the fan were the tools employed. "Clean provender which hath been winnowed with the shovel and with the fan." — Isaiah xxx. 24. "Like as grain is sifted with a sieve" — Amos ix. 9. For this purpose, exposed situations on the tops of hills were chosen; and in the illustrations and Scripture references, it will be noticed that the tramping or thrashing was performed in the open air, contrary to our usual practice, but persevered in in the Eastern countries to this day. The climate in that part of the world is not so variable as our

Fig. 7258.

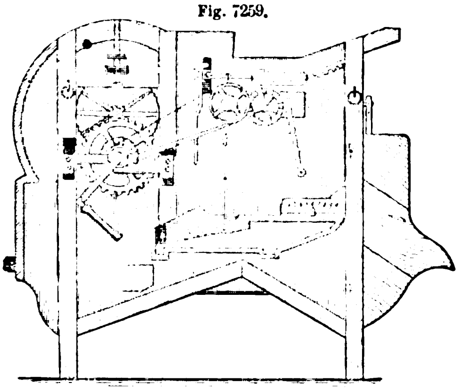


Winnowing in Egypt (1500 B. C.).

own; and while Palestine and Syria were blessed with the early and latter rain, yet the interval was dry, and full dependence could be placed on the state of the weather. In Upper Egypt, rain was and is a rarity, as we learn from Herodotus, the father of history, and from modern geographers. In Lower Egypt, as the Mediterranean, the climate is more moist, as might be expected from its vicinity to so large a body of water.

We do not know at how early a date artificial devices were made use of to create a draft of air, but it was in the remote past, and the Scripture references are frequent. "His fan is in his hand, and he will thoroughly purge his floor"; that is, cleanse or clean, by separating foreign and useless matters; the fan is still used for this purpose in several forms. In some Eastern countries, the ordinary fan, on a large scale, is held in the hand, and made efficacious in blowing away the chaff as it and the grain descend from a riddle held aloft and shaken by another man. The writer still recollects one form in which the bars of a revolving reel were furnished with cloths and rotated by a hand-crank, the concern being six or seven feet long and having its bearings in posts of a frame standing upon the barn

Fig. 7259.



English Winnowing-Machine.

floor. It is among the histories of the machine that when it was introduced in Scotland, certain sensitive persons pronounced it an impious device, as "it raised a wind when the Lord had made a calm." This is another inflection of the old opposition that met Kepler and Galileo.

Fig. 7259 illustrates a machine, still in use, invented by Gooch of Northampton, England, in 1800. It embraces the important features of the more modern machines: the rotating fan, the shaking-riddle, and sieves for sorting the grain and separating extraneous matters. See also FANNING-MILL.

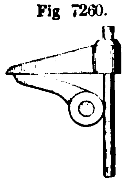
Winze. (*Mining.*) *a.* A shaft sunk from one level to another for communication or ventilation.

b. A wheel and axle for hoisting.

Wip'er. 1. (*Valve Motion.*) A cam which projects from a horizontal shaft and acts periodically upon a toe whose elevation lifts the valve-rod and puppet-valve.

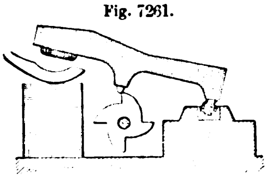
The *wiper* has usually a rotary reciprocation: when the rotary motion is continuous, it becomes a wiper-wheel, which may have a number of cams acting consecutively in the course of a revolution. See also WIPER-WHEEL.

Fig 7260.



Wiper and Toe.

Fig. 7261.



Wiper-Wheel.

2. (*Small-arms.*) A steel implement having two twisted branches; it is screwed on the end of the ramrod, and carries a piece of cloth or some tow for cleaning out the bore of a musket. One accompanies each musket issued to the troops. Those of large size, used for cleaning out cannon, are fixed on a wooden staff, and are called *worms.*

The wiper for ordnance is called a *sponge.*

Wip'er-wheel. A cam-wheel placed below the shank of a tilt-hammer to lift it periodically, allowing it to fall by its own weight.

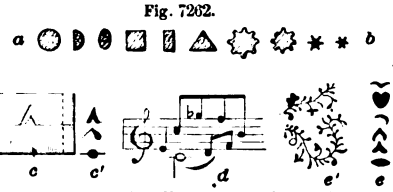
The motion is found in many other machines, such as stamping-mills for ore and stone, etc.

Wire. A metallic rod, thread, or filament of small and uniform diameter. The largest size, numbered 0000, of the Birmingham wire-gage, has a diameter of .454 inch; but smaller sizes even than this, except when drawn out to considerable lengths, are generally known as bars or rods. See WIRE-GAGE.

Lead wire for the manufacture of bullets may considerably exceed the above diameter.

Wire is usually cylindrical, but it is also made of various other forms, as oval, half-round, square, and triangular, and of more complicated shapes for small pinions; for forming the pattern on blocks used in calico-printing, and for other purposes. See PINION-WIRE.

Fig. 7262.



Wires for Mechanical Uses and for Music-Printing.

Wire was originally made by beating the metal into thin plates, and then cutting it into strips and rounding it with a hammer. The sacerdotal dress of Aaron had interwoven shreds of gold, which were obtained by this process, doubtless. The interweaving of gold threads into dress-stuffs is mentioned by Pliny, who ascribes the invention to King Attalus; but it was practiced in Egypt and in Oriental countries before the era of that monarch.

Gold wire is found attached to rings bearing the date of Osirtasen I., 1740–1696 B. C.

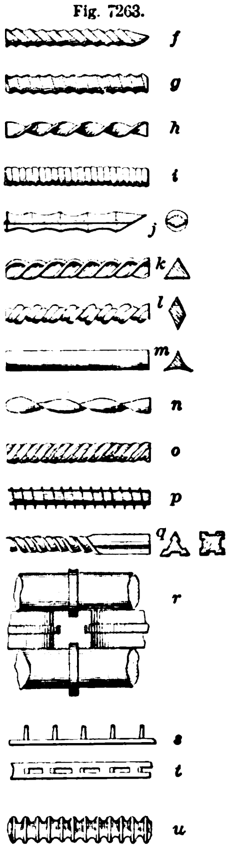
In ancient times, and, indeed, during the Middle Ages, gold and silver were almost, if not the only, metals which were formed into wire. In the reign of Elizabeth, iron and brass wire were both manufactured and imported into England. Copper wire was first made in England in the seventeenth century.

Beckman states that "as long as the work of wire-making was performed by the hammer, the artists of Nuremberg were called *wire-smiths;* but after the invention of *drawing* wire, they were called *wire-drawers* or *wire-millers.* Both these appellations occur in the history of Augsburg as early as the year 1351, and in that of Nuremberg in 1360; so that according to the best information I have been able to obtain, I must class the invention of the *drawing-iron,* or proper wire-drawing, among those of the fourteenth century."

The art was not introduced into England till the sixteenth century, but had attained great excellence in the reign of Charles I. See DRAW-PLATE.

This does not fully indorse the ascription of the invention to Rodolph of Nuremberg, A. D. 1410, but he may have much improved the art; mills were erected in Nuremberg, 1563. The first wire-mill in England was erected at Mortlake, in 1663.

Fig. 7263.



Wires for Shoe-Fastenings, etc.

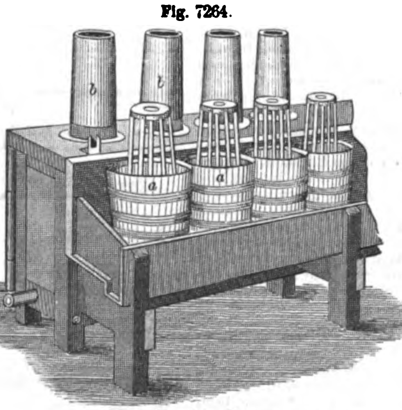
a (Fig. 7262) shows forms of round, oval, half-round, square, and triangular wires.
b, pinion-wires for watch-makers.
c c', draw-plate and music wire.
d, music, as printed with wire type.
e e', fancy wires made for calico-printing rollers; example of the effect of association of the various patterns.
f g h (Fig. 7263), Godfrey's wire shoe-peg.
i, Wickersham's short-twist round-thread wire.
j, Blake and Libby's lenticular wire-nail.
k l, Smith's polygonal metallic peg.
m n, Townsend's polygonal wire, before and after twisting.
o p, Townsend's wire; thread raised by pressure.
q, Dudley's angular wire, with grooved faces.
r, mode of making Dudley's wire.
s, Proctor's wire, with serrated edges for burring and feed-cylinders.
t, Beatty's flat perforated wire.
u, Bigelow's shoe-wire, circumferential grooves; no thread.

The general process of manufacturing iron wire on a considerable scale is as follows: —

The rods, from ¼ to ½ inch in diameter, received from the rolling-mills in bundles, are heated and rerolled in grooved rollers, one above the other, so that the rod runs from the first roll to the second, and so on, without reheating. The rollers run with great rapidity, reducing the rod to a coarse wire which is then passed through the successive holes in the draw-plate. The DRAW-PLATE (which see) is a flat piece of hard steel having holes corresponding to the various numbers or sizes of wire.

The best are made of a combined plate of highly tempered steel and wrought-iron. The holes are tapering, the smallest opening being on the steel side through which the wire first enters. For drawing very fine wire, in which great uniformity is required, perforated rubies or other hard stones are fixed in the plate. The wire is annealed and drawn cold. The machinery includes a draw-bench, which lifts the wire from a reel to the first hole in the draw-plate, from which it passes to another reel or drum on which it is wound to be again drawn through the next smaller hole in the draw-plate, and so on down until it is reduced to the required size. It requires to be annealed several times during the process. Grease and wax are used for lubricating. The plan of covering brass wire with a film of copper has been lately introduced; this proves of great service in drawing, and can be wholly removed at the last annealing. The rapidity of drawing is regulated according to the ductility of the metal and size of the wire; as it becomes attenuated the speed may be increased; that used for iron and brass varies from twelve to forty-five inches per second according to size, while the finer kinds of gold and silver wire are drawn at the rate of sixty or seventy inches per second.

Fig. 7264.



Wire-Drawing Frame.

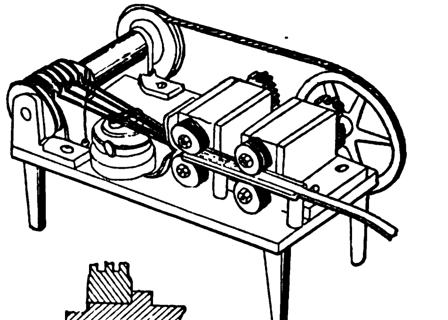
Fig. 7264 illustrates the wire-drawing frame employed for sizes smaller than No. 19; *a a* are tubs in which are placed a series of upright reels for containing the coils of wire. One end of the wire is attached to one of the drums *b*, revolved by suitable gearing beneath, by which it is drawn through the die-plate in the manner previously described. The frame may be provided with any desired number of drums; but four are shown in the figure.

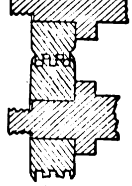
Fowler, January 5, 1869, makes wire of sheet-metal, cutting it into strips between pairs of rollers with interlocking sharp-edged ridges and grooves. The lower figure shows, on an enlarged scale, a vertical section through a pair of rolls. See also his patent, No 87,557.

A similar process is used in cutting shirrs from a ribbon of india-rubber. See Fig 4489

Silver wire, in which the most delicate tests could detect no

Fig 7265.





Fowler's Sheet-Metal Wire-Machine.

variation in diameter, has been drawn through plates of rubies to a length of 170 miles.

Very fine gold and platinum wires, used for the *spider-lines* of telescopes, are formed by coating the metal with silver, which is then drawn down to a great tenuity, after which the silver coating is removed by nitric acid, leaving an almost invisible interior wire, which has been so attenuated that a mile in length weighed only a grain.

L. Chelot, a Belgian manufacturer, makes a pentagonal wire.

Threaded wire — cable wire — for boots and shoes, made under patents: —

Prosser, 116,218, June 20, 1871.
Wickersham, 118,318, August 22, 1871.

See also Fig. 3568, page 1648.

The modern uses of wire are almost innumerable: —

Telegraphy, cables for suspension-bridges, ropes for ships' rigging, hoisting, etc.; fences, strings for musical instruments, hoop-skirts, pins and needles, shoe-sole fastenings (see Fig. 7263), are some of its manifold applications. Twined broom-wire is a considerable item. Culinary and table utensils are extensively made from white-wire. It is used in the manufacture of cards, heddles, reeds for looms, and, when woven, is employed in flour, paper, and other machinery. Woven wire of iron, brass, and copper is made into baskets, screens, sieves, cages, dish-covers, and a great variety of other objects.

Electrical, magnetic, philosophical, and other scientific instruments also consume considerable quantities of wire.

Another great use for wire occurred in the demand for tempered flat steel wire for crinolines. At the outset this wire cost three dollars a pound, because in tempering it was necessary to wind the flat wire in volute coils kept apart by interlaced iron wires, the coils being then carefully heated in a furnace, and then plunged into a hardening bath. In August, 1858, Henry Waterman patented a plan of drawing the wire lengthwise from the fire through the hardening liquid, and by this means reduced the cost from three dollars a pound to three cents. Waterman's process of tempering wire is said to have brought him $83,000 over all expenses.

Wire-an-neal'ing. Softening a wire by heat after it has been hardened by drawing or by exposure to cold after heating.

G. I. Washburn, October 7, 1862, patented a process for annealing wire in an artifical atmosphere in the pot or vessel, whereby he is enabled to control the degree of or prevent oxidation of the iron or steel being annealed. The object is to keep it bright and prevent scaling, and the consequent necessity for the acid bath.

A suggestion published in 1868 gives some detail of a plan for excluding the atmosphere. "Large wire as well as small can be annealed, and still retain the brightness it possessed, after passing through the drawing-dies. The process is to pack the coils in cylindrical cast iron pots with double lids, the outer one resting on a projection or rim half an inch below the top of the pot, leaving room between the outside of the inner lid and the inside of the outer, for dry sand to exclude the atmosphere. The pots should not be opened until quite cool after the heating process, otherwise the atmosphere will so far oxidize the surface as to turn the color to a blue or black."

See patents: —

No.	Date.	No	Date
21,286.	April 24, 1858	65,699.	June 11, 1867.
131,680.	September 7, 1872.	65,215.	May 28, 1867.
131,681.	September 7, 1872.	70,881.	November 12, 1867.
65,481.	June 4, 1867.	26,143.	November 15, 1859.
31,361.	February 5, 1861.	90,314.	May 15, 1869.

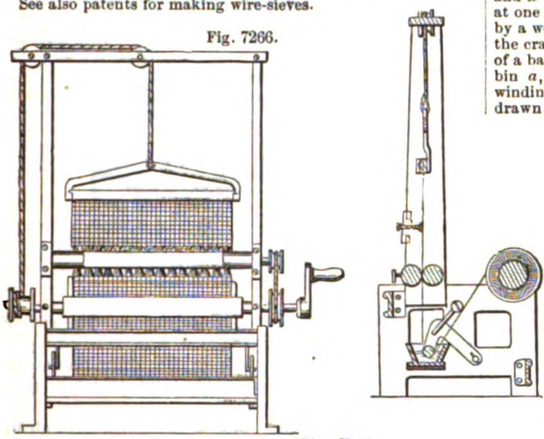
Wire-car′tridge. A cartridge for fowling in which the charge of shot has wire ligaments.

Wire-cloth. A fabric whose woof and weft are of wire; the size of the wire, the shape and sizes of the meshes, being adapted to the uses of the completed screen, sifter, or sieve, or the character of the machine in which it is to be used. Besides the purpose of separating materials of different finenesses, screens are used in hat-forming machines and bran-dusters (Fig. 2431); also as fire and window screens and guards, kiln-floors, panels of fences, meat-safes, dish-covers, bed-bottoms, lamp-covers, as in the safety-lamp. See also patents: —

No.	Name and Date.	No.	Name and Date.
5,005.	Jenkins, March 6, '47 (crimping).	124,286.	Peters, Mar. 5, '72.
25,578.	Nutting, Sept. 27, '59.	126,081.	Parker, April 23, '72.
49,556.	Zerns, August 8, '65 (crimping).	127,227.	Edge, May 28, '72 (weaving wire-tubes).
92,949.	Fisk, July 27, '69.	128,438.	Turnbull, June 25, '72.
108,553.	Beck, Oct. 25, '70.	131,885.	Le Ren, Oct. 1, '72.
117,272.	Goodhue, July 25, '71.	132,528.	Farley, Oct. 29, '72.
118,283.	Seitzinger, Aug 22, '71.	133,886.	Peters, Dec. 10, '72.
120,150.	Gardner *et al.*, Oct. 24, '71.	138,491.	Field, May 6, '73.
121,111.	Kohn, Nov. 21, '71.	139,077.	Parker, May 20, '73.
		140,160.	Peters, June 24, '73.

See also patents for making wire-sieves.

Fig. 7266.



Machine for painting Wire-Cloth.

One of the most important uses of wire-cloth is for the webs in paper-making machines. These have from 2,300 to 6,400 meshes to the square inch. They are woven in lengths of 30 to 40 feet, the widths varying from 4 to 10 feet, and their ends are joined together so as to form endless bands, known as "paper-machine wire."

Wire of sufficient fineness can, however, be woven so as to have over 19,000 perforations or *holes* to the square inch. Sieves of this fineness are occasionally used for sifting impalpable powders.

Wire-cloth Crimp′er. The wire-crimper is for giving the dentations to heavy wire before weaving. See patent 118,283, August 2, 1871. The crimping of the cloth is performed in a machine also.

Wire-cloth Loom. One for weaving warp of wire with a weft of wire. Its construction varies somewhat with the size and pliability of the wire.

See patents: —

No.	Date.	No.	Date.
138,090.	April 22, 1873.	131,584.	September 24, 1872.
14,000.	December, 25. 1855.	18,320.	October 6, 1857.
86,233.	January 26, 1869.	4,873.	December 5, 1846.
36,377.	September 2, 1862.		February 23, 1826.
10,546.	February 21, 1854.		

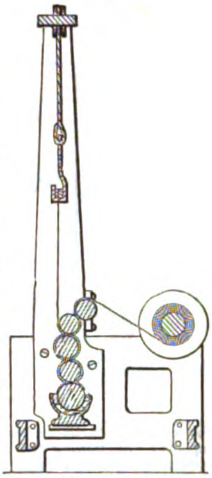
Wire-cloth Paint′er. A machine for painting wire-cloth in the web. It is passed through a trough containing paint, between pressure-rollers and under a rotating brush.

See also patents: —

No. 124,569. March 12, 1872.
14,320. February 26, 1856.
130,350. August 6, 1872.

Wire-cloth Print′er. A machine for printing figures on wire-cloth. The arrangement consists of a roller having the figures to be painted engraved thereon, and a pressure-roll, between which rollers the wire-cloth is passed. The lower roll supplies paint to the engraved roll.

Fig. 7267.

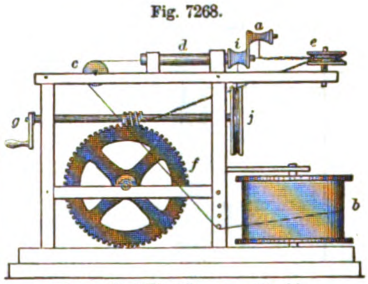


Machine for printing Wire-Cloth.

Wire-cov′er-ing Ma-chine′. A machine for covering wire with thread or other smaller wire.

In Wagstaff's (Fig. 7268) the thread is carried on a bobbin *a*, and the wire to be covered is wound upon a drum *b*, whence it passes over a pulley *c*, through a tube *d*, around a grooved pulley *e*, and is wound upon a drum having at one end a worm-wheel *f* turned by a worm on a shaft operated by the crank *g*. This shaft has also a pulley *j*, which, by means of a band, rotates the pulley *i* having an arm carrying the bobbin *a*, which thus revolves around it and around the wire, winding the thread about the latter in a spiral coil as it is drawn onward by the movement of the drum.

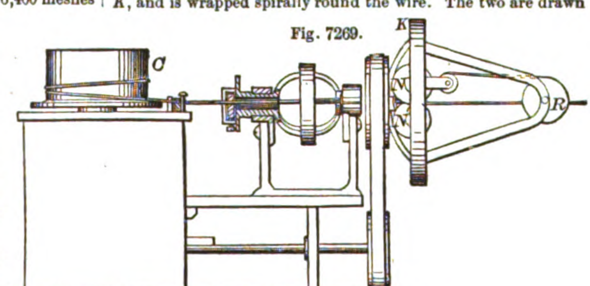
Fig. 7268.



Wagstaff's Wire-Covering Machine.

In Fig. 7269 a thin ribbon of metal from the spool *R* is drawn between the grooved rollers *N N′*, carried by the rotating-head *K*, and is wrapped spirally round the wire. The two are drawn

Fig. 7269.



Machine for making Compound Telegraph-Wire.

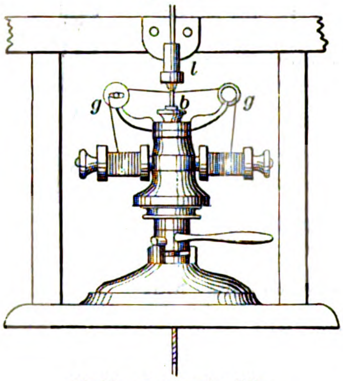
together through the draw-plate which unites them, and are wound upon the drum *C*.

Fig. 7270 is a machine for covering wire with fine wire. The hollow fixed head *l* for the wire is independent from, but in line with, the hollow axis *b* of the revolving head, which carries spools of fine wire to be wound around the wire which is fed along the axis of revolution. The tension is obtained by passing the wire around grooved rollers *g g*.

See also patents: Loft, No. 27,456, March 13, 1860; Reinwarth, No. 154,342, August 25, 1874 (covering piano strings).

In Sperry's machine (Fig. 7271) the wire to be covered is drawn upward through the hollow spindle *a*; a sleeve driven

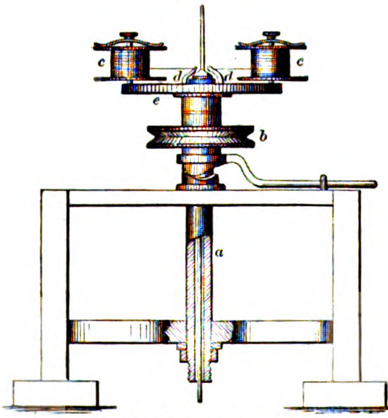
Fig. 7270.



Machine for covering Wire.

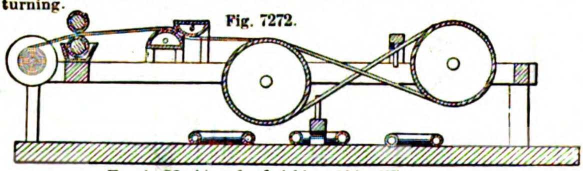
by a pulley *b* turns on the spindle as an axis and carries two spools *c c* containing the covering wire; this is conducted between two guides *d d* and applied spirally to the wire as it advances by the revolution of the table *e* on which the spools are held by spindles, while the wire to be covered is prevented from turning.

Fig. 7271.



Sperry's Wire-Covering Machine.

Fig. 7272.

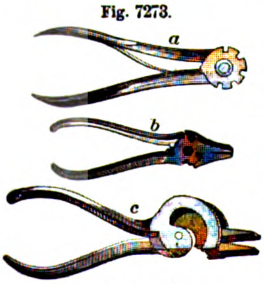


Frost's Machine for finishing Skirt-Wire.

Fig. 7272 shows a machine for sizing and finishing covered skirt-wire. The covered braided wire is passed from the supply-reel through the sizing medium, and back and forth over heated drums, and thence back through the sizing medium again to the second coat, and so on, as many times as may be desirable to apply successive coats of size, one over the other.

See also Chesney's patent, No. 40,244, October 13, 1863.

Fig. 7273.



Wire-Cutting Plyers.

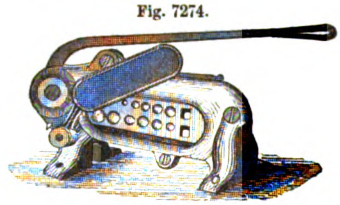
Wire-cut'ter. A nippers for cutting off wire.

a (Fig. 7273). Each leg of the cutter terminates in a disk having corresponding openings to receive the wire, which is sheared between their edges when the legs are brought together.

b. The edges of the jaws have corresponding slots, with cutting edges, into which the wire is inserted. The instrument is also used as a plyer.

c. The upper jaw is slotted, and the lower one works within it; the two serve as a plyer. The under side of the lower jaw has a cutting edge next to the joint, which severs the wire.

Fig. 7274.

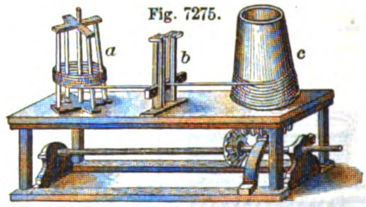


Wire-Cutter.

Wire-draw. To reduce in transverse size by drawing through an eye in a draw-plate.

Wire-draw'ing Bench. Iron wire, previously reduced to a diameter of $\frac{1}{4}$ to $\frac{1}{16}$ inch, is drawn down by the apparatus (Fig. 7275), consisting of a reel *a* on which the wire to be reduced is wound, a draw-

Fig. 7275.



Wire-Drawing Bench.

plate and stand *b*, and a conical drum *c*. The end of the wire is pointed and reduced sufficiently to pass through the proper aperture in the draw-plate, and is secured to a hook on the drum *c*, which is then set in motion by bevel-gearing.

Wire-drawn. (*Steam.*) The condition of steam when the pipes or ports leading to the cylinder have not sufficient carrying capacity.

Wire-fas'ten-ing. A tie for a cork in a bottle of champagne, soda-water, or other effervescing liquor.

"Henry W. Putnam's wire-fastening for bottle-stoppers, patented in 1864, was a slight and simple thing sold for a dollar and a half a gross, or a trifle more than a cent apiece. But the labor it saved in the tying of corks in soda-water bottles alone amounted to nine millions of dollars in nine years, estimating the labor at one dollar and twenty-five cents per day. The inventor made twenty thousand dollars from it in the same time."

Wire-feed Screw-ma-chine'. A machine for making screws from a continuous length of wire.

Admirable examples are to be found in the American Watch Company's works at Waltham, where jewel and other screws are made by perfectly automatic operations from wire fed from spools.

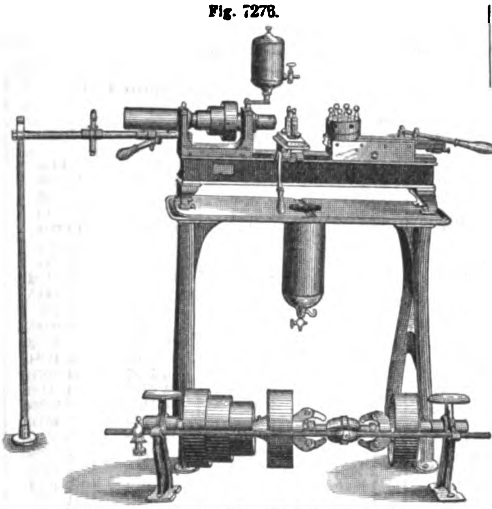
Fig. 7276 shows one on a larger scale by Pratt and Whitney, of Hartford, Conn.

Wire-fence. Hurdles of woven wire, or wire stretched from post to post.

Fig. 7277 shows one form in which the sections are strained between movable self-supporting posts.

In Fig. 7278, the wires are attached to the corner-posts, and passed through all the uprights and the capstan-blocks at the midlength of the fence. The panels have strut-bars at top, and a triangular trestle supports each corner transversely. The capstan-blocks are separate, so as to allow the independent

Fig. 7276.



Pratt and Whitney's Wire-Feed Screw-Machine.

tightening of each wire, and are turned by radial arms which are secured by wires to the nearest post.

Fig. 7279 is an iron post for wire-fences. The posts are made of strap-iron bent around at the top and spread at the bottom; the sides are connected by stay-rods, and are braced at the angle near the foot by angular-flanged frames.

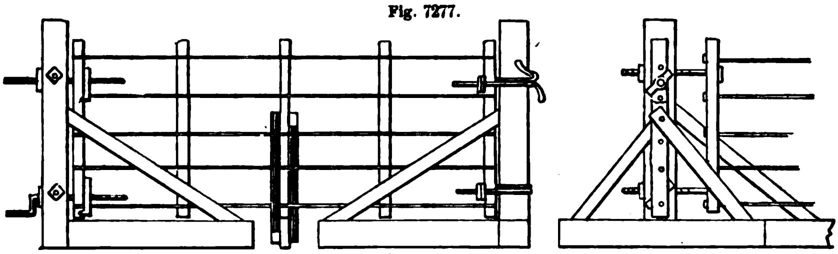
Fig. 7280 is a machine for making combined wood and wire fence. The batten is suspended by rods which have bearings in notches in the frame; it can be suspended parallel to the heddles or in an oblique position to enable the fence to be constructed so as to set on uneven ground. A knife is attached to the frame of the loom to sever the superfluous ends of the poles.

See patents: —

Name and Date.	No.
Clinger, September 13, 1859	25,387.
Esminger, December 8, 1868..........	84,810.
Gale, August 18, 1863................	39,563.
Hill, June 18, 1872	128,145.
Jenkins, February 14, 1849	6,106.
Knapp, June 7, 1864..................	43,032.
Lakins, August 27, 1873	146,246.
Little, June 24, 1873.................	140,147 and 159,691.
Mendell, August 3, 1869	93,326.
Meriweather, November 8, 1858.....	10,211.
Nicholson, April 25, 1871	114,029.
Norcross, January 10, 1865..........	45,852.
Rappleye, July 4, 1871...............	116,755 and 136,094.
Reyman, September 29, 1857.........	18,301.
Rose, May 13, 1873	138,763.
Sisson, April 25, 1871...............	114,057.
Smith, June 25, 1857................	66,182.
Speakman, January 16, 1872.........	121,862 and 153,390.
Wakefield, March 14, 1871	112,658.
Walker, May 29, 1853................	9,642.
Wilson *et al.*, December 6, 1870......	109,858.
Patterson, July 14, 1868.............	79,854.
Darlington, August 11, 1874..........	154,024.
Glidden, November 24, 1874..........	157,124.
Haish, January 20, 1874	146,671 and 164,552.
Hall, December 1, 1874	157,891.
Merrill, December 29, 1874...........	155,538 and 164,576.
Withers, October 6, 1874.............	155,603.
Ellwood, May 11, 1875	163,169.
McClellan, November 2, 1875.........	169,265.
Seabury, November 10, 1875.........	170,024.
Stover, June 29, 1875................	164,947.

Wire-gage. A gage for measuring the thickness of wire and sheet-metals. It is usually a plate of steel having a series of apertures around its edge, each corresponding in width to the diameter of wire of a certain number.

Fig. 7277.



Wire-Fence.

Wire-gages are commonly of oblong form, and are formed by drilling a number of holes near the edge of the plate; notches are then sawed from the edge into the holes, saws of the width proper for each being used; and, lastly, the little parallel plates of steel termed drifts are driven into the notches, to smooth and make them of uniform width.

The circular wire-gage, which is neater and more compact than the ordinary kind, is now very generally used (Fig. 7281).

Holtzapffel remarks that "the Birmingham and other gages seem to have originated, in great measure, accidentally, or almost by the eye alone, and without any attempt at system, either as regards the values of the intervals between the successive measures or numbers, or their correspondence with the subdivisions of the inch."

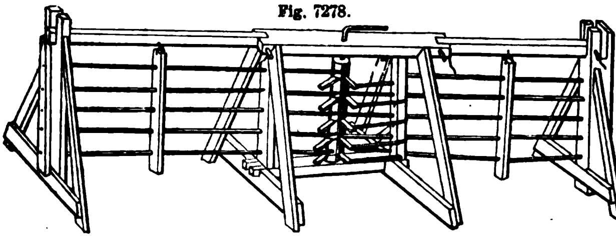
The Birmingham gage is the best known and most generally used in England, and was in this country until a more systematic gage was devised. It is so called from its being employed as the standard at Birmingham, always the great headquarters of the iron trade.

The defects indicated by Holtzapffel have led to attempts to introduce gages based upon more correct principles, in which a greater degree of uniformity in the progressive differences between the various sizes of wire should be observed. Fig. 7281 is a gage of this kind, prepared by Messrs. Brown and Sharp of Providence, R. I.

The wire is entered in a tapering slit in the gage, which has marks at intervals indicating the number of the wire which just fills the width of the slit at that point.

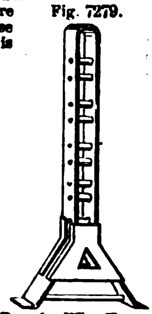
A new set of numbers and dimensions are also adopted. The difference between these and those of the old, or Birmingham, gage is shown in the following table: —

Fig. 7278.



Portable Wire-Fence.

Fig. 7279.



Post for Wire-Fence.

Weight of Wrought-Iron, Steel, Copper, and Brass Wires and Plates.

Diameters and Thickness determined by American Gage of Brown, Sharpe, & Co.

No. of Gage.	Size of each No.	Weight of Wire per 1,000 lineal Feet.				Weight of Plates per square Foot.			
		Wrought-Iron.	Steel.	Copper.	Brass.	Wrought-Iron.	Steel.	Copper.	Brass.
	Inch.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
0000	.46000	560.74	566.03	640 51	605 18	17.25	17.48	20.838	19 688
000	.40964	444.68	448.88	507.95	479.91	15.3615	15.5663	18 557	17.533
00	.36480	352 66	355 99	402.83	380.67	13.68	13 8624	16.525	15.613
0	.32486	279 67	282.30	319.45	301 82	12.1823	12.3447	14.716	13 904
1	.28930	221.79	223 89	253.34	239 35	10.8488	10.9934	13 105	12.382
2	.25763	175.89	177.55	200.91	189.82	9 6611	9.7899	11 671	11 027
3	.22942	139 48	140.80	159.32	150 52	8.6033	8 7180	10.393	9 8192
4	.20431	110 62	111.66	126.35	119.38	7.6616	7.7638	9.2552	8 7445
5	.18194	87.720	88.548	100.20	94 666	6.8228	6 9137	8.2419	7 787
6	.16202	69.565	70.221	79.462	75 075	6 0758	6.1568	7.3395	6.9345
7	.14428	55.165	55.685	63.013	59.545	5.4105	5.4826	6 5359	6 1752
8	.12849	43.751	44 164	49.976	47.219	4.8184	4.8826	5.8206	5.4994
9	.11443	34.699	35.026	39.636	37.437	4 2911	4.3483	5 1837	4.8976
10	.10189	27.512	27.772	31.426	29.687	3.8209	3 8718	4.6156	4 3609
11	.090742	21.820	22.026	24.924	23.549	3.4028	3.4482	4.1106	3.8838
12	.080808	17.304	17 468	19.766	18.676	3.0303	3 0707	3.6606	3 4586
13	.071961	13.722	13 851	15.674	14 809	2 6985	2 7345	3.2598	3.0799
14	.064084	10 886	10.989	12 435	11 746	2.4032	2.4352	2.9030	2.7428
15	.057068	8.631	8.712	9.859	9 315	2.1401	2.1686	2.5852	2.4425
16	.050820	6.845	6.909	7.819	7 587	1.9058	1.9312	2.3021	2.1751
17	.045257	5.427	5.478	6.199	5.857	1.6971	1.7198	2.0501	1 937
18	.040303	4 304	4.344	4.916	4.645	1.5114	1.5315	1.8257	1.725
19	.035890	3.413	3.445	3 899	3 684	1.3459	1.3638	1.6258	1 5361
20	.031961	2.708	2.734	3.094	2 920	1.1985	1.2145	1.4478	1.3679
21	.028462	2 147	2.167	2.452	2 317	1.0673	1.0816	1 2893	1.2182
22	.025347	1.703	1.719	1.945	1.838	.95051	.96319	1.1482	1.0849
23	.022571	1.350	1.363	1.542	1 457	.84641	.8577	1.0225	.96604
24	.020100	1.071	1.081	1.223	1 155	.75375	.7638	.91053	.86028
25	.017900	.8491	.8571	.9699	.9163	.67125	.6802	.81087	.76612
26	.01594	.6734	.6797	.7692	.7267	.59775	.60572	.72208	.68223
27	.014195	.5340	.5391	.6099	.5763	.53231	.53941	.64303	.60755
28	.012641	.4235	.4275	.4837	.4570	.47404	.48036	.57264	.54103
29	.011257	.3358	.3389	.3835	.3624	.42214	.42777	.50994	.48180
30	.010025	.2633	.2688	.3042	.2874	·37594	.38095	.45413	.42907
31	.008928	.2113	.2132	.2413	.2280	.3348	.33926	.40444	.38212
32	.007950	.1675	.1691	.1913	.1808	.29813	.3021	.36014	.34026
33	.007080	.1328	.1341	.1517	.1434	.2655	.26904	.32072	.30302
34	.006304	.1053	.1063	.1204	.1137	.2364	.23955	.28557	.26981
35	.005614	.08366	.08445	.0956	.09015	.21053	.21333	.25431	.24028
36	.005000	.06625	.06687	.0757	.0715	.1875	.19	.2265	.2140
37	.004453	.05255	.05304	.06003	.05671	.16699	16921	.20172	.19059
38	.003965	.04166	.04205	.04758	.04496	.14869	.15067	.17961	.1697
39	.003531	.03305	.03336	.03775	.03566	.13241	.13418	.15995	.15113
40	.003144	02620	.02644	.02992	.02827	.1179	11947	.14242	.13456
Specific gravity........		7.7747	7 847	8.880	8.386	7.200	7 296	8.698	8.218
Weight per cubic foot..		485.874	490.45	554.988	524.16	450.	456.	543.6	513.6

The sizes of needle-wire bear no relation to those of the wire-gage (Birmingham).

	Nos.					
Needle-wire	1,	2,	2¼,	3,	4,	5, up to 21.
Birmingham gage..	18½,	19,	19½,	20,	21,	22, up to 38.

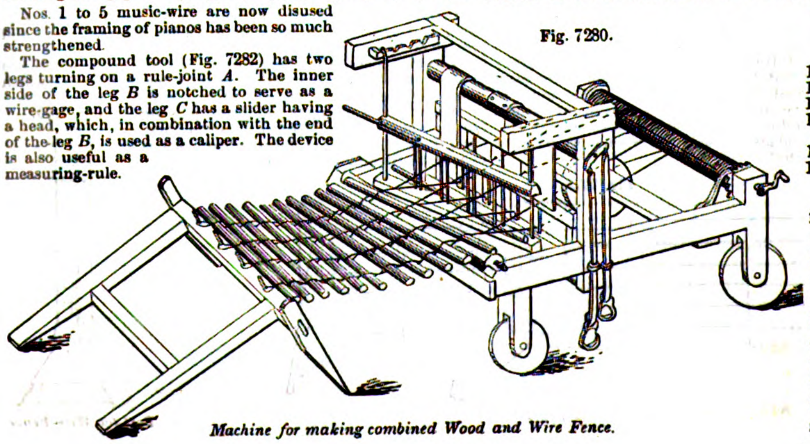
So also of piano-forte wire: —

Music-wire.........	6,	7,	8,	9,	10,	11,	12,	14,	16,	18, 20.
Birmingham gage..	26,	25½,	25,	24½,	24,	23½,	23,	21,	21,	20, 19.

Nos. 1 to 5 music-wire are now disused since the framing of pianos has been so much strengthened.

The compound tool (Fig. 7282) has two legs turning on a rule-joint *A*. The inner side of the leg *B* is notched to serve as a wire-gage, and the leg *C* has a slider having a head, which, in combination with the end of the leg *B*, is used as a caliper. The device is also useful as a measuring-rule.

Fig. 7280.



Machine for making combined Wood and Wire Fence.

Wire-gauze. A fine, close quality in wire-cloth.

At the London Exposition of 1851, French specimens of wire-gauze were exhibited having 260 parallel threads to the linear inch, or 67,600 meshes to the square inch.

Wire-guard. A fire-guard of wire-cloth.

Wire-mat'tress. One having a web of wire-cloth or chain stretched in a frame for supporting a bed.

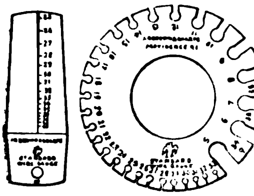
See patents: —

No.	Date.
139,077.	May 20, '73.
144,564.	Nov. 11, '73.
145,249.	Dec. 2, '73.
133 533.	Dec. 3, '72.
79,040.	June 16, '68.
109,446.	Nov. 22, '70.
132,175.	Oct. 15, '72.

Wire-mark'-ing Ma-chine'. A machine used in measuring and marking off lengths of wire for hoop-skirts. The endless band carries dies for marking the wire as it is fed from a spool. The band is

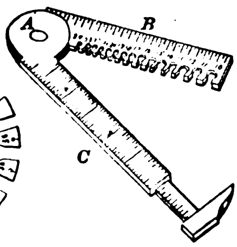
stretched over drums and under an ink-roller, and then passes between rollers, simultaneously with the wire to be marked.

Fig. 7281.



American Wire and Screw Gage.

Fig. 7282.



Caliper, Rule, and Wire Gage.

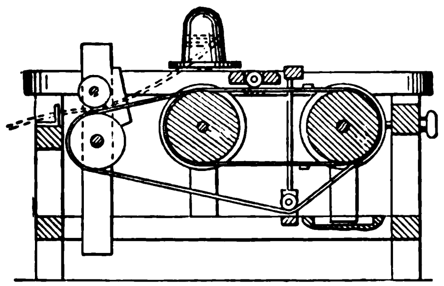
Wire-mi-crom'e-ter. A comparison of authorities shows that two other forms of micrometer were used before the wire-micrometer was introduced by Malvasia, about 1654.

These were the micrometer by Gascoigne, 1640, which consisted of nicely ground parallel edges of adjustable brass plates; and the slip of metal used by Huyghens, 1652. The latter was made to cover the image of the object in the focus of the lenses, and then compared with the breadth of the field. Hooke substituted parallel hairs for the parallel edges.

Malvasia constructed a micrometer having two parallel series of crossing silver wires, which divided the field of view into squares of equal size.

The *filar*, or *wire-micrometer*, has spider-lines, or fine wires, across the field of the instrument, and these are capable of being illuminated to assist observation. The wires are arranged in parallel and intersecting series, and some are capable of being moved by screws, so as to traverse the field of vision in a direction perpendicular to their length, so as to approach and recede from the others as measures of distance, the graduated heads of the adjusting screws noting the fractional parts of a turn.

Fig. 7283.



Machine for making Skirt-Wire.

The telescope of the mural circle, in the National Observatory, Washington, has at its focus a fixed diaphragm, having seven vertical wires and one horizontal wire. Another diaphragm, movable by a micrometer-screw, is furnished with five horizontal and equidistant wires, by which the distance of any star from the fixed horizontal wire is measured as it passes through the field. The intervals between the wire being previously accurately determined, the observation is conducted as follows: in whatever part of the field a star appears, a micrometer-wire is close at hand, and the star is bisected by the nearest wire, while the time at which it passes the several vertical wires is also noted. The number of the bisected wire and the reading of the micrometer being now entered, the observation is complete.

Wire-nail. A nail made from wire with a swaged head and point, or one forged in imitation thereof. Chests and boxes from the Continent of Europe and from Asia are found to be fastened with nails of this character. See NAIL.

Wire-nail'ing Ma-chine'. A machine for closing shoes with wire. See NAILING-MACHINE, pages 1507, 1508.

Wire-net'ting Ma-chine'. A machine for weaving wire-netting.

See patents: —

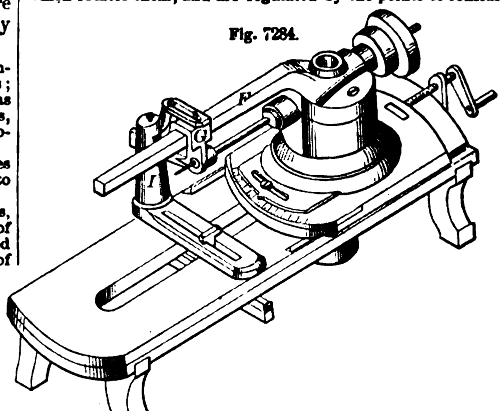
10,743. Nesmith, April 4, 1854.
121,831. Weber, Dec. 12, 1871.
133,951. Powers, Dec. 17, 1872.

Wire-peg'ger. A machine for fastening boot-soles with wire. Also called a wire-nailing machine. The kind of wire used is twisted so as to constitute it a screw, and is known as cable-screw wire. The thread gives it a better hold in the leather. See NAILING-MACHINE, Figs. 3283 – 3285.

Wire-point'ing Ma-chine'. The wire is slipped through the hollow mandrel of a lathe-head and secured. The end is presented to a stationary cutter in the overhang-rest G, which is supported upon the post I. The lathe-head is adjustable laterally to vary the angle of presentation and determine the taper of the point. A guide-arm F projects from the head and through a slot in the rest.

In Fig. 7285, the dies are arranged in the end of the shaft which rotates them, and are regulated by the points of conical screws which pass through them and into cavities in the bottom of the dovetail cross groove.

Fig. 7284.

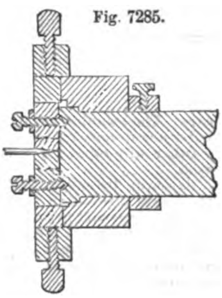


Wire-Pointing Machine.

See also patents: —

No.	Name and Date.
46,242.	Jillson, Feb. 7, '65.
47,974.	Jillson, May 30, '65.
58,730.	Manville, Oct. 9, '66.
59,778.	Plumer, Nov. 20, '66.
62,336.	Hopson *et al.*, Feb. 26, '67.
63,270.	Lockwood, Mar. 26, '67.
85,520.	Fowler, Jan. 5, '69.
87,557.	Fowler, Mar. 9, '69.

Fig. 7285.



Wire Pointing and Reducing Machine.

Wire-road. A wire suspended from posts, and serving as a track for transportation purposes. See WIRE-WAY.

Wire-rope. A collection of wires twisted or bound together, so as to act in unison in resisting a strain.

Wire-ropes were used in the Hartz mines in 1831, and there demonstrated their superiority to hempen ropes in situations where they are occasionally dragged through muddy water, rubbed upon rough surfaces, and exposed to constant friction upon pulleys.

Their introduction into England dates from about 1838. Mr. Telford, in his justly famous Menai suspension-bridge, used chains having long links.

Wire-rope has since superseded chain in the construction of suspension-bridges.

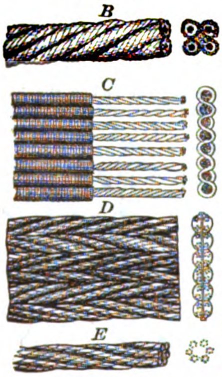
Its manufacture was commenced in Western Pennsylvania, by Mr. John A. Roebling, in 1837, and it was first introduced upon the inclined planes of the Portage Railway, over which the boats of the Pennsylvania Canal, divided into sections,

were transported across the Alleghanies. The roads of the Delaware and Hudson Canal Company and of the Pennsylvania Coal Company soon adopted them, and heavier ropes of 2 to 2½ inches diameter were then introduced upon the inclined planes of the Morris and Essex Canal in New Jersey. See INCLINED PLANE.

The earliest form of wire-rope was the *selvagee* rope, consisting of a number of wires laid together parallel, and secured by fine wire wound spirally around the whole. This was covered by woolen list, wrapped around in the contrary direction, and protected by a *service* of tarred rope-yarns, wound in the same direction as the covering wire.

This was succeeded by the plan of twisting soft annealed wire-strands, several of which were afterward laid up together, as in ordinary hempen ropes. It is inferior in strength to the selvagee rope, but more pliable, and readily admits of being spliced (*B*, Fig. 7286).

Fig. 7286.



Wire-Ropes.

About the same time flat wire-rope (*C*), composed of several strands having alternately a right and a left hand twist, was introduced; these strands were at first woven together with rope-yarn, but subsequently wire, passed in zigzag lines between the different strands, was employed (*D*).

At a somewhat later period *laid* rope (*E*) came into use; it is composed of strands of untwisted hard wire laid spirally around a central core of hemp or wire; a number of these strands, without any additional twist being placed around a hempen core, form the rope.

It is stronger than either of the preceding kinds, and is now generally employed.

For making wire-rope the very best iron is selected, and the bars are drawn down at a welding heat to wire about ¼ of an inch in diameter. This is then cleaned in warm water acidulated with a little oil of vitriol, and being coated with a paste of rye flour, it is drawn through a succession of holes in a wire plate until it is reduced to the thickness of No. 5, when it is annealed by heating from five to eight hours, and is then cleaned and drawn down again until it is of the required degree of fineness. In general, ropes are made of strands, each of which has 3, 7, or 19 wires, the ropes having either 9, 49, or 188 wires.

A number of machines have been contrived for making wire-rope. Smith's (Fig. 7287) has been extensively employed for forming the strands by which submarine telegraph-cables are protected.

It consists of a number of disks *a a a* united by longitudinal rods, and rotated by speed-pulleys. In the axes of these disks frames carrying bobbins *b b b* containing the wire are centered, but are prevented by weights *c* from turning therewith. The wires from six of the bobbins are conducted through central openings in the disks *a a a*, and pass through the plate *d*, and over the *laying-top e*, the seventh wire serving as a core. After passing between the rollers *f*, and around the horizontal wheel *g*, the strand is conducted backward and wound upon the reels *h h*, the tension being regulated by a friction-brake *i*.

The strands are laid up into ropes by a similar machine.

In Fig. 7288, the spool-frames *C C′* are arranged between disks *B B′ B″* on the hollow shaft *A*. The spool-frames have a universal joint at one end to enable them to be readily lifted to receive the spools *D*, and at the other end are rods *b′ b′*, *c c′*, having cranked ends inserted into apertures in the disk *E*, through which an eccentric on the shaft *A* passes. A rotary motion is thus imparted to the spool-frames as the wires are withdrawn from the spools, and, passing through a fixed perforated block, are laid together to form the rope.

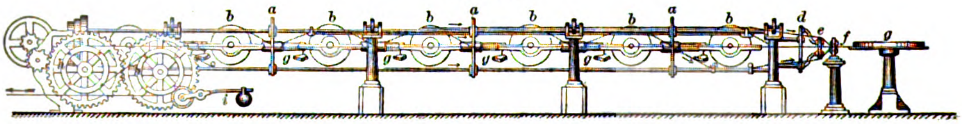
Wire-rope is made either with a wire or a hempen core. The latter is the more pliable, and will wear better where there is short bending. The larger sizes made at Roebling's, as also the more pliable, used for hoisting or running rope, are composed of 133 wires. Stiffer ropes, for guys or standing rigging, have 49 wires. These are only 1/6 the bulk and 1/2 the weight of hempen ropes of the same strength, and when used for shrouds and stays lighten the top hamper by that much, while affording less resistance to the wind.

When not galvanized, the wire is preserved by coating it with raw linseed-oil, applied with the hair side of a piece of undressed sheepskin, or by applying a paint of equal parts lampblack and Spanish brown, or Venetian red, mixed with linseed-oil.

It is protected under ground by saturation with a composition of one bushel fresh-slaked lime to one barrel mineral or vegetable tar, applied while boiling.

Wire-rope, for standing rigging, generally consists of six *strands* laid or spun round a hempen core, each *strand* consisting of six *wires*, laid the contrary way round a smaller hempen core. The spinning mechanism is so contrived that neither the *wires* nor *strands* are twisted.

Fig. 7287.



Smith's Wire-Rope Machine.

Other wire-ropes are made of three strands of three wires each.

Barbarin, December 10, 1867, solders the ends of wire-ropes to prevent unwinding.

The longest and heaviest wire-rope probably in existence was made by Messrs. J. & E. Wright of Birmingham, England. It consists of six strands, containing each ten wires, surrounding a central core of hemp. Its length is 11,000 yards, and weight upward of 60 tons.

Other ropes, 5,000 to 6,000 yards long, weighing from 25 to 34 tons, have been made by the same firm.

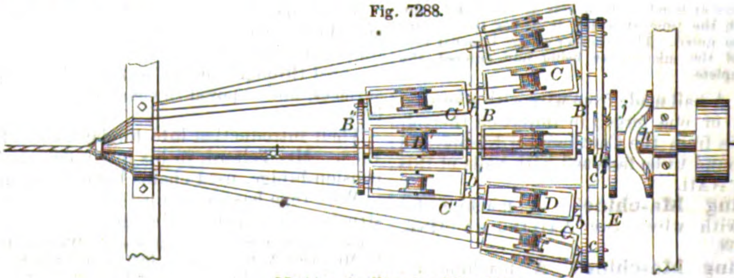
These, of course, bear no proportion in weight or length to some submarine telegraph-cables. The latter, however, are not made in one unbroken length.

Wire-ropes are used in the transmission of power from one locality to another, when the distance to be traveled is such as to render belting unsuitable.

At Frankfort-on-the-Main, the power of a 100 horse-power turbine is transferred 3,200 feet, to a cotton factory which is posted in a convenient position. Wheels 13½ feet in diameter are used, making 114 revolutions per minute. A ⅝-inch wire-rope is used; stations 400 feet apart.

A series of powder-mills, embracing the various shops where the compounding, grinding, sifting, glazing, etc., are carried on, are arranged in a series around the circumference of a circle of 1,200 feet radius, the machinery being driven by wire-ropes from a water-wheel in the center of the circle. The buildings are isolated by traverses, and have the benefit of the detached situation without the necessity for separate motive-powers.

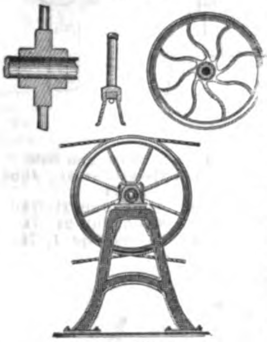
Fig. 7288.



Machine for Weaving Wire-Rope.

At the falls of the Rhine, near Schaffhausen, in Switzerland, a number of turbines are placed, having an aggregate horse-power of 600 horses. This is transmitted diagonally across the river to the town, which is about a mile lower down, and then distributed; advantage being taken of certain rocks in the river as foundations for the piers, which form the stations for the carrying-rollers.

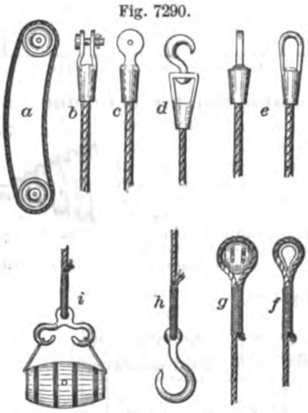
Fig. 7289.



Wheel for Wire-Ropes.

Fig. 7289 shows wheels and details of wheels employed in transmitting power by means of wire-rope. They are made of cast-iron, and the rims have one or more grooves adapted to receive and retain a packing on which the rope runs, to protect it from wear. A variety of materials are used for this purpose, as soft wood, leather, old tarred rope, oakum, and india-rubber, the latter material being preferable. It is cut into short pieces, having a section corresponding to, but slightly larger than, that of the groove into which the pieces are forced, so that they will not fly out. If leather be used, it is cut into thin strips, which are set on edge, several thousand being required for a large wheel. Tarred oakum is driven in by wedging; and ratline stuff or jute yarn, tarred, may be wound into the groove, soon becoming compacted by use.

Fig. 7290.

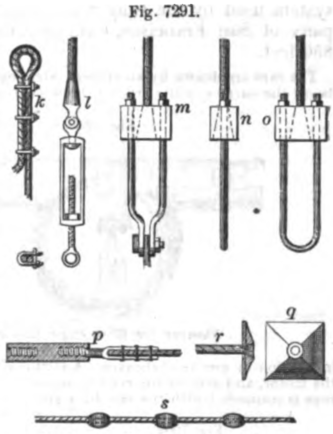


Roebling's Wire-Rope Fastenings.

Figs. 7290, 7291, illustrate Roebling's wire-rope fastenings:—

a, endless splice, for belt-ropes, etc.
b c, open socket, with pin; side and end views.
d, swivel-hook.
e, closed socket.
f, eye.
g, dead-eye.
h, eye, with hook.
i, eye with sister hooks.
k, thimble and clamps.
l, turn-buckle.
m, open stirrup.
n o, cast-iron socket with closed stirrup.
p, fastening for oil-well tools.
q r, plate fastening; plan and section.
s, hand-rope, with lugs.

Fig. 7291.



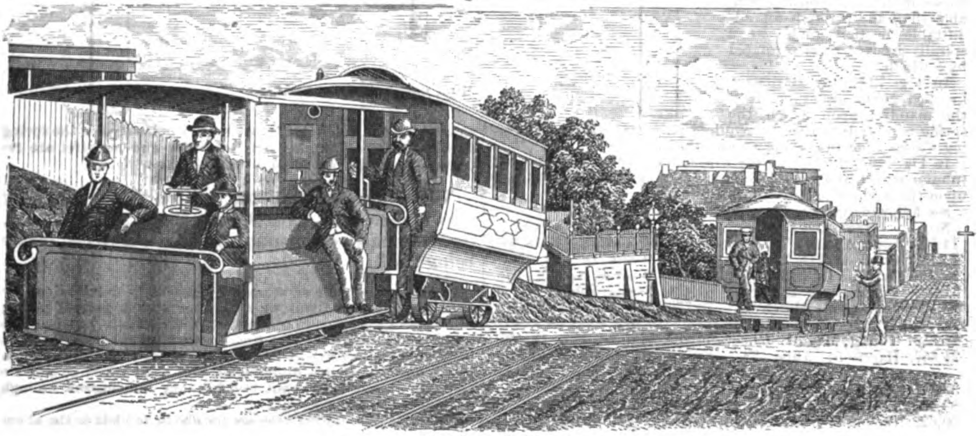
Roebling's Wire-Rope Fastenings.

TABLE OF WIRE-ROPE (ROEBLING).

Rope of 133 wires.				Rope of 49 wires.			
Trade Number.	Circumference in inches.	Ultimate strength in tons of 2,000 lbs.	Circumference of hemp rope of equivalent strength in inches.	Trade number.	Circumference in inches.	Ultimate strength in tons of 2,000 lbs.	Circumference of hemp rope of equivalent strength in inches.
1	6¾	74.00	15½	11	4⅝	36.00	10¾
2	6	65.00	14½	12	4¼	30.00	10
3	5½	54.00	13	13	3¾	25.00	9½
4	5	43.60	12	14	3⅜	20.00	8¼
5	4⅜	35.00	10¾	15	3	16.00	7¼
6	4	27.20	9½	16	2⅝	12.30	6¼
7	3½	20.20	8	17	2⅜	8.80	5½
8	3⅛	16.00	7	18	2⅛	7.60	5
9	2¾	11.40	6	19	1⅞	5.80	4¾
10	2¼	8.64	5	20	1⅝	4.09	4
10¼	2	5.13	4½	21	1⅜	2.83	3½
10½	1⅝	4.27	4	22	1¼	2.13	2¾
10¾	1½	3.48	3¾	23	1⅛	1.65	2½
				24	1	1.38	2¼
				25	⅞	1.03	2
				26	¾	0.81	1¾
				27	⅝	0.56	1½
				27½	½	....	..
				28	..	large sash-cord.	
				29	..	small sash-cord.	

Wire-rope Railway. Fig. 7292 illustrates Halladie's wire-rope traction-railway

Fig. 7292.

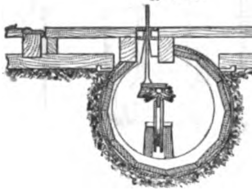


Wire-Rope Railway.

system used by the Clay Street Hill Railway Company of San Francisco, Cal., on grades as steep as 850 feet.

The cars are drawn by an endless wire-rope placed in a tube below the surface of the ground, between the tracks, and kept

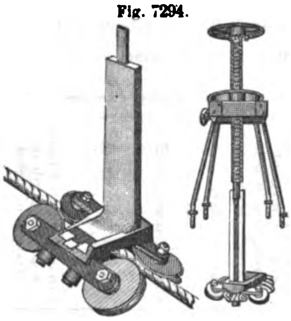
Fig. 7293.



Sheaves for Wire-Rope Railway.

in position by means of sheaves. A stationary engine is used as the motor, and acts on the rope by means of grip-pulleys. The rope is connected with the cars by a gripping attachment passing through a narrow slot in the upper side of the tube. The rope is supported at intervals of 39 feet and at the turnings by large sheaves, as shown in Fig. 7293.

Fig. 7294.



Gripping-Attachment for Wire-Rope Railway.

Fig. 7294 shows the gripping-attachment. It is provided with guide-sheaves and gripping-jaws, operated by the movement of a hand-wheel and screw; the jaws are clamped to the rope when the cars are set in motion. In stopping them, the jaws are released, and the sheaves then come in contact with the rope, but serve merely as guides. To return, the car or dummy-engine is transferred by means of a turn-table to another track, under which the rope moves in a reverse direction. See also WIRE-WAY.

Wire-spring. Coiled wire-springs are used for many purposes: in spring-balances; chronometer-balances; for upholstering cushions, chair and sofa backs, mattresses; and in many other places where but a moderate power is required.

It is customary to coil the wire upon a *former* of the required shape, cylindrical or conical, as in Fig. 7295, in which the wire passes from the coil on a detachable shaft and through an adjustable friction-guide to a spirally grooved former rotated by a winch.

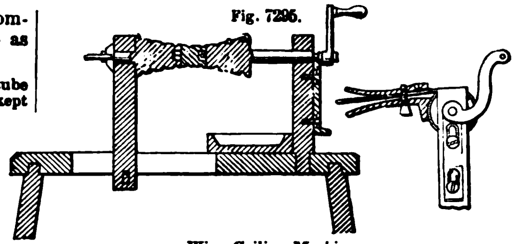
In Fig. 7296, the stationary inclined guide nearly encircles the mandrel upon which the spring is wound, to give the required pitch; two or more forming-wheels bend the spring around the mandrel.

In Fig. 7297, the joint of the wire is confined in the bisected tubular socket, and, commencing at the point, the wire is wound upon the conoidal, grooved former.

See following patents: —

No.	Name and Date.	No.	Name and Date.
14,566.	Lent, April 1, '56.	58,156.	Vose *et al.*, Sep. 18, '66.
16,483.	Harrison, Jan. 27, '57.	59,145.	White, Oct. 23, '66.
16,916.	Gardiner, Mar. 31, '57.	63,445.	Weaver, April 2, '67.
21,635.	Young, Sept. 28, '58.	69,421.	Evans, Feb. 16, '67.
23,142.	Jenkinson, March 1, '59.	70,770.	Woods *et al.*, Nov. 12, '67.
24,259.	Young, May 31, '59.	74,238.	Manuel, Feb. 11, '68.
24,557.	Harrison, June 28, '59.	88,031.	Goodale, Mar. 23, '69.
32,395.	Young, May 21, '61.	112,526.	Allen *et al.*, Mar. 14, '71.
50,420.	Kellogg, Oct. 10, '65.	112,868.	Van Fleek, Mar. 28, '71.
50,622.	Payne, Oct. 24, '65.		

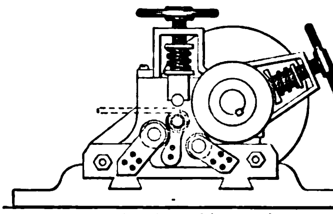
Fig. 7295.



Wire-Coiling Machine.

No.	Name and Date.	No.	Name and Date.
113,099.	Russell, Mar. 28, '71.	152,557.	Haskall *et al.*, June 30, '74.
115,413.	Baggott, May 20, '71.	158,387.	Smith, July 21, '74.
122,523.	Rhinelander *et al.*, Jan. 9, '72.	153,388.	Smith, July 21, '74.
126,315.	Mayall, April 30, '72.	154,563.	Powers, Sept. 1, '74.
136,473.	Ward, Mar. 4, '73.		

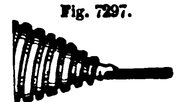
Fig. 7296.



Machine for Coiling Springs.

Wire-spring Coil'ing-ma-chine'. A machine for forming spiral springs from strips of metal.

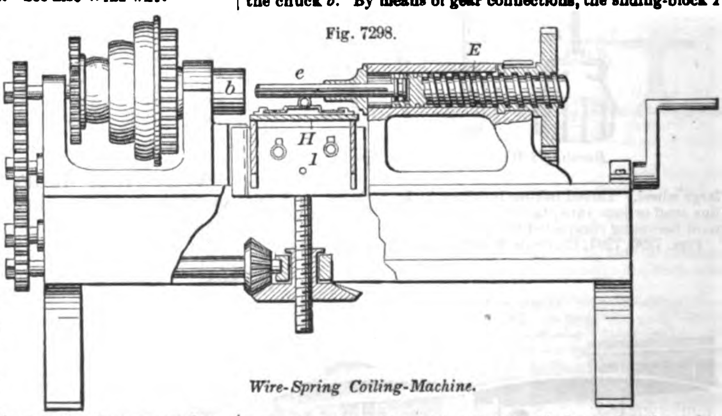
Fig. 7297.



Spring-Coiling Mandrel.

In Fig 7298, the heated strip of metal is held by a guide-rest *H*, and its end inserted in a slot in the mandrel *e*, which turns loosely in the screw *E*. The mandrel is rotated by being brought into connection with the chuck *b*. By means of gear connections, the sliding-block *I*

Fig. 7298.



Wire-Spring Coiling-Machine.

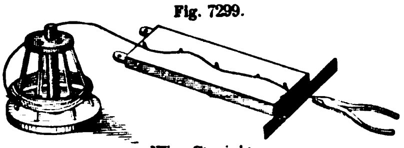
supporting the guide-rest is automatically lowered as the spring is coiled on the spindle, and the screw and mandrel are retracted by means of a hand-lever and gears.

Wire-straight'en-ing. Wire, being generally drawn upon reels, is met with in spiral coils, and, for most purposes, requires to be straightened before being used.

In the case of soft or annealed wire this is usually done by fixing one end and pulling the other with a pair of pliers; short pieces may be straightened by rolling them between two boards. The soft steel wire used for making needles is cut into lengths of four or five inches, and arranged in bundles within iron hoops four inches in diameter, and then rolled to and fro beneath a bar of iron about two feet long and narrow enough to lie between the rings.

Hard and unannealed wires are too elastic to yield to the above

Fig. 7299.



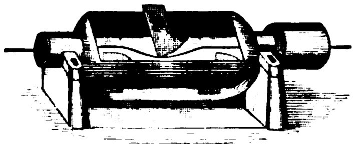
Wire-Straightener.

methods, and for straightening or *taking the spring out* of them, the *riddle* (Fig. 7299) is used.

This is a piece of wood or metal with sloping pins, which lean alternately opposite ways, so as to keep the wire close down on the board, and compel it to pursue a slightly serpentine course, which is considerably exaggerated; five pins are commonly used, but sometimes seven or nine.

In practice, the riddle is made wide enough to contain several

Fig. 7300.

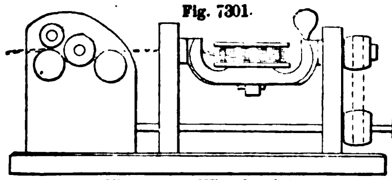


Wire-Straightener.

rows of pins, suitable for as many different sizes of wire as each wire requires a different set of pins. Between the pins of each set, and fixed down close to the board, is a straight metallic wire, about three times the diameter of the wire to be straightened, serving as a bed for the latter to run on.

The board is held in place by two staples at one end, which fit loosely over studs or nails in the work-bench.

Fig. 7301.



Washburn's Wire-Straightener.

The wire is drawn between the edges of two fixed pieces and an adjustable piece, by which the bends are straightened out.

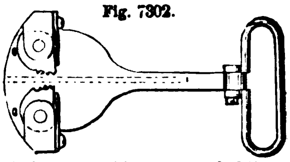
In Washburn's wire-straightener, July 4, 1865, a double-elbowed shaft, supported horizontally in suitable framework, carries within the elbow a reel supported by and turning upon a short journal, which projects from and at a right angle to the central horizontal portion of said elbow. The wire, first wound upon the reel, is thence passed through an orifice made through and coincident with the axis of one of the journals of the elbowed shaft, and thence to a series of small rollers suitably arranged for straightening the wire as they draw it gradually from the reel. In practice, the elbowed shaft is made to revolve with considerable velocity, and as the reel is carried around with it, the torsion thus produced keeps the wire perpetually turning over, thus offering successively every portion of its surface to the proper action of the straightening rolls.

See also patents No. 149,666, Mallett, April 14, 1874.
152,987, Greenwood, July 14, 1874.

Wire-stretch'er. A tool for straining lightly telegraph or fence wires.

The instrument is applied by moving it forward upon and against the wire, so as to force the jaws open to receive it; then on pulling the instrument it grasps the wire tightly.

Fig. 7302.



Tool for Stretching Telegraph-Wires.

Wire-tem'per-ing Ap'pa-ra'tus. A machine for giving the required degree of hardness to steel-wire.

It is passed at a proper speed through the apparatus. *A* is the heating-furnace containing a muffle, formed of an iron tube, coated externally and internally with graphite and clay, and closed at its ends by plugs of graphite or asbestus through which the wire passes. The wire next passes through a cylinder *c*, containing a bath of oil kept at a regulated temperature by a water-jacket; next it passes over a bed of charcoal which draws the temper. The wire is kept stretched by gripping-rollers.

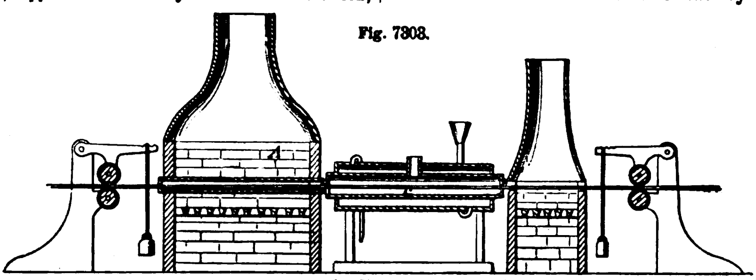
Fig. 7304 is an apparatus in which the object is to save space, and to bring both the discharging and receiving drums under care of one operator. The wire passes through the melted metal, and then, after passing through the oil-tank, turns around a roller and returns through the tempering-tank.

Patent No. 65,699 uses gas-jets.

Wire-tram'way. A mode of conveyance by or upon a wire supported on posts. See WIRE-WAY.

Wire-twist. A kind of gun-barrel made of a ribbon of iron and steel, coiled around a mandrel and welded. The ribbon is made by welding together laminæ of iron and steel or two qualities of iron, and drawing the same between rollers into a ribbon.

Fig. 7303.



Apparatus for Tempering Steel-Wire.

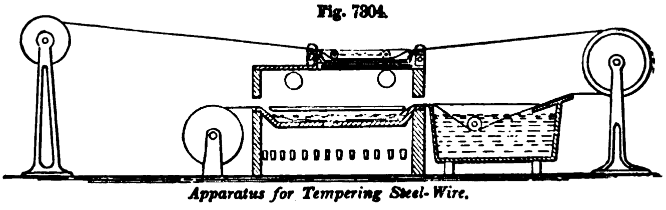
Wire-twist'ing Ma-chine'. A tool used for uniting the ends of sections of telegraph or fencing wire, and for other purposes.

See patents: —

40,586. Dimock, Nov. 10, 1862 (tags).
122,908. Murray, Jan. 23, 1872 (fire-screens).
130,778. Wolcott, Aug. 20, 1872 (telegraph).
145,994. Fry, Dec. 23, 1873 (telegraph).

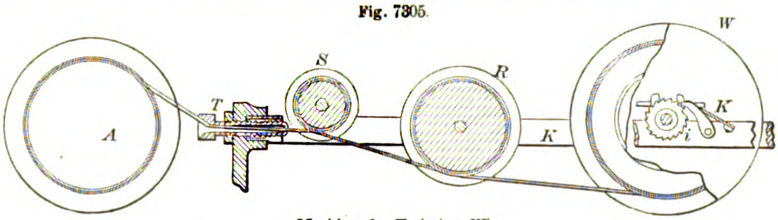
Smith's machine, for making cable-screw wire, is shown in Fig. 7305. The wire is polygonal in form, is wound from a drum, *A*, passes through a die *T* to a winding-drum *W*, which by the

Fig. 7304.



Apparatus for Tempering Steel-Wire.

Fig. 7305.



Machine for Twisting Wire.

action of a spring keeps it at the proper tension, and winds it as fast as twisted. One wheel *S* guides it through the die, and another *R* draws it; the revolution of the frame *K* is constant and gives the twist. The variation in the twist is given by the rate of drawing.

In Shortan's machine the band or wire is stretched the length of the machine, being held in the slotted standards and their intervening slotted pinions. The latter being revolved by the sector-wheels, which are oscillated by a treadle, the revolution of the pinions twists the wire.

Wire-way. A wire or wire-rope suspended from posts, and forming a way upon which loaded carriages traverse for the conveyance of freight.

This mode of transportation was described and represented in a work written by Mandey and Moxon, and published in London in 1696.

Hodgson's **wire-tramway**, lately introduced into England, is substantially similar to the elevated railways which were patented in England in 1825 by Palmer, Fisher, and Dick. See ELEVATED RAILWAY.

An endless wire-rope is carried on a series of grooved pulleys, supported in pairs upon stout posts ordinarily about fifty yards, but in some cases at much farther intervals apart. At one end the rope passes around a clip drum, worked by a stationary engine; at the other end it passes around a plain cylinder.

In one erected in Leicestershire, for conveying stone from the quarry to a railway station, a distance of three miles, the rope, ½ inch in diameter, is driven at the rate of four miles an hour by a 16 horse-power engine working with ten pounds of steam; this may be increased to five or six miles an hour. The boxes or carriages are about two feet long, one foot to eighteen inches wide, and six inches deep, their ordinary load being one cwt. They are not clamped to the rope, but adhere to it by friction; an upright stanchion on each side is bent over at top, and the two ends are connected by a block of wood which is hollowed out beneath so as to fit the rope, and pass over the suspension pulleys. The hourly delivery of stone at the station is ten tons, and the empty boxes are returned at the same rate as the full ones are delivered. Where the amount of freight to be accommodated is large, it is proposed to use a stout fixed rope to support the carriages and a lighter traveling rope to pull them.

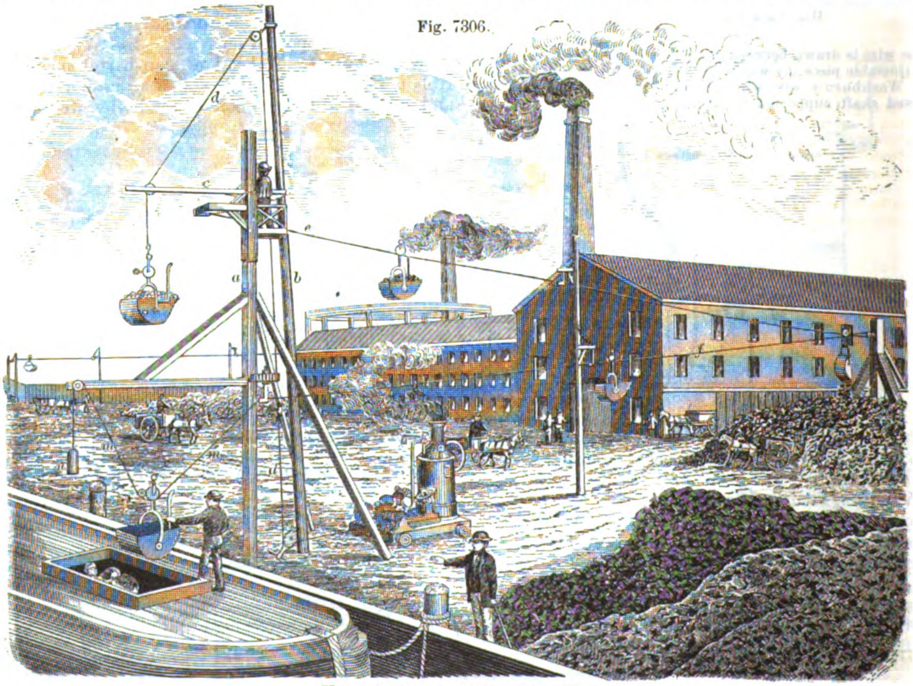
An elevated tramway at Brighton, England, on the Hodgson plan, is five miles long, and is capable of carrying each way one hundred and twenty tons per day of ten hours, two hundred and forty tons in all. When working to its full capacity both ways the loads on the opposite wires tend to counterpoise each other, and the expenditure of power is reduced to a minimum.

Various other plans on the same general principle, but differing in detail, are in operation in various parts of the world. In some the rope supporting the carriages is movable, and in others it is stationary, the carriages being drawn by an auxiliary rope.

Havens's automatic wire-rope railway (Fig. 7306) is particularly designed for loading and unloading vessels, or conveying freight from one point to another in the same vicinity. The rope is stationary, and the movement of the carriage is effected by its own gravity.

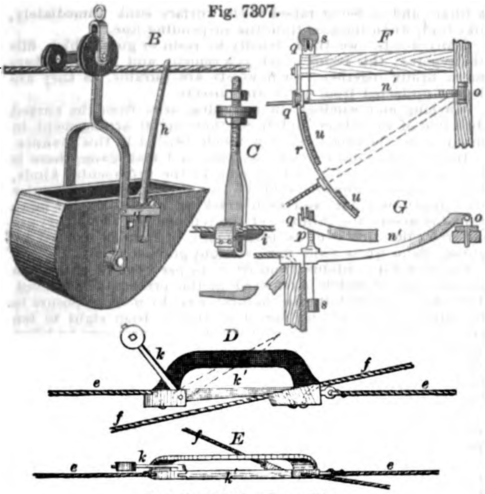
Fig. 7306 illustrates the apparatus at work discharging coal from a barge. Two tall poles *a b* are erected near the wharf. The first has a hinged outrigger *c* which can move only in a vertical plane. The loaded bucket is hooked on to the fall *d*, and run up by the hoisting-engine until a knot in the rope strikes the outrigger, which is then lifted with the bucket until it becomes vertical, and the bucket is brought directly over the rope *e*. The fall is then slacked, and an attendant on the elevated platform guides the rollers of the bucket directly on to the rope, along which it descends until arriving at the point of discharge, where the load is automatically dumped and the bucket transferred to the return rope *f*. *B* (Fig. 7307) shows the

Fig. 7306.



Havens's Automatic Wire-Rope Way.

Fig. 7307.



Details of Wire-Rope Way.

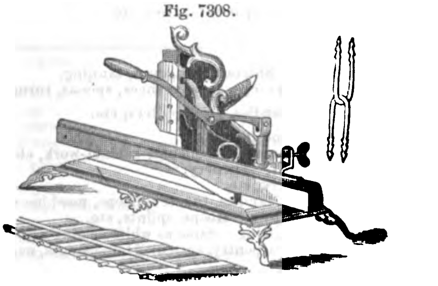
bucket, which is suspended from a larger and smaller connected pulley by an upright bar extending upward from the bail. At the side of the bail is a slotted piece *g*, slipping over an upwardly projecting stud, and holding the bucket horizontal; to this is attached a rod *h*, which, when the bucket arrives at its destination, is arrested by a stop disengaging the catch, and allowing the bucket to tilt and discharge its contents. The supports, which prevent the rope from sagging and at the same time permit the buckets to pass freely along the line, are shown at *C*. These depend from arms attached to the posts, and in them the rope is held fast by keys *i*.

After discharging, the buckets are transferred to the return-rope *f*, by the device shown in elevation at *D* and in plan at *E*. The tongue *k'* of the bent lever *k* is ordinarily held in the raised position shown by the dotted lines, but when struck by the pulleys as the bucket passes it is depressed and the bucket runs along it, and some distance up the rope *f*, until its momentum is checked and it commences its return movement; it then proceeds along *f* to the place of loading, and on passing the last suspending pulley, dependent from the post *b*, runs upon the rope *m* having a weight *n* attached, and, raising the weight, descends by its own gravity into the vessel's hold to be reloaded.

F G are respectively a plan and elevation of a switch, by which the buckets may at any point of their course be turned off and directed on to another line of rope. *n'* is a curved metallic arm connected by a double pivot *o* to a support, so as to have both transverse and vertical motion; at the opposite end is a standard *p*, on top of which is a small roller *q*, and which is lifted by an attached cord and weight *s*.

Fastened to the framework of the device is a track *r*, on which the roller *q* runs, and which bends downwardly between its two supports. While the arm *n* is drawn up by the weight *s* it remains at the highest point of the track *r*, and in line with the upper rope, but when a bucket arrives and slides upon the

Fig. 7308.



Blind-Wiring Machine.

arm *n'*, its gravity causes the arm to descend until it is arrested at a point directly opposite to the end of the rope *f'*, to which the bucket is to be transferred; stops *u u* along the track prevent the bucket running off the arm, until it is brought into the correct position.

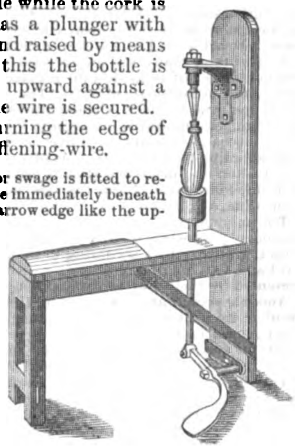
Wire-wheel. A brush-wheel made of wire, iron, or brass, instead of bristles, used for cleaning and scratching metals, preparatory to gilding or silvering. Also used in *matting* polished metallic surfaces.

Wir'ing-ma-chine'. 1. A machine for driving the staples connecting the slats to a Venetian blind, and for wiring the slats to the rod which turns them.

That illustrated is attached to a bench and operated by hand; others have an independent stand and are worked by a treadle. The devices embrace guides for directing the staples; a feeder for inserting them between the guides; a driver, and a device for moving the rod forward any required distance as each staple is driven; the whole being operated by the hand-lever or treadle. See also Figs. 719, 720.

2. An apparatus for securing a soda-water or other bottle while the cork is being wired. It has a plunger with an enlarged head, and raised by means of a treadle. On this the bottle is placed, and pressed upward against a fixed piece while the wire is secured.

Fig. 7309.



Cork-Wiring Machine.

3. A machine turning the edge of a tin-pan over a stiffening-wire.

A square roller, die, or swage is fitted to revolve in a suitable frame immediately beneath a round roller with a narrow edge like the upper roller of a common wiring-machine.

Wisp. A besom. A small broom.

Witch'et. A kind of plane with a conical aperture and inclined knife, which reduces to roundness a bar which is rotated as it is passed therethrough.

See ROUNDING-PLANE; AUGER.

Withe. 1. A band or tie made of a twisted flexible sapling.

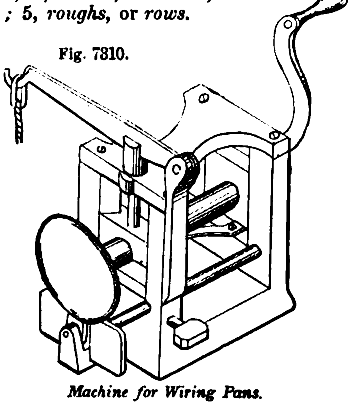
2. A flexible handle to a cold-chisel, setter, or fuller.

3. (*Nautical.*) A ring or boom-iron, by which a beam is set out or in on its principal spar.

4. (*Building.*) A wall dividing two flues in a stack of chimneys.

Witts. Tin ore from the stamping-floor. The earthy portions being removed by water, the clean *witts* are sorted according to size into, 1, *jigged;* 2, *flucan;* 3, *smalls*, or *smales;* 4, *slime;* 5, *roughs*, or *rows*.

Fig. 7310.



Machine for Wiring Pans.

Wolf. A *beating* or *opening* machine, for tearing apart the tussocks of cotton as delivered in the bale. It is a preliminary operation, by which dust and trash are rendered separable and the fiber delivered in a

more downy condition, so as to subsequently form a *lap*.

Also called a *devil*, *willower*, *twilly*, etc. See COTTON-CLEANING MACHINE.

Wolfram. Native tungstate of iron and manganese. *Mock-lead.*

Wood.

In countries where the palm and bamboo grow, the smaller stems are used as tubes for the conveyance of water, and the larger stems for joists.

The hard fibers of the palm, which are embedded in the pithy substance of the trunk, are in some cases employed as nails. Small palms, under the name of partridge and Penang canes, are used as walking-sticks.

Some varieties are employed in cabinet and marquetry work, for billiard-cues, snuff-boxes, etc. The twisted palm walking-sticks are made of the central rib from the leaf of the date-palm, twisted while green and stretched.

The nuts of many species are also used in the arts. The betel or areca nut is made into necklaces, the tops of walking-sticks, and other small objects. The husk of the cocoa-nut yields coir, and its shell is made into cups, vases, and buttons. The hard coquilla-nut is turned into knobs, small toys, etc..

The cocoa-nut palm is of universal utility where grown, its fruit affording food, the husk coir of ropes, the leaves are made into baskets and mats, the stem is used for building purposes, and different parts of the tree are made to yield oil, sugar, palm wine, and arrack.

The exogenous woods are, however, of greater value for most economic purposes; in this regard they may be divided into several groups, either according to their physical character, as hard and soft, tough and brittle, or according to the appearance presented by their dressed surfaces, the grain.

Another classification adopted by Holtzapffel depends on the peculiar uses for which they are fitted, comprising building woods, used in ship and house carpentry and engineering; woods for machinery and mill work; turnery woods; furniture woods; ornamental woods; dye woods.

These divisions, of course, blend into one another to a certain extent.

At the principal entrance of an ancient Roman villa, near Pompeii, which had apparently been overwhelmed by the same eruption which nearly destroyed that city, A. D. 79, was found, in 1835, a large beam of squared wood, probably intended for the lintel of a door. It appeared completely charred, and emitted a strong odor of carbonic-acid gas. On being handled, the outer part crumbled into dust, but the center was sound, though black as jet.

After being exposed to the air for two years, to free it from its offensive smell, it was sawn, and two tables made from the wood. One of these was shown at the London Exhibition of 1851. The age of the wood, when cut, was estimated at two centuries, so that it would now be about 2,000 years old.

The densest known wood is the *iron-bark* wood of New South Wales, which has a specific gravity of 1.426; the lightest, the *Cortica*, or *Anona palustris*, from Brazil, having a specific gravity of only 0.206, being lighter than cork.

Woody fiber is considerably denser than water; the presence of air between the pores causes most kinds to float in water; but when thoroughly saturated they sink. Scoresby relates the case of a boat which was dragged down to a great depth by a whale, and on being raised to the surface sunk immediately, like lead, when released from the suspending-line.

Many woods owe their density to resin or gum, which fills their pores; this seems to act as a cement, and bind the fibers more firmly together: such woods are durable, as they are better protected from water and insects.

Warping and winding, in seasoning, arise from the curved direction of the fibers, and from their spiral arrangement in many trees: boxwood is often much twisted in this manner.

In straight-grained woods, as pine and mahogany, there is but little contraction; but in some of the ornamental kinds, having great confusion of fibers, the shrinkage is so irregular that much warping, and even cracking, result. In the more valuable woods, the thinness of the veneers into which they are cut remedies this evil, as permanence of form is secured by gluing them upon some firm, straight-grained wood.

Green wood contains from 38 to 45 per cent of water, the greater part of which is removed in the process of seasoning. This, when effected in the natural way, by mere exposure to the air, requires a long period of time — from eight to ten years — for large-sized oak timber. Unless great care be taken dry-rot is apt to set in; it is also liable to irregular contraction and splitting, particularly in the direction of the medullary rays. There is usually no material reduction in the length of the timber.

In teak this contraction is hardly perceptible, while in soft woods it may amount to ½ inch in the foot. The elasticity depends upon the straightness of the longitudinal fibers, freedom from knots, and the simple character of the medullary rays; the most elastic woods, as lance-wood and hickory, are easiest to split, while those in which the fibers are much interlaced, as lignum-vitæ and gnarled oak, are split with great difficulty. The interlacement of the fibers, while depriving wood of its elasticity, renders it tough, and gives to many species, when polished, a beautifully variegated appearance.

The flexibility of woods is much increased, for the time, by steaming; this is done in the case of ship-timber, shafts, staves, etc., which are bent in the direction of the grain: economy of material and strength are thus secured. Timber treated with steam, at a temperature of 482° Fah , has its fibers drawn closer together; maple and pine thus treated are rendered more valuable for musical instruments, as sound-boards, etc.; walnut becomes darker from the formation of a kind of tar, which tends to preserve it. The loss of weight is from one third to one half. Mechanical compression greatly increases the density of wood; this is practiced in the case of tree-nails, which are driven through metallic rings, smaller than themselves, into the ship's side (Annersly's patent, 1821), the fibrous structure remaining undisturbed.

Wood is subject to unsoundness. It may be

Ring-hearted; split in the direction of the rings of yearly growth.

Shaky; split in the direction of the medullary rays; that is, from the heart outward.

Knotty; defaced by large or loose knots.

Doted: decayed.

Lumber is depreciated in value by the above, and by

Sap; the *alburnum*, or sap-wood between the inner bark and the hard wood, or *duramen*.

Waney portions; where the edge is not square.

Knots, *burls*, *blisters*, and *bird's-eye* are irregularities of grain produced at the divarications of limbs, the healing over of wounds, and protuberances, from whatever cause, which twist or warp the grain from its straight course.

TABLE OF WOODS ("*Eastern U. S.*" *means East of Rocky Mountains*).

Name of Tree.	Botanical Name.	Native Place, or where chiefly grown.	Qualities, Uses, etc.
Acacia	Acacia proxima mordi..	Warm climates....	Hard, tough. Shipbuilding, gum, tanning.
Alder	Alnus glutinosa, etc.....	Europe, etc.......	Hard. Cogs, pumps, wooden shoes, spoons, turnery.
Almond	Amygdalus communis..	South of Europe, Syria, Barbary	Hard. Tool-handles, cogs, pulleys, etc.
Amboine	....	W. coast of Africa..	Fancy tables and boxes.
Apple	Pyrus malus...........	America & Europe	Medium. Turnery, ornamental cabinet-work, etc.
Apple (Am. crab)....	Pyrus coronaria	Eastern U. S.	Hard, light red. Turnery.
Arbor vitæ	Thuja occidentalis, etc..	Temperate climes.	Soft. Carpentry, etc.
Ash	Fraxinus excelsior......	Britain, etc.......	Hard, tough. Handles, turnery, hoops, machine-work.
Ash (black)	Fraxinus sambucifolia..	Eastern U. S.	Hard, very lasting. Hoops, splints, etc.
Ash (blue)	Fraxinus quadrangulata	Eastern U. S.	Hard, white, lasting. Same as white or gray ash.
Ash (white)	Fraxinus americana....	Eastern U. S.	Hard, white. Carpentry, agricult'l implements, wagons.
Bamboo	Bambusa arundinacea.	China, India, etc..	Various.
Bar-wood	....	Africa...........	Turning ramrods, violin-bows, dyeing.
Basswood	(See Linden.)		
Beech	Fagus sylvatica........	Temperate Europe..........	Hard. Handles, lasts, boot-trees, planes, pegs; stained for furniture.
Beech	Fagus ferruginea.......	Eastern U. S.	Hard, yellow. Framing planes, tool-handles, turnery.
Birch	Betula alba............	Temperate Europe	Hard. Legs for tables, water-taps, butter-molds, spoons.
Birch (paper)	Betula papyracea	N. E. America....	Canoes.
Birch (white)	Betula alba populifolia..	N. E. America....	Furniture.
Birch (yellow)	Betula lutea...........	N. E. America....	Furniture.
Biti	....	India............	Open-grained; resembling rosewood in color.

Name of Tree.	Botanical Name.	Native Place, or where chiefly grown.	Qualities, Uses, etc.
Black Botany Bay wood	....	Australia, etc.....	Hard. Handles for instruments, turning.
Blue gum	Eucalyptus globulus....	Australia	Hard. House and ship building, bridges, piles.
Bog-oak	Quercus (?)	Eng. and Ireland..	Hard and black. Fancy cabinet-work, inkstands, etc.
Boxwood	Buxus sempervirens	S. and W. Europe and Asia Minor	Hard. Turnery, wood-engraver's blocks, rules, etc.
Brazil wood	Cæsalpina echinata	Brazil	Dyeing, violin-bows, turning.
Buckeye	Æsculus glabra	Tennessee and northward	Soft, spongy, white. Splints for baskets, bowls.
Bullet-tree	Achras sideroxylon	Jamaica	Hard, durable. Best timber-tree of Jamaica.
Buttonwood	(See Sycamore)		
Calamander	Diospyros quæsita	Ceylon	Very hard; beautifully marked. Furniture.
Camphor-wood	....	Warm climates	Soft. Cabinet-work and turning.
Cam-wood	....	Africa	Dyeing and turning.
Canary-wood	....	Brazil	Cabinet-work, marquetry, turning.
Cangica-wood	....	Brazil	Cabinet-work, turning.
Catalpa	Catalpa bignonoides	Eastern U. S.	White, lasting. Posts.
Cedar	Cedrela australis	New S. Wales	Soft. Furniture and small cabinet-work.
Cedar (bastard)	Libacedrus decurrens	S. California.	
Cedar (red)	Juniperus virginiana	East'n U. S. & Utah	Soft. Pencils, furniture, cigar-boxes.
Cedar (rock) (yellow cedar).	Juniperus californica	Utah to Pacific	Yellow, lasting. Various.
Cedar (Spanish)	....	W. Ind., S Am'ca	Cigar-boxes.
Cedar (Western)	Juniperus occidentalis	Utah to Oregon	Various.
Cedar (West Indian).	Cedrela odorata	W. Indies	Soft. Furniture, small cabinet-work, cigar-boxes.
Cedar (white)	Cupressus thyoides	N. J. & southward	Building and fencing.
Cedar (white)	Thuya occidentalis	N. E States	Various.
Cedar-wood	Cedrus libani	Lebanon.	
Cherry	Prunus cerasus	Europe	Soft. Cabinet-work, turnery, Tunbridge-ware, etc.
Cherry (wild black).	Prunus serotina	Eastern U. S.	Medium, red. Furniture.
Cherry-tree	Exocarpus cupressiformis	Australasia	Hard. Gun-stocks, axe-handles, spokes, turnery, etc.
Chestnut	Castanea vesca	Am'ca and Europe	Takes a good polish. Furniture, turnery, hoops, etc.
Cocoa-wood	....	W. Indies	An exogenous hard wood used for turning and flutes.
Cogwood	Laurus chloroxylon	Jamaica	Hard. Mill-framing, cog-wheels, etc.
Coquilla-nut	Attalea funifera	Brazil	Nuts, hard. Used in turnery.
Cork-oak	Quercus suber	S. W. Europe	The bark affords common cork.
Cotton-wood	Populus monilifera	W. States and Terr.	Medium, white.
Cowdi pine	Dammara australis	Temperate climes	Wood very durable. Turnery, etc.
Cypress	Cupressis sempervirens. Cupressis thyoides	Southern U. S. Florida, etc.	Soft. Carpentry, shingles, etc.
Cypress	Torreya taxifolia	New Zealand	Hard. Shipbuilding, etc.
Deodar	Cedrus deodar	Himalaya and India	Wood very durable. Building, etc. Yellow color.
Dogwood	Bedfordia salicina	Tasmania	Hard; beautifully marked. Ornamental furniture.
Dogwood	Cornus florida	Eastern U. S.	Hard, red. Turnery.
Dogwood	Piscidia erythrina, etc.	Jamaica	Hard. Wheels, carriages, etc.
Douglass pine	Abies douglassii	Britain, etc.	Medium. Carpentry, building, etc.
East India blackwood	Dalbergia latifolia	India	Heavy, close-grained. Furniture.
Ebony	Diospyros ebenus	Mauritius, Ceylon, India, Africa	Hard. Boxes, inkstands, furniture, etc. Black ebony.
Ebony (West Indian)	Brya ebenus	Jamaica	Hard. Turnery, cabinet-work, etc. Green ebony.
Elder	Sambucus nigra	Europe and Am'ca	Soft. Turnery, rules, shuttles, sap-spiles.
Elm	Ulmus campestris, etc.	Europe	Hard, durable. Planking, wedges for railway chairs.
Elm (red)	Ulmus fulva	Eastern U. S.	Medium, red. Carpentry. Bark yields slippery elm.
Elm (white)	Ulmus americana	Eastern U. S.	Medium, white. Staves, hoops.
Fir (red silver)	Abies amabilis	Sierra Nevada	(See also Spruce; Hemlock)
Fir (Scotch)	Pinus sylvestris	Europe	Medium hardness. The yellow *deal* used in Europe.
Fir (silver)	Abies grandis	California.	
Fustic	Morus tinctoria	N and S. America	Dyeing, mosaic-work, and turning.
Greenheart	Nectandra rodiæi	Guiana, Trinidad	Hard and very durable. Shipbuilding, wharves, bridges.
Gum (sour or black)	Nyssa multiflora	Eastern U. S.	Hard, tough, white. Hubs.
Gum (sweet or red)	Liquidamber styraciflua	Eastern U. S.	Inferior to the black.
Hawthorn	Cratægus oxyacantha	Europe, etc.	Hard and white; takes a good polish. Turnery.
Hazel	Corylus avellana	Europe	White; takes a good polish. Turnery, hoops, etc.
Hemlock (spruce)	Abies canadensis	Northern America.	Various.
Hickory (Eastern shell-bark)	Carya alba	East of Alleghanies	Hard. Implements and vehicles.
Hickory (Western shell-bark, etc.)	Carya sulcata, etc.	Mississippi Valley	Hard. Implements and wagons.
Holly	Ilex aquifolium	Europe	Hard. Turnery, cabinet-work, calico-printer's blocks.
Holly	Ilex opaca	S. E. United States	Hard, white. Ornamental.
Hoonsay	....	India	Alternate red and black streaks.
Hornbeam	Carpinus betulus	Europe	Hard. Mill-work, turnery, etc.
Horse-chestnut	Æsculus hippocastana	Asia and Europe	Soft. Brush-backs, Tunbridge-ware, turning.
Huon pine	Dacrydium franklinii	Tasmania	Hard. Planking, house, and ship building, cabinet-work, picture-frames, etc.
Iron-wood	Bumelia lycioides	Eastern U. S.	Hard. Turnery.
Iron-wood (redwood).	Exythoxylon areolatum.	Jamaica	Hard. Cog-wheels, mill-frames, etc.
Jack-wood	Artocarpus integrifolia	S. Asia, Ceylon	Hard. Furniture, etc.
Juniper	(See Cedar.)		
Kiaboca-wood	....	E. Indies	Boxes and ornamental work.
King-wood	....	Brazil	Hard. Turning and small cabinet-work.
Laburnum	Cistisus alpinus, etc.	Europe	Hard. Turnery, etc.
Lancewood	Anona duquetia	S. America	Hard. Springs, archery bows, cues, and fishing-rods.
Lancewood (black)	Oxandra virgata	Jamaica	Hard. Springs, archery bows, cues, and fishing-rods.
Larch	Larix europæa	Europe	Durable. Various uses; source of Venice turpentine.
Larch (Western)	Larix occidentalis	Oregon	(See also Tamarac.)
Laurel (mountain)	Kalmia latifolia	Penn. & southward	Hard, red. Turnery.
Leopard-wood or Letter-wood	Piratinera guianensis	C. America	Hard; takes a fine polish. Canes, etc.
Lignum vitæ	Guiacum officinale	W. Indies	Hard. Pestles, mortars, turnery, sheaves, bowls, rulers.

Name of Tree.	Botanical Name.	Native Place, or where chiefly grown.	Qualities, Uses, etc.
Lignum vitæ	Guiacum sanctum	S. Florida	Hard, dark. Turnery and ornamental.
Lime	Tilia europæa	Europe	Close-grained. Carving, hoops, turnery, etc.
Linden (Linn, bass-wood)	Tilia americana	Eastern U. S.	Soft, white, flexible.
Locust	Hymenæa courbaril	W. Indies	Hard. Timber for steam-engine frames, tree-nails, etc.
Locust	Robinia pseudacacia	East of Miss. River	Tough and durable. Posts, tree-nails, turnery, hubs.
Logwood	Haematoxylon campechianum	Jamaica, Honduras	Dyeing.
Mahogany	Suretema mahagoni	C. America, Cuba	Hard. Furniture, cabinet-work, turnery, etc.
Mahogany (mountain)	Cereocarpus ledifolius	Rocky Mountains	Hard, dark-red. Ornamental.
Mangrove	Various	Tropics	Cabinet-making, shipbuilding.
Maple (black)	Acer nigrum	Eastern U. S.	Same as saccharinum.
Maple (red)	Acer rubrum	Eastern U. S.	Soft, and less useful.
Maple (sugar)	Acer saccharinum	Eastern U. S.	Hard, white. Sugar, carving, gun-stocks, framing-timber, furniture.
Mountain-ash	Eucalyptus pilularis	Australia	Hard, tough. Poles and shafts for carts, wagons, etc.
Mountain-ash (rowan)	Pyrus aucuparia	Britain, etc.	Similar to the apple.
Mulberry	Morus alba et nigra	Europe, China	Leaves, for the silkworm.
Mulberry (red)	Morus rubra	Eastern U. S.	Medium, red, very lasting. Posts and framing.
Muskwood	Eurybia argophylla	Tasmania and N. S. Wales	Hard; smells of musk; takes a fine polish. Ornamental furniture.
Mustaiba		Brazil	Turning, knife-handles, etc.
Myrtle	Myrtus communis	S. Europe	Hard. Close-grained; takes a good polish.
Myrtle (Tasmanian)	Fagus cunninghamii	Tasmania	Dark; finely marked. Cabinet-work, turnery, etc.
Nellee		India	Dark flesh-color.
Nettle-tree	Celtis australis	S. of Europe	Close-grained. Flutes, carving.
Norfolk Island pine	Araucaria excelsa	Norfolk Island	Medium. Building, carpentry, etc.
Norway spruce	Abies excelsa	Norway	Medium. The white *deal* used in England.
Novaladdi		India	Greenish brown; close-grained; takes fine polish.
Oak	Quercus robur, etc.	Europe, etc.	Hard. Shipbuilding, furniture, turnery, implements.
Oak (African)	(See Teak)	Africa	Hard. Shipbuilding, furniture, turnery, etc.
Oak (black)	Quercus tinctoria	Eastern U. S.	Hard, red. Building, shingles.
Oak (chestnut)	Quercus prina	Eastern U. S.	Building, fencing, etc.
Oak (red)	Quercus tinctoria	Eastern U. S.	Hard, red. Building, shingles.
Oak (white)	Quercus alba	Eastern U. S.	Hard, yellow. Building, furniture, implements, wagons.
Olive	Olea europæa	Europe, Syria, etc.	Medium. Furniture, turnery, etc.
Osage orange (Bois d'arc)	Maclura aurantiaca	Ark. and southward	Hard, yellow, very lasting. Wagons and implements, wedges.
Osiers	Salix viminalis, etc.	Europe	Soft. Baskets, plait, wicker-work generally.
Oyster Bay pine	Callitris australis	Tasmania	Hard. Agricultural implements, cabinet-work, etc.
Paddle-wood	Aspidosperma excelsum	Guiana	Paddles, cotton-gin rollers.
Palm	(See Porcupine-wood)	Tropical climes	Various uses in mechanics. Oil.
Partridge-wood	Heisteria coccinea, etc.	W. Ind. and S. Am.	Hard. Walking-sticks, umbrella-handles, etc.
Pear	Pyrus communis		Turning, carving, blocks for calico-printers, etc.
Pheasant-wood			Another name for partridge-wood.
Pine	Species very numerous	Europe and Asia	Medium. Lumber for building and carpentry.
Pine (Cal. yellow)	Pinus jeffreyi	California	Various.
Pine (pitch)	Pinus rigida	S. E. United States	Various. Turpentine.
Pine (red)	Pinus resinosa	Eastern U. S.	Building, etc.
Pine (spruce)	Pinus glabra	S. Car. & southward	
Pine (white)	Pinus strobus	Eastern U. S.	Principal timber-tree of North America.
Pine (yellow)	Pinus mitis	Northern America	Medium, yellow. Building and various.
Plane (occidental)	Platanus occidentalis	N. America	Medium; called buttonwood and sycamore. Bed-steads, musical instruments, etc.
Plane (Oriental)	Platanus orientalis	Asia	Medium. Joinery, cabinet-work, turnery.
Plane or sycamore	Acer pseudo-platanus	Britain, etc.	Soft. Wooden dishes, carving generally.
Plum	Prunus domestica	Britain, etc.	Soft. Turnery, ornamental work, small cabinet-wares.
Poon-wood	Calophyllum angustifolia	India	Planks for shipbuilding and spars.
Poplar	Populus alba, etc.	Europe and Asia	Medium. Furniture, carving, turnery, etc.
Poplar (white, tulip-tree)	Liriodendron tulipifera	Eastern U. S.	Medium. Building, furniture, paper.
Porcupine-wood	Cocos nucifera	Tropical climes	An ornamental wood: takes a good polish.
Purple-heart	Copaifera pubiflora	Brazil	Hard. Furniture, beds for mortars, etc.
Quassia		Tropical America	Medicinal.
Ratans	Calamus rotang	Tropical climes	A cane. Brooms, plaiting, lashing, etc.
Red sanders	Pterocarpus santalinus	India	Dyeing and turning. Called also ruby-wood
Redwood	Sequoia gigantea	California	Various.
Rhododendron	Rhododendron (various)	Himalaya	Hard. Close-grained; takes a good polish.
Rosewood	Dalbergia (?)	Brazil, C. Am., Ind.	Moderately hard. Pianos, furniture, turnery, etc.
Rosewood (African)	Pterocarpus erinaceus, etc	Gambia	Hard. Pianos, furniture, turnery, etc.
Rosewood (Tasmanian)	Acacia (?)	Tasmania, etc.	Hard. Ornamental furniture, turnery, etc.
Sandal-wood	Santalum album	India	Soft, fragrant. Fancy boxes, etc., and carving. Colors, white, yellow, and red.
Sapan-wood	Cæsalpina sapan	India	Dyeing, turning.
Sassafras	Atherosperma moschata	Tasmania	Hard. Flooring of houses, carpenter's bench-screws.
Sassafras	Sassafras officinalis	America	Turning, cabinet-work, and in medicine.
Satin-wood	Chloroxylon swientenia	E. Indies	Ornamental cabinet-ware, beautifully marked.
Saul or sâl	Shorea robusta	E. Indies	Hard. Carpentry.
Scotch fir	Pinus sylvestris	Scotland, etc.	Medium. Affords the yellow *deal* used in England.
Service-tree	Amelanchier canadensis	Eastern U. S.	Red, hard, and lasting. Tool-handles, etc.
She-oak	Casuarina quadrivalvis	Tasmania	Hard. Cabinet-work, chairs, picture-frames, etc.
Silver-wood	Leucadendron argenteum	Cape of Good Hope	Hard, beautifully marked. Furniture, cabinet-work.
Sissoo	Dalbergia sissoo	India	Hard. Shipbuilding, etc.
Snake-wood		W. Indies and S. America	Walking-sticks, etc. Also known as *leopard*-wood and *letter*-wood. Beautifully variegated.
Spindle-tree	Euonymus europæus	Britain, etc.	Soft. Skewers, etc.
Spruce (black)	Abies douglassii	Sierra Nevada.	
Spruce (Engelmann's)	Abies engelmanni	Rocky Mountains.	
Stringy bark	Eucalyptus fabrorum	Australia	Hard. Building, carpentry, etc.
Sycamore	Acer pseudo-platanus	Temperate climes	Soft. Wooden platters, turnery, carving, etc.

Name of Tree.	Botanical Name.	Native Place, or where chiefly grown.	Qualities, Uses, etc.
Sycamore............	Platanus occidentalis...	Eastern U. S.	Hard, white, coarse. Turnery, furniture.
Sycamore (Fig)......	Ficus sycomorus	Egypt...........	Light. Cases for mummies in ancient times.
Tamarac (Am. larch).	Larix americana	N. and N. E. States.	
Teak (African).......	Oldfieldia africana......	W. Africa........	Hard. Railway-carriages, shipbuilding, etc.
Teak (Indian).......	Tectona grandis........	India	Hard. Railway-carriages, shipbuilding.
Thorn	Cratægus punctata.....	Eastern U. S.	Hard, light-red. Turnery.
Toon-wood	Cedrela toona..........	India	Furniture and cabinet-work.
Toqua	....	Himalaya	Dark-colored; takes fine polish.
Tulip-wood	Harpulia pendula......	Australia, etc.	Hard. Veneers, cabinet-work, turnery, etc.
Turtle-wood	....	Surinam	Turnery.
Vegetable ivory	Phytelephas macrocarpa	C. America, etc. ..	A nut used in turnery.
Walnut (black)......	Juglans nigra..........	Eastern U. S.	Medium, dark. Furniture, ornaments, gun-stocks.
Walnut (English)....	Juglans regia..........	Europe, etc.......	Hard. Furniture, gun-stocks, etc.
Walnut (French)....	....	Persia, Asia Minor, etc.......	*French* is a misnomer. Called in England *Circassian* walnut.
Walnut (white) (butternut)..........	Juglans cinerea........	Eastern U. S.	Soft, pale brown. Furniture.
White-wood.........	Pittosporum bicolor, etc.	N. S. Wales, etc...	Hard; resembles box. Wood-engraver's blocks.
Willow.............	Salix (various).........	Europe and Am'ca	Soft. Wooden shoes, pegs, spoons, baskets, plait, hoops.
Yacca-wood	....	Jamaica..........	Cabinet and marquetry work and turning.
Yew	Taxus baccata	Britain, etc.......	Hard. Furniture, turnery, walking-sticks, etc.
Yew	Taxus brevifolia	Cal. and Oregon ..	Hard, red.
Zebra-wood	....	Brazil...........	Cabinet-work, brushes, etc.

Wood, Ar-ti-fi'cial. A composition which is plastic when warm or wet (as the case may be), but hardens into a material resembling or having the uses of wood.

The materials are usually selected from among the following: —

Paper, paper-pulp, glue, flour, sawdust, hemp, shavings, ivory and bone dust, albumen, resins, gums, metallic oxides, drying-oils, gelatine, sulphur, caoutchouc, gun-cotton, gutta-percha, mineral salts.

The means used are pulping or other means of incorporation; pressure in molds, baking, etc., according to material.

The purposes are moldings, veneers, parquetry, the usual uses of horn, ivory, hard rubber, bone, etc.

English patents from 1772 to 1865: —

Nos. 1,011, of 1772, Whittock and Hodgson. Composition for carving, casting, or modeling, composed of cartridge-paper, glue, wheat-flour, beech-tree sawdust, and hemp.

1,573, of 1854, Hitchins and Batley. Shavings of wood, ivory, and bone, combined with glue, and perfumes added, forming a plastic mass which may be molded by pressure.

2,232, of 1855, F. C. Lepage. Mixture of sawdust and albumen, gelatine, or size, with vegetable, animal, or metallic powders.

2,359, of 1855, A. Parkes. 1. Oils are treated with chloride of sulphur solution, converting them into a substance resembling vulcanized rubber, which may be combined with caoutchouc.

2. To a solution of gun cotton are added gums, resins, india-rubber or gutta-percha, animal substances, as phosphates of ammonia or magnesia, oxide of cadmium, perchloride of mercury, oxide of tin, alum, etc.

518, of 1858, John C. Martin. Any fibrous substance of which paper may be made, resin, soda or potash, glue, a drying oil, and sugar of lead.

No. 112, of 1861, C. Stevens. Wood-shavings are treated with caustic lye, rendering the fibers separable. The mass is then fermented, and the resulting paste may be molded into any desired shape.

No. 2,680, of 1864, A. H. A. Durant. Hemp or other fiber is combined with papier-maché.

Wood-bend'ing Ma-chine'. Wood is bent for many purposes: ship-timbers, furniture, plows, and other tools of agriculture, sleigh-runners, carriage-bows and wheel-rims, hoops, staves, etc.

The Vienna bent-wood furniture is very elegant and light, and the Gardner chair-seats of bent and perforated veneers are both strong and well-looking.

The use of heat as an agent in bending wood was known to the ancients. In the "Argonautics" of Valerius Flaccus, we read of the building of the renowned ship "Argo." The passage has been rendered thus: —

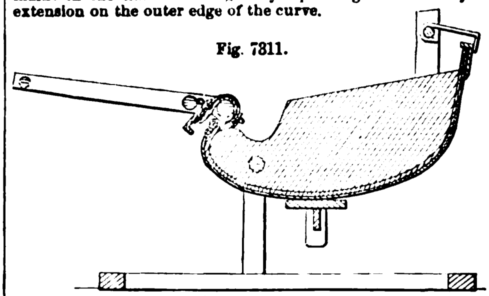
"The bustling throng of men, and groves he sees
Hewn down, and axes sounding through the shores;
With the thin saw how Tiphys slits the pine,
And joins the sides, he views: *how stubborn beams*
Relent and soften to the suppling fire."
Book I., verse 125.

Theocritus, the Greek poet, describes the chariot-maker bending a heated wooden tire to form "the circumference of a chariot-wheel." The wood is described to be that of a wild fig-tree. The Egyptians also bent their tires.

It is found that while the compression of the fibers of wood in bending but slightly impairs their strength, the effect of stretching is to permanently weaken them. By placing the piece of wood in an iron frame which prevents any elongation and causes the whole bending to take place by compression, the piece is not rendered sensibly weaker.

Many of the patented improvements are to enable the wood to be so clamped as to prevent cracking or checking, and to maintain the natural strength by repressing the tendency to extension on the outer edge of the curve.

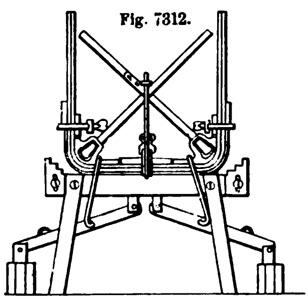
Fig. 7311.



Sleigh-Runner Bender.

Fig. 7311 is a means for bending sleigh bodies or runners. The flexible metallic band binds the strip upon the *former*, and has an eye on its end through which the strip is passed to be grasped by the clasp on the roller, which forms the front curve of the runner.

Fig. 7312.

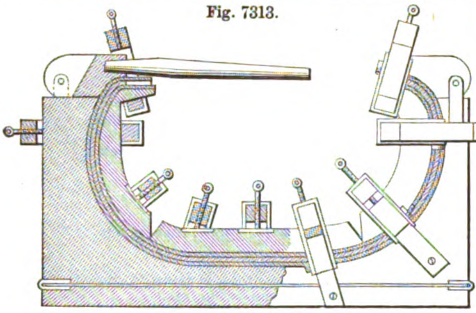


Carriage-Bow Bender.

Fig. 7312 is a carriage-bow bender. The strips are supported, when the bending begins, by the flexible plate that presses the strips against the *formers* to prevent their being abruptly bent and broken.

Fig. 7313 is to bend the front of pianos, when built up of thin sheets of wood and veneered, and it consists of a concave

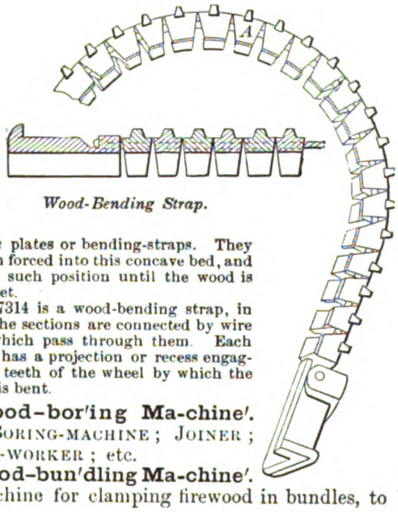
Fig. 7313.



Piano-Front Bender.

bed, having the form of the front and corners of piano-frames, in which the thin sheets that form the frame are glued together and veneered on the two sides, and held between heated

Fig 7314.



Wood-Bending Strap.

metallic plates or bending-straps. They are then forced into this concave bed, and held in such position until the wood is firmly set.

Fig. 7314 is a wood-bending strap, in which the sections are connected by wire ropes which pass through them. Each section has a projection or recess engaging the teeth of the wheel by which the timber is bent.

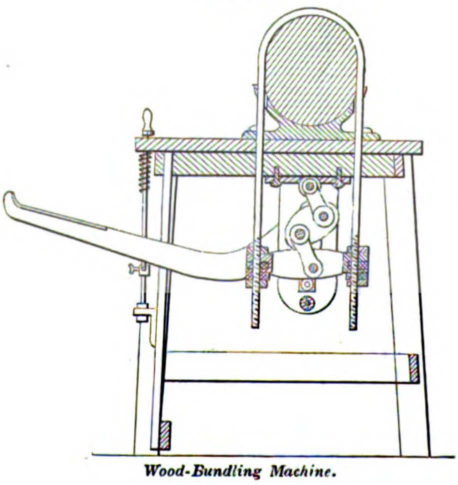
Wood-bor'ing Ma-chine'. See BORING-MACHINE; JOINER; WOOD-WORKER; etc.

Wood-bun'dling Ma-chine'. A machine for clamping firewood in bundles, to be tied.

Such usually have a pair of clamping-jaws which grasp the sheaf of sticks tightly while being tied with wire or string.

Fig. 7315 is a machine in which the lever, by intermediate

Fig. 7315.



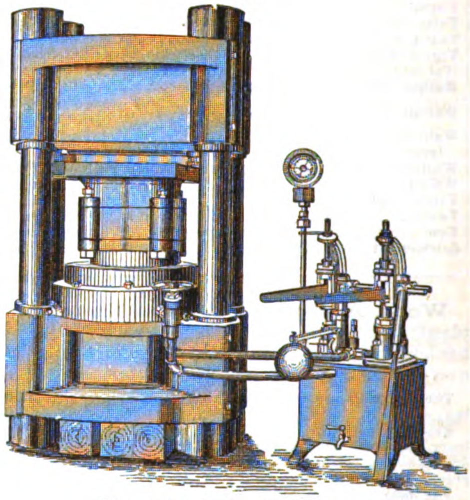
Wood-Bundling Machine.

devices, tightens the gripping bow upon the split wood that lies in a slotted cradle, and holds it firmly for binding.

Wood'bur-y-type. A process of photo-engraving and printing, invented by Mr. Walter Woodbury.

A plate, coated on one side with a solution of bichromate of potash or bichromate of ammonia, in gelatine, is exposed, in contact with a negative, to the light, which, passing through the unshaded portions of the negative, renders certain portions

Fig 7316.



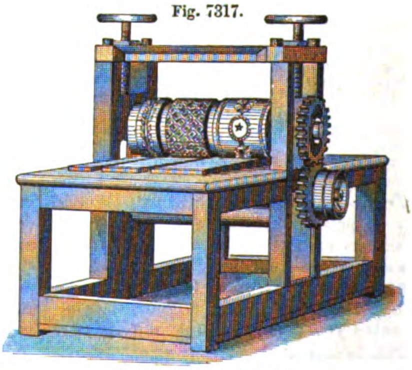
Press used in the Woodbury Process.

of the gelatinous film insoluble, while the other parts remain more or less soluble, in proportion to the intensity of shade in the negative.

The plate is then placed in a bath of warm water, and the soluble portions of the gelatine removed. This leaves the gelatinous film in the condition of a woodcut, the shades being in relief and the lights in intaglio.

It is, after becoming dry and hard, placed in a hydraulic press (Fig. 7316), covered with a plate of type-metal, and subjected to a powerful pressure, which gives a reversed impression of the gelatinous film, the lights being in relief and the shades in intaglio, enabling the plate to be printed from after the manner of a copperplate-engraving. In order to bring out the half-tones, a peculiar ink is employed, consisting of gelatine hold-

Fig. 7317.



Wood-Carving Machine.

ing coloring-matter in solution, by which the effect of a water-color drawing is produced, the paper absorbing from the plate a quantity of ink proportional to the depth of each depression.

Several printing-presses, of very simple construction, are placed on a revolving-table, which is turned to bring each of them successively to the hand of the operator, who applies the paper and ink, and waits until the same press comes around again to remove the picture, in order to allow the impression time to become fixed.

Wood-car'pet. A floor-covering made of slats or more ornamental shapes, glued or cemented upon a cloth backing. The slats or strips of wood are of different colors, and are arranged to produce all the effects of tessellated floors, mosaic work, etc., and, being about one fourth of an inch in thickness, they will wear many years. They are finished in oil.

Wood-carv'ing Ma-chine'. A machine by which designs and patterns resembling carved work are produced in wood by pressure. The material is passed between a bed-plate and a die-cylinder, on which the required design is cut. See also Fig. 1169, page 492.

Wood'cock-eye. An English name for a snap-hook.

Wood'cut. See WOOD-ENGRAVING.

Wood-em-boss'ing. One form of wood-*carving*, so called, is made by softening and then pressing in molds; another is a burning process. See Braithwaite's, mentioned on page 492.

In a Parisian process known as Xyloplasty, the wood is softened by steam, and imbued with certain ingredients, which impart to it sufficient ductility to enable it to receive bas-relief impressions from four to five millimetres in hight. For medallions, bosses, etc., mastic is forced into the hollows, so that all tendency in the compressed wood to split or open is completely overcome. For book-binding purposes much seems to be expected from this process, as it is applicable to the scented or odoriferous woods — cedar, teak, cypress, rosewood, etc. — which repel worms.

Wood'en Brick. A brick-shaped block built into a wall, to afford nail-hold in securing the inside wood-work.

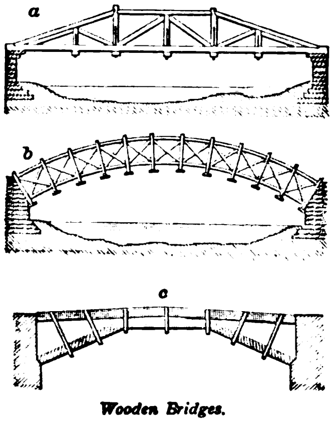
Wood'en Bridge. One altogether of wood, or a wooden frame resting upon masonry piers.

The bridge across the Euphrates, at Babylon, described by Herodotus as built by Nitocris, consisted of wooden spans supported on stone piers. The latter were constructed during a temporary deviation of the river into a vast basin excavated to form a lake. (HERODOTUS, I. 186.)

The bridge across the Tiber, the Pons Sublicius, was made of wooden beams, as its name indicates. It was built by Ancus Martius when he united the Janiculum to the city of Rome, and is renowned as the scene of the exploit of Horatius, when Rome was attacked by "Lars Porsenna of Clusium." It was still a wooden bridge in the time of Augustus, and was carried away by a flood in the time of Otho. It was situated at the foot of the Aventine mount.

Cæsar's bridge, over the Rhine, 55 B. C., was of wood, built upon piles (Fig. 924, *a*). Cæsar tells us that two timbers, 18 inches square, and pointed at their lower ends, were sunk into the river, and afterward driven 2 feet distant from each other by machines; these piles were slightly inclined; two others were driven opposite to them, at a distance of 40 feet, inclining in the contrary direction; the two pairs were connected at the top by a transverse beam 2 feet thick, and over these were laid joists in the direction of the breadth of the river, which were covered with hurdles, to sustain the road. On the down-stream side inclined piles were driven, to support the bridge against the force of the current; and above the bridge were

Fig. 7318.



Wooden Bridges.

others, to protect it from injury against floating objects. It was completed in ten days.

The bridge of Trajan, across the Danube, had 22 wooden arches and 23 piers. It was 3,010 feet long and 48 feet high. It was destroyed by Hadrian, professedly to prevent incursions of the barbarians on the north of the Danube, but possibly to remove a great work which dwarfed his own memorials. He also put to death the architect, Artemidorus. See Fig. 924, *b*, page 379.

In small wooden bridges the pieces running from pier to pier are called *sleepers*, or *string-pieces*. These support the *cross-joists*, on which the *planking* is laid. Caps on the pier-posts, to shorten the bearing of the sleepers, are called *bolsters*.

The wooden bridges of the Middle Ages were generally supported upon piers composed of one or more rows of piles, and sufficiently near together to be connected by single timbers of moderate length. This very simple construction did not admit of long spans.

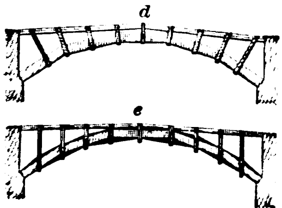
In the works of Palladio we find examples of the truss. Fig. 7318, *a*, shows a bridge of his over the turret of Cismone, near Bassano, having a span of 108 feet. Fig. 7318, *c*, is another bridge, by Palladio, over the Brenta.

A third bridge, by the same architect, on the arch principle, is shown in Fig. 7318, *b*. Each compartment corresponds to a voussoir in a masonry arch.

These constructions enable short timbers to be used for a comparatively long span. The joints, however, cannot be made very strong, and tend to diminish the stability of the structure, so that it sooner gives way under the jarring strains to which it is exposed.

Fig. 7319, *d*, shows one of the wooden arches, 49 feet in span, over the Thames, at Kingston. This approaches in form the continuous curved rib, which is, however, a more solid construction, being built up of pieces, arranged to break-joints, and bolted together, so as to act as a solid mass (Figs. 312-316). This principle has been adopted in many bridges of consider-

Fig. 7319.



Wooden Bridges.

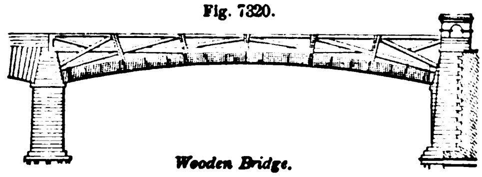
able magnitude, both in Europe and America, among others that over the Regnitz, near Bomberg, designed by Wiebeking, and built in 1809 (*e*, Fig. 7319).

The celebrated wooden bridge over the Rhine, at Schaffhausen, erected in 1757, had a span of 364 feet. A stone pier, the relic of a former structure, existed near the middle of the stream, but it is said that the builder, Ulric Grubenmann, though erecting the bridge directly over this pier, in deference to the timidity of the authorities, apparently using it for a central support, purposely took care that the bridge should not rest upon it. The bridge was destroyed by the French in 1799. Both Ulric Grubenmann and his brother John displayed great skill and boldness in their bridge constructions. John built a timber-bridge at Kirchenaw, 240 feet in length; and the two, conjointly, one near Baden, 200 feet in length, and another, at Wattenghen, 198 feet long.

The two leading forms of modern wooden bridges are the lattice, in which the principle of the truss is employed; and the arched, which derives its strength from the actual compression of the wood, the ends, as in other arched structures, resting upon and pressing against abutments. This is the style of bridge which appears to have been principally employed in Europe; while the lattice, or truss, or some combination of it with the arch, has been very extensively made use of in the United States. One of the best examples of the former, the bridge over the Limmat, in Switzerland, was built shortly after the middle of the eighteenth century, by the Grubenmann brothers; the span of its wooden arch was 390 feet, with a rise or versed sine of 43 feet; this is said to have been the widest span ever formed of timber.

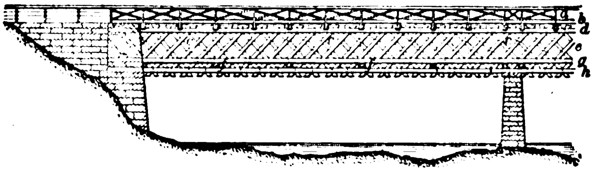
A bridge over the Seine, at Paris, built in 1802, has a span of 104 feet, with a versed sine of but 6 feet 6 inches. The lattice

Fig. 7320.



Wooden Bridge.

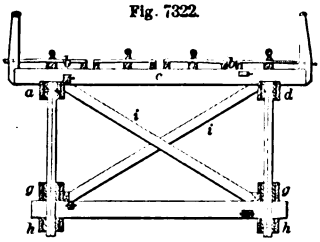
Fig. 7821.



Town's Lattice-Truss (Side Elevation).

bridge has generally, in practice, where great strength and rigidity are required, been combined with the arch, though examples of smaller structures more especially, in which the whole weight of the bridge and its load are borne by the truss, are extremely common. The widest single-span wooden bridge ever built in the United States is believed to have been that over

Fig. 7322.



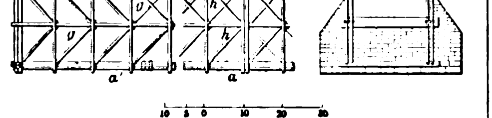
Town's Lattice-Bridge (End Elevation).

the Schuylkill, at Fairmount, destroyed by fire in 1838. It had a span of 340 feet.

Among the various forms of bridge-truss employed in the United States may be cited those of Town, Long, Burr, Howe, and McCallum.

Town's lattice-truss (Fig. 7321) has been employed for spans up to 150 feet. The roadway *a* rests upon sleepers *b*, which

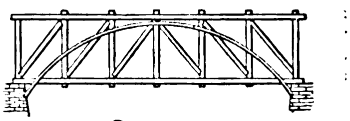
Fig. 7323.



Long's Wooden Bridge.

are supported on the transverse beams *c*; these rest on the stringers *d d*, secured by tree-nails to the lattice-ribs *e e*, at their upper crossings. Lower cross-beams *f*, and two lines of stringers *g h*, one above and the other below the cross-beams, and

Fig. 7324.



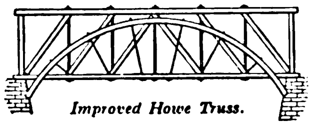
Burr Truss.

diagonal braces *i i*, with some auxiliary pieces, complete the framing.

The depth of the lattice-work is proportioned to the width of the span. In that illustrated, the span is 78 feet, the depth 9 feet 6 inches. Fig. 7321 is a side and Fig. 7322 an end elevation.

Long's (Fig 7323) has been employed for spans of 150 feet. The example is 110 feet, with a depth of 15 feet. *a a'* are the

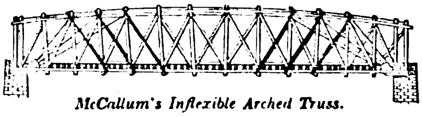
Fig. 7325.



Improved Howe Truss.

longitudinal stringers, supporting the roadway, *b b* the posts, *c c* main braces, *d d* counter-braces. The frames are connected at top and bottom by cross-beams *e f*, the latter supporting the roadway. Diagonal braces, marked *g* at top and *h h* at bottom, serve to stiffen the framework laterally. *A* is an elevation; *B* a plan of the top, and *C* of the bottom of the frame. The posts and braces are secured to the stringers by wedges, so that the

Fig. 7326.



McCallum's Inflexible Arched Truss.

joints may be readily tightened up, and the whole easily put together or taken apart.

The Burr truss (Fig 7324) was extensively used in this country prior to the era of railways. It answered very well on common roads, and where sufficient rise was given to the arch, but, owing to the difficulty of combining the principles of the arch and truss, and the absence of counter-braces, was not found sufficiently enduring for railway travel.

The Howe truss has counter-braces, and vertical iron tension-rods were used instead of posts. Fig. 7325 represents what is known as the improved Howe truss.

McCallum's inflexible arched truss (Fig. 7326) has braces and counter-braces; the spaces between the posts are diminished toward the ends of the spans, and diagonal braces, tending from the piers and abutments toward the middle portion of the upper arched beam, tend to reduce the tension upon the lower chord.

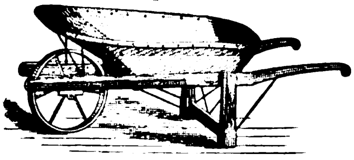
Bridge-building was one of the arts brought to the greatest state of perfection during the late civil war. General McCallum states that the Rappahannock River bridge, 625 feet long and 35 feet high, was rebuilt in nineteen working hours; Potomac Creek bridge, 414 feet long and 82 feet high, in forty working hours; Chattahoochee bridge, 780 feet long and 92 feet high, in four and a half days; that between Tunnel Hill and Resaca, 25 miles of permanent way and 230 feet of bridges, was constructed in seven and a half days; and near Big Shanty 35¼ miles of permanent way and 455 feet of bridges, in thirteen days.

The following are the dimensions of some of the best known timber bridges: —

Name.	River.	Place.	Widest Arch. Span.	Widest Arch. Rise.	Curve.	Architect.	Date.
			Ft.	Ft. In.			
Colopus	Schuylkill	Philadelphia	340	20 0	Segment	Wernwag	1813
Piscataqua	Piscataqua	New Hampshire	250	27 4	Segment	Palmer	1794
Bamberg	Regnitz	Germany	208	17 4	Segment	Wiebeking	1809
Trenton	Delaware	Pennsylvania	200	32 0	Segment	Burr	1804
Writtenghen	Rhine	Switzerland	198	30 10	Segment	Grubenmann	1777
Pont Louis	Iser	Freysingen	154	13 6	Segment	Wiebeking	1809
Ellicott's Mills	Patapsco	Maryland	150	20 0	Lattice	Unknown	1838
Erie Railway	Portage	New York (1,000 ft long)	......	.....	Trestle		....

See also Trestle.

Fig. 7327.



Foundry-Barrow.

Wood'en-frame Bar'row. One with an iron box, for foundry purposes.

Wood-en-grav'ing. Wood-engraving, or the making of woodcuts, differs from plate-engraving in the fact that the design in the former is in cameo, while the latter is in intaglio. It is difficult to assign a date to the invention, as the signets of royalty in ancient times were made upon the same principle, if not with similar tools, upon the same material. The Chinese, as usual, seem to have had the art from a very ancient date. (See PRINTING.) Our friends on the Continent of Europe claim that the manufacture of cards first called woodcuts into existence. It may have suggested the use of the art, and it may have arisen by an original process of thought, but it was certainly long antedated by the ancients and Orientals.

The gravers used in this branch of the art of engraving are more numerous than those in plate-engraving. The same angular-edged gravers are used, together with others much more acute-angled, and farther a variety of tools with flat and rounded bellies of varying widths for cutting tints and for gouging out the intervals. See TINT-TOOL.

Box-wood is used for the best work. Pear and sycamore are in favor for common work. The blocks are sawn *across* the log, so that the section or block stands with the grain vertical during engraving and in the press. The blocks, when their surfaces are finished, are of a thickness exactly equal to the length of a type, with which they are associated in the chase, for printing.

Bewick, born 1753, died 1828, was the restorer of the art, giving grace and graphic effect, where conventional dreariness before existed.

Stereotype or electrotype impressions are obtained from wood by the usual process of molding in plaster of Paris and subsequent casting, or brushing with graphite and electro deposit.

Woodcuts have also been multiplied by molding with warm gutta-percha, and then taking a cast of the same gum, to be used as a woodcut in the printing-press.

Wood'en Leg.

"Inepte, frustra crure ligneo curres." — MARTIAL, X. c. 6.

See LEG, ARTIFICIAL.

Wood'en Pave'ment. See PAVEMENT, pages 1639-1642, and Plate XXXVIII.

The experience of American cities which have used wood-pavement goes to show that some system of preservation is necessary to secure a durable wood-pavement.

If the question of wood-preservation is not finally and perfectly solved, it must be admitted that the methods now in use show a decided progress in that direction. The respective efforts tend to neutralize the external influences of water, air, and heat, by

First. A more or less complete removal of the water and extraction of the aqueous solutions of vegetable matters contained in and between the cells and fibers of the wood. This is done mostly by pneumatic process, in iron air-tight cylinders.

Second. A subsequent injection of fluids under hydrostatic pressure, by means of which permanent chemical combinations are formed. These antiseptic fluids are either diluted *metallic solutions* (impregnation proper) or those *oily substances* obtained from the distillation of tars. The oils, which are obtained at certain temperatures of distillation (varying from 180° to 230° Fah.), are charged with substances (also the product of the distillation) which coagulate all albuminous matter, rendering it insoluble, and, in some degree, fixed. This action penetrates even the cells where this albuminous matter is mostly found. Besides the chemical action of this kind of treatment, it also acts mechanically by repelling water, or at least reducing absorption measurably; and in the Robbins process, if thoroughly carried out, the pores become more or less closed with resinous matters. The following processes have been used, namely: —

1. First class, or impregnation with metallic solutions.

(*a.*) Burnettizing, or impregnation of chloride of zinc.

(*b.*) Samuels's process of impregnation with sulphate of iron.

2. Second class, or injection of oily substances.

(*a.*) The Seeley process; impregnation with creosote, carbolic acid derived from pine tar.

(*b.*) Robbins's process; impregnation with heavy oils charged with creosote, carbolic acid, etc., derived from coal-tar at a higher temperature than by the Seeley process.

Where *ironizing* has been tried, reports from various cities are unfavorable. This stands to reason, since sulphate of iron is well known to have no affinity for the formation of insoluble combinations with the vegetable matters to be neutralized, nor has it hardly any poisonous action on low organisms when applied in diluted solutions. The disengagement of sulphuric acid, in consequence of oxide of iron being fixed upon the fibers, also tends to exercise a destructive influence on the texture of the wood, being so much stronger than the hydrochloric acid that may be liberated by the Burnettizing process. The function of the acids being that of merely conveying metallic oxide, of course the use of the weaker acid is preferable.

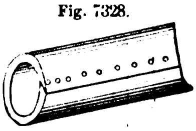
Creosoted wood has, in some cases, proved offensive. It has to be handled with great care by the workmen, as it produces eruptions and sores, and in Belgium its use for preserving telegraph-poles was abandoned on account of this; otherwise it is efficient and lasting. See WOOD, PRESERVATION OF.

Wood'en Pipe.

Wooden pipes (*canules ligni*) were common in ancient Rome in ordinary structures. Lead was used for the superior class of work, in conducting the water of the aqueducts to the fountains and baths. See AQUEDUCT.

Pipes made of elm logs, bored, were used for the mains in the London water-works from 1582, when Morice started the works at London Bridge, down to about 1800. Lead-pipes had previously been used, as early as 1285, in bringing water from the springs of Tyburn to the city, and were also used by Morice for distributing-pipes. When it was determined, about 1800, to replace the wooden mains by cast-iron pipes, the New River Company had 400 miles of wooden mains, which were taken up, and iron substituted, at the rate of twenty miles per annum. The iron mains vary from 1 to 3 feet in diameter.

Fig. 7328.



Lap-Seam Wooden Pipe.

In the plan adopted at Ithaca, N. Y., the pine or other lumber is sawed into lengths of proper thickness, and by peculiar hollow augers, of different sizes, is cut or bored out in concentric tubes or pipes, only leaving at last a small core, a little less than the bore of the smallest pipe. In this way a piece of timber, originally 10 inches in diameter, will *turn out* several pipes of say 10, 8, 6, 4, and 3 inches in outer diameter, and about 1½ inches in thickness, or of greater thickness if required, by decreasing the sizes of the inner tubes proportionately. The hollow auger cuts away only from ⅛ to ¼ of an inch. This piping is then properly strengthened by iron bands, and subjected to a bath of asphaltum or other cement to make it impervious to gas or water, and to prevent decay.

In Brisbane's pipe, the boards are steamed and bent longitudinally in cylindrical form till the edges lap on each other, and are then riveted.

Wood'en Rail'way. The old form of tramway laid down in the English colliery region about two centuries since; at Newcastle, in 1676; Whitehaven, 1738. Subsequently the wooden rail received an iron plate, as with our own early *strap-rail* system; eventually the iron rail was substituted. See RAIL.

As a cheap expedient the wooden rail is being revived in remote situations where wood is very abundant, money scarce, and iron difficult to procure.

A wooden railway on the 4 feet 8½ inch gage has been constructed from the town of Sorel, at the confluence of the Richelieu River with the St. Lawrence, through Drummondville, to Athabaska, province of Quebec. The ties of hemlock and tamarac are brought down on trucks from the woods through which the railway runs; they are put on a rollway, run up to circular saws, so gaged that at one operation they are *gained* the proper depth and distance, for the reception of the rails. As fast as they are cut they are sided by another circular saw. The rails are of maple, four by seven inches, and 14 feet long, the gage of the line being 4 feet 8½ inches. Each rail lies on seven sleepers, to which it is fastened by wedges. The cost of the line, in which cost are included nine stations, car and locomotive depot, engine and repairing shops, engine and tender, two passenger-cars, eight grain-cars, and twenty-five wood-cars, is $5,000 a mile, in full for all but the Yamaska Bridge, which cost $35,000. Land damages, fences, etc., are included, also, in this amount.

Wood'en Screw. A screw of wood; such as is used in the clamping-jaw of a carpenter's bench, or in the clamp of the joiner.

Wood'en Shoe. See SABOT, page 2008.

Wood'en Type. Large type, cut in wood, for posters, etc.

Wood'en Ware. A specific term for vessels, such as bowls, platters, spoons, butter-prints, etc., turned from wood; or, more generally, domestic wooden articles of merchandise.

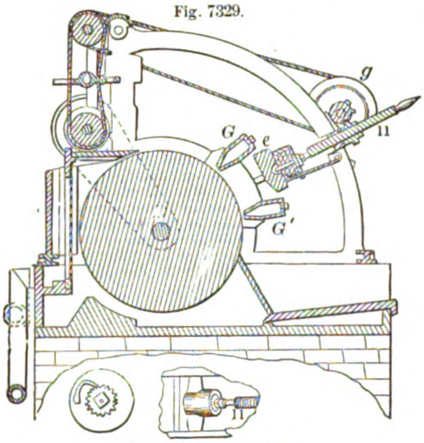
Wood'en Wing. (*Nautical.*) A lee-board.

Wood-gear. Cog-wheels of wood; used sometimes in roughly made cider mills and presses, etc. Also formerly in clocks. Apple, pear, dog, and box wood are good timber for the purpose.

Wood-grind'er. A machine for rasping wooden blocks, to make paper-pulp. See WOOD-PAPER; PULP-GRINDER.

Voelter's machine for grinding paper to pulp has a rasping-mill in which the fibers of wood are torn off and separated from

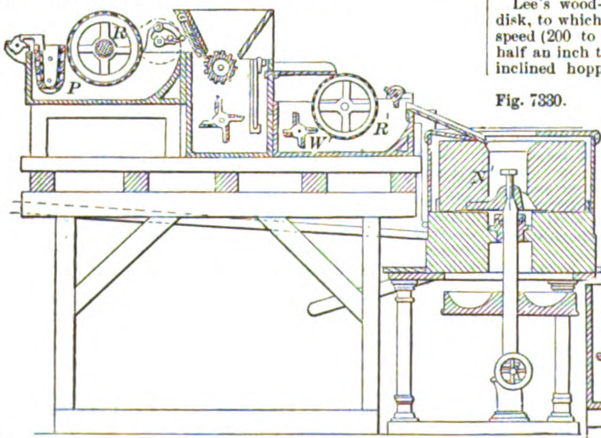
Fig. 7329.

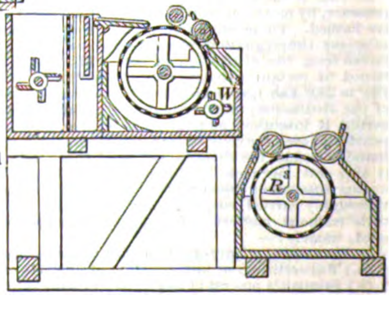


Voelter's Wood-Grinder.

the wooden block by the action of a cylindrical stone against which it is pressed. This stone has a diameter of 48 inches, 16 inches width of face, and makes 150 rotations per minute. Running 24 hours, it will produce 1,000 pounds of pulp per day, the pulp estimated in its air-dry condition, in which it is in the proper state for transportation, but is one half water. The pulp is one half the weight of the wood. Fig. 7329 shows the grinder, and Fig. 7330 the strainer and sorter.

Fig. 7330.





Voelter's Wood-Pulp Strainer and Sorter.

The wood is prepared for the machine by being sawed into lengths of 15 inches, after having been first deprived of its bark and reduced to the diameter of about 5 inches. Knots are removed by boring. Each billet is then placed in a holder G G' adapted to apply it firmly to the stone. Six such holders are attached to the machine (though but one is shown in the cut), and occupy about one quarter of a circumference. The pressure is applied by means of a screw (11) behind each follower e, which is very gradually driven by the machine itself. A single band acts at once upon all these screws by intermediate mechanism; and in case the several billets are not ground off with equal rapidity, the proper adjustment effects itself by the slipping of the band g.

The stone is inclosed in an iron box, and water flowing in constantly at the top removes the disintegrated fibers as fast as they are produced. From the mill, the comminuted mass is carried along, in suspension in water, into the first tank P, in which there is a cylindrical strainer R, formed of very coarse wire-gauze, constantly in revolution. The discharge from this tank takes place from the axis of this strainer, which is made large and tubular for the purpose. The flow is, therefore, from the exterior to the interior, through the meshes of the strainer; and the slivers and coarser fragments of the wood, being thus prevented from passing, are from time to time removed. The water, with the available portion of the fiber, is discharged through a lateral duct into a second tank W^1 at a lower level, where it undergoes a straining similar to the preceding, but through a gauze considerably finer. The process is repeated until the pulp has undergone four successive strainings, when the material is passed into a fourth tank, in which the strainer R^3 is so fine as to allow the water only to pass. Between the second W^1 and third W^3 of these straining-tanks is a grinder N', which reduces the coarser fragments detained by the second drum R^1. The 3d and 4th cylinder strainers constitute a sorting-apparatus, and furnish pulp of successive degrees of fineness.

The preferable woods for this purpose are pine, fir, poplar, linn (linden or bass), birch, perhaps about in the order named; the latter, together with beech, being used much in France and Belgium, where these trees abound. Poplar is principally used in the United States and makes a whiter pulp than fir.

Fig. 7331 is Marx's apparatus, in which several boxes are arranged around the periphery of the rough-faced revolving grindstone, and in each blocks of wood are forced edgewise against the grinding surface, by followers actuated by gearing and weights, while a stream of clear water is poured upon the surface. The pulpy result is sorted by a series of sieves, and discharged into different receptacles, according to quality.

See also Fig. 4018.

In Fig. 7332, the blocks of wood are held against the grindstone by a series of chains, partially surrounding the blocks, and kept tense by a pendent weight. After being coarsely ground, the wood particles pass between the lower surface of the same grindstone and a stationary stone, and are thus comminuted.

Fig. 7333 is Negri's machine for reducing wood to fiber for the formation of paper pulp. It consists of a casing a having a hollow cylinder b eccentrically journaled therein, and rotated by belt and pulley. The cylinder b has a series of peripheral slots in which cutters are fixed, leaving sufficient spaces for the shavings, as they are detached, to pass into the interior. The blocks of wood are fed into the mouth c, and, by the rotation of the cutting-cylinder, are carried around the winding tapering passage c c until they are entirely reduced to fine cuttings. See PULP-GRINDER, Figs. 4015-4018. See also PULP-DIGESTER, PULP-DRESSER, etc., pages 1821-1825.

Lee's wood-cutter (English) consists of a massive cast-iron disk, to which a knife is secured, which, revolving at a great speed (200 to 300 revolutions per minute), slices off sections, half an inch thick, from the ends of stout timber balks into an inclined hopper. Suitable rolls feed the wood up to the face of the disk, and a pair of horizontal rolls, revolving at different speeds, receive the slices as they drop from the knife, and disintegrate the curved cross-sectioned slices. This is so thoroughly done, that a log of timber 14 inches square, under the action of knife and rolls, drops out in bits ½ inch square by ¼ inch thick, with jagged surfaces which make every particle amenable to the strong chemical agents.

See also Burghardt's machine, Fig. 4019.

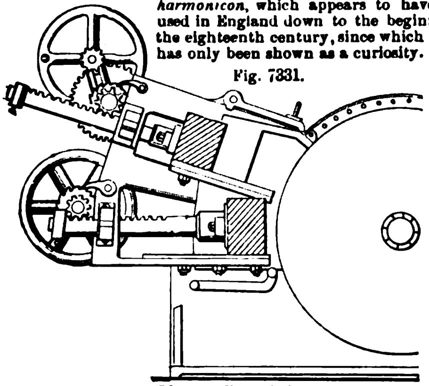
Kingsland's machine, Fig. 4015; Jones's, Fig 4016; Sellers's, Fig 4014; and that shown in Fig. 4017, are for acting upon material partially reduced.

Wood-hang'ing. Thin veneer on a paper backing, to be used as wall-paper.

Wood-har-mon'i-con. (*Music.*) The instrument with bars of sonorous wood is shown in Plate CIII., Bonanni's "Istromenti Armonici," Roma, 1776.

The name *regal*, besides being formerly applied to a small keyed instrument of the organ class, was also used to denote a *wood-harmonicon*, which appears to have been used in England down to the beginning of the eighteenth century, since which time it has only been shown as a curiosity.

Fig. 7331.

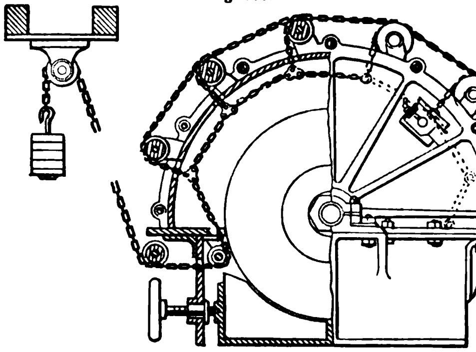


Marx's Wood-Grinder.

The resonant powers of some kinds of wood are well understood among the Orientals. Besides the batons, castanets, and *bones* (so called), are instruments in which bars of different sizes are arranged and tuned in octaves like the stone-harmonicon (see LAPIDEON) and the glass-harmonium (see HARMONICA; DULCIMER).

Fig. 7334 shows a Burmese wood-harmonicon described by Captain Yule in his "Mission to Ava." It is well known

Fig. 7332.



Marx's Apparatus for Reducing Wood to Paper-Pulp.

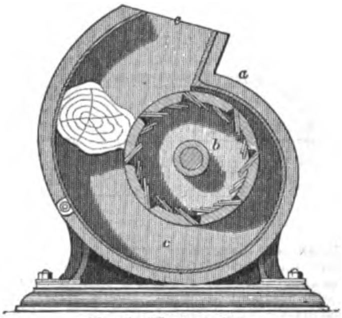
through the East Indian Archipelago, though it has not been noticed in Hindostan. Something like it is also used by the negroes in Brazil. In the upper figure, 18 to 24 flat slips of bamboo, about 1½ inches broad and of graduated length, are suspended in a catenary over the mouth of a trough-like sounding-box. The round outside of the bamboo is uppermost, and while the extremities of the bamboo are left of their original thickness, the middle part of each is thinned and hollowed out below; by this thinning and the proportioning of the length, the bars are tuned. The instrument is played with two drumsticks, like the familiar little glass dulcimer.

A similar instrument in which slips of iron or steel were substituted for the wooden bars was to be seen at the capital of Burmah, and was said to have been made by King Tharawadee himself, a monarch who, like Louis XVI., cared more for iron work than regal honors.

The lower figure shows a Burmese guitar of three strings in a frame shaped like an alligator and receiving its name from thence. It is laid on the ground before the performer.

The *fang-hiang*, or wood-harmonicon of the Chinese, had 16 slabs of an oblong shape suspended in a wooden frame. The

Fig. 7333.



Negri's Wood-Grinder.

slabs were arranged in two tiers one above another, and were of equal length and width, but different thickness.

The *king*, or stone-harmonicon, of the Chinese is composed of slabs of sonorous stone, and is said to have greatly charmed Kung-fu-tse, 500 B. C. The *yu* is the favorite stone, and is probably an agate. The *pien-king* is a modern form, and is tuned in intervals called *lu*, twelve in the compass of an octave.

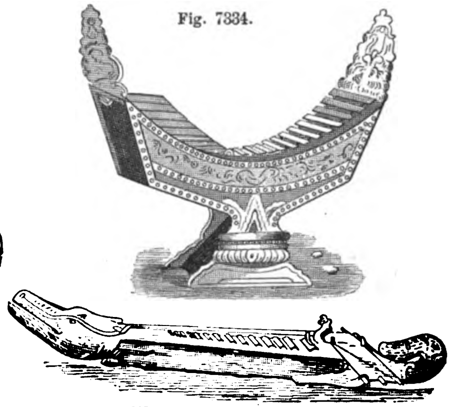
The stones are suspended by strings and tuned by chipping or grinding to a size or thickness. Such were used among the Peruvians before the conquest. Also used in Central Africa and Angola.

Wood-lock. (*Nautical.*) Blocks in the scores of the stern-post to keep the rudder from lifting off its bearings.

Wood-pa'per. Paper made of wood reduced to a pulp by mechanical or chemical means; more usually by a combination of the two.

Oriolli's plan was to treat the wood with a [dilute ?] mixture of hydrochloric acid, 80; nitric acid, 20 parts, for 24 hours; in stone reservoirs. Wash; press in a mortar; wash; neutralize the acid by a 10 per cent soda lye; bleach with 10 per cent

Fig. 7334.



Wood-Harmonicon.

chloride-of-lime bath. The difficulty of providing reservoirs and the unhealthiness of the fumes were unsurmounted difficulties, and the process is principally interesting as leading to effective methods which followed.

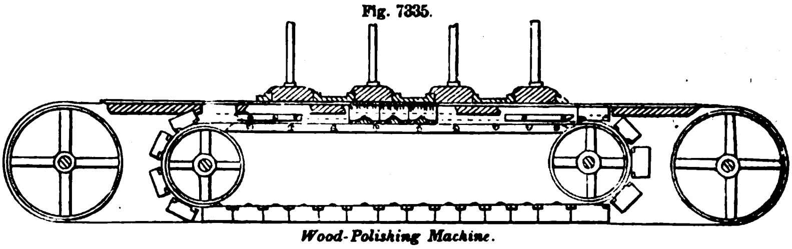
In the chemical treatment of wood for paper, solutions of the fixed alkalies at high pressure and at 300° Fah. are employed. Or a strong solution of hydrochloric acid, to which a small quantity of nitric acid has been added. Or a dilute solution of hydrochloric acid at a boiling temperature, followed by washing, draining, grinding, digesting in a solution of ammonia, and bleaching by chloride of lime.

Bachet and Machard's process is to digest the billets of wood in a boiling solution of hydrochloric acid, withdraw the liquid, saturate with carbonate of lime, ferment and distill; this utilizes the substances which incrust the fibers of wood. The wood is then crushed, strained, and made into paper, which is rolled on mandrels and partially bleached by exposure to chlorine gas, or fully so by treatment with lime-water, carbonate of soda, and chloride of lime, successively.

In Lee's process (English) the wooden chips are digested in a solution of caustic soda at 220° Fah.

Koop's English patent, 1802, describes the use of straw, hay,

Fig. 7335.



Wood-Polishing Machine.

thistles, hemp, and flax refuse, wood, and bark, for making printing and other paper. He digested the materials in a solution of quicklime and river-water, and then macerated for several days with frequent agitation; then washed. This was repeated; the mass was then treated with soda or potash. Fermentation was sometimes allowed to assist in the disintegration of the fiber. The plant stuff was cut by machinery to a length of two inches; wood was reduced to shavings before treatment.

The process pursued at the Manyunk mills, Philadelphia, is about as follows: —

The poplar-wood is made into chips by choppers, which reduce from 35 to 40 cords of wood per day. The chips are carried by elevators to the boilers, where they are digested in alkali for five or six hours. The mass is dropped from the boilers in vats and lixiviated with water to remove the chemicals. Ten of these boilers turn out 300,000 pounds per day. The pulp is then bleached, diluted with water to make it work in the cylinder paper-machine, which brings it into convenient transportable form. These sheets of dried pulp are taken to other mills and mixed with cotton pulp or straw, in such proportions as may be required for the purpose intended, — book or newspaper work.

See PULP-BOILERS, Figs. 4008 - 4013; PULP-DRESSER, Fig. 4014; PULP-GRINDER, Figs. 4015 - 4019. See also WOOD-GRINDER.

In the manufacture of paper from bamboo, early in the month of June the canes are cut into pieces from 5 to 7 feet long, and placed in a pit which is supplied with water. After soaking for several weeks, the canes are beaten with mallets, in order to remove the thick bark and green skin. The remaining filaments, resembling a fine sort of hemp, are treated with lime and water, raised to a certain temperature. After remaining in this bath for about a week, the filaments are removed, washed with cold water, passed through a lye made of wood-ashes, and then placed in a boiler. This process is repeated until the material begins to grow putrid, when it is transferred to a mortar and pounded into pulp, by means of water-power, after which the mass is treated with bleaching-powder. The pulp thus prepared is made by hand into sheets of various thickness, by means of a web of silk tissue within a light frame, on to which the workman places the required quantity of pulp. When the water has run off from the corners of the frame, he turns the sheet over on to a large table, when it is pressed. Each sheet is afterward raised and dried separately in a kiln built for that purpose.

Writing-paper is made from the finest part of the bamboo material. Another kind is made by mixing rice-straw with the bamboo fiber. A very strong paper, used for window-blinds and other articles, which, in this country, are generally constructed of woven substances, is made by mixing 60 per cent of the bark of a tree called *tchou* with 40 per cent of bamboo material. Another variety of strong paper is obtained from the bark of the *Morus papyrifera*, a paper mulberry. The same material, made from thinner pulp, is employed in the manufacture of umbrellas, fans, and fire-screens. Bark-paper, which is to be printed, is first passed through a solution of alum-water, to destroy the fine filaments which are commonly found on the upper side of the sheet as it lies in the silk tissue-frame; the lower side in contact with the tissue being much more smooth. For many uses, when only one color is required, the coloring material is added to the pulp. See also page 1606.

Paper is made in Siam from the root of a tree called the *ton koy*, four or five feet in length, and sold in bundles of 10,000 pieces for 25 cents. The roots are first soaked in fresh water, and then transferred to tanks with lime-water, where they are left for several days. They are then boiled in a peculiarly constructed pan, the lower part of which, exposed to the fire, is made of sheet-iron, while the upper part is of basket-work. After being well steamed in these vessels, it is taken out in small quantities and thoroughly hammered on a table. After this process a bundle of the fiber is thoroughly agitated in water until small feathery clumps swim about in the tub. The contents of the tub are poured through a sieve and the fiber caught on the meshes in tolerably uniform thickness. This uniformity is farther aided by rolling bamboo over it, and the sieve is then exposed to the sun until the mass is thoroughly dry. The sheets of paper prepared in this way depend in size upon the sieves. They are sometimes ½ yard wide and 2½ yards long. Two workmen can make twenty sheets in a day. No sizing is used, as the gelatine of the root is sufficient for that purpose. A better sort of paper is sold in sheets 12 to 18 inches long, and 4 to 5 inches wide. Writing is done with charcoal, or with pencils prepared of coal and lime.

Wood-plan'ing Ma-chine'. Bramah's English patent, 1802.

The planing-machine for wood long preceded that for metal. General Bentham's reciprocating planing-machine was invented in 1791; Bramah's transverse planer, in 1802. See PLANING-MACHINE, pages 1728, 1729.

Wood-pol'ish-ing Ma-chine'. Fig. 7335 shows a machine for polishing pencils, which are placed on an endless apron, that runs over a table. The ends of the pencils enter guide-notches in the blocks of an inner endless apron, running at a different speed from the former apron, so as to cause rotation in the pencils as they are carried forward beneath the polishing-blocks, which are reciprocated transversely as to the machine and lengthwise of the pencils. The blocks are coated with sand-paper of various degrees of fineness and depressed by springs.

Wood, Pres-er-va'tion of. Seasoned timber is but little liable to decay under the influence of a dry atmosphere, and will resist decomposition for an indefinite period, when kept totally submerged in the water. The piles of old London Bridge, driven 800 years before, were found to be in good condition when the new bridge was erected in 1829, and those which served as the foundation for Trajan's bridge over the Danube, A. D. 105, are said to be still visible at low stages of water.

Probably the oldest timber in the world which has been subjected to the use of man is that which is found in the ancient temples of Egypt. It is found as dowel-pins, in connection with stone-work which is known to be at least 4,000 years old. These dowels appear to be of tamarisk, or chittim-wood, of which the ark is said to have been constructed, — a sacred tree in ancient Egypt, and now very rarely found in the valley of the Nile.

When exposed to the combined action of heat, air, and moisture, however, the best seasoned and most durable timber soon decays, its albuminous matters becoming decomposed and evolving ammoniacal gases; the fibrous portions are then readily disintegrated. To remedy this it is necessary that the albumen should be coagulated, and that antiseptics should be introduced into the pores to replace those which the vital force of the wood itself eliminates from the earth and air while in a living state.

The processes of painting, or coating and carbonizing the exterior, to prevent access of air and moisture, have been known from the earliest ages; these, however useful they may be for many purposes, tend but to palliate the evil, and somewhat postpone the period of decay.

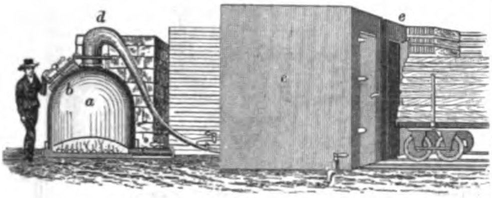
The methods, besides these, employed at present may be divided into two principal classes, — those in which the wood is saturated with the preservative material by immersion, and those in which the material is forced into the pores in a vaporiform state. The first of these processes appears to date back no farther than the last century; the latter is of still more recent introduction.

As early as 1740, Fagol, a Frenchman, experimented with solutions of alum, sulphate of iron, and other substances, in which he immersed the wood for several days.

In 1756, Haller recommended the use of vegetable oil for this purpose. Jackson, in 1767, proposed to employ a solution of sea-salt, to which sulphate of iron and magnesia, alum, lime, and potash, were to be added. Pallas, 1779, proposed to mineralize wood by immersion first in solution of copperas and afterward in milk of lime.

Dr. Hales recommended steeping in solution of sulphate of copper (blue vitriol), and coating with oil of tar; for which Dr. Fordyce substituted sulphate of iron; this was tried with good

Fig. 7336.



Apparatus for Preserving Wood.

results in the West Indies. Colonel Congreve, in 1784, proposed coating with creosote.

Sir Samuel Bentham, among his other numerous inventions, patented a method of exhausting air from the pores, and then forcing in chemical agents.

Sir Humphry Davy suggested a solution of corrosive sublimate; this was subsequently used in the process of Kyan.

Other modes of treatment, as burying the timber in hot sand, steaming, and the application of water-proof coating of various kinds, were also tried with more or less success.

The processes and materials employed or proposed have been very numerous, and have formed the subject of many patents.

Among the substances which have at various times been the subject of patents are: —

Acetate of copper.	Sulphuric acid.
Sulphate of copper.	Lime-water.
Sulphate of lime.	Potash and lime.
Sulphate of alumina.	Silicate of potash.
Sulphate of soda.	Nitrate of potassa.
Sulphate of iron.	Arsenious acid.
Carbonate of soda.	Corrosive sublimate
Carbonate of potassa.	Oil.
Carbonate of baryta.	Tallow.
Tar.	Rosin.
Creosote.	Petroleum.
Smoke.	Pyrolignite of iron.
Chloride of sodium.	Refuse liquors of chlorine works.
Chloride of zinc.	Mother water of marshes.
Sulphate of magnesia.	Metallic sulphurets, after decomposition by an acid or a metallic salt.
Sulphate of baryta.	
Phosphate of baryta.	
Borax.	

In 1832, Kyan, in England, patented a method of preserving timber by immersing it in a solution of bichloride of mercury (corrosive sublimate): the proportions are varied somewhat, generally about 2 parts of sublimate to 100 of water are employed. Large timbers are placed in air-tight tanks, the air is exhausted, and the solution forced in under pressure.

Margary's process, 1837, consisted in immersing the wood in acetate or sulphate of copper.

Sir William Burnett, 1838, patented a process for saturating wood with a solution containing 1¼ parts of chloride of zinc (white vitriol) to 100 parts water, forced into the pores of the wood, from which the air was exhausted, under a pressure of 125 to 150 pounds per square inch.

Bethel's patent (English, 1838). The wood is impregnated with oil of tar and other bituminous matters, containing creosote, and also with pyrolignite of iron, which holds more creosote in solution than any other watery menstruum. It is placed in close iron tanks, which are filled with the oil of pyrolignite; the air is then exhausted, and afterward more of the impregnating material is forced in, and a pressure of 100 to 150 pounds per square inch maintained for six or seven hours, when the wood will be found to have increased in weight from eight to twelve pounds per cubic foot, and become thoroughly saturated.

Boucherie's process, 1840, is extensively employed in France. It consists in forcing sulphate of copper solution into the pores of the wood under the pressure of its own gravity. The timber is set on end and covered with a water-tight cap, into which the liquid, from a reservoir at a considerable elevation, is conducted by a flexible pipe. The sap is forced out at the lower end, and its place supplied by the solution, which consists of 1 part of the sulphate to 100 parts water.

Chloride of sodium, similarly introduced, renders the wood flexible when seasoned. Earthy chlorides are employed for rendering it incombustible. In a similar way odors, resins, and coloring matters may be introduced.

Baron Champy indicated a method of preserving wood by dipping while green in tallow, at 200° Fah.; the water and gases being expelled, the melted tallow penetrates the pores under atmospheric pressure.

Payen, employing nearly the same process, substituted rosin for tallow.

Chapman's process consisted in a peculiar system of treatment with sulphate of iron.

Phosphate of baryta, formed within the fiber of wood, has been used as a preventive of decay. The wood is to be first steeped in a solution containing 7 per cent of the phosphate of soda. When dry it is again treated with a solution containing 13 per cent of chloride of barium.

Payne, 1842, used sulphate of iron (green copperas).

The wood is introduced into a cylindrical vessel, and steam admitted to expel the air; a portion of the sulphate solution is then injected to condense the steam and form a partial vacuum, which is completed by means of an air-pump. The remainder of the sulphate is allowed to flow in and a force-pump applied, by which it is forced into the pores of the wood. At the end of a few minutes the solution is withdrawn, steam is readmitted, and the wood similarly treated with muriate of lime; the reactions produce sulphate of lime and muriate of iron, which remain within the substance of the wood, rendering it much heavier and harder, and preventing the attacks of insects.

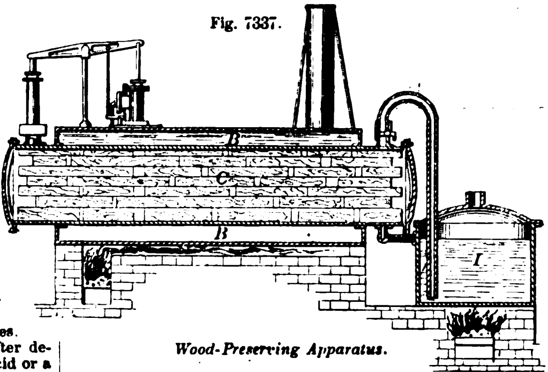
Soaking timber in lime-water has been recommended for preserving it from dry-rot and the effects of the weather; also, superficial carbonization by a gas-flame or the flame of the heavy hydrocarbon oils.

Davis and Symington, in England, introduced a desiccating hot-blast to remove moisture.

Behr's patent embraces the employment of boiling solution of borax.

Szerelmey's patent: 1st, immersing wood in boiling solution of potash and lime, and treating it with cold dilute sulphuric acid;

Fig. 7337.



Wood-Preserving Apparatus.

and, 2d, coating it with compounds of petroleum, asphaltum, lime, zopissa, and sulphuric acid.

L. S. Robbins's method consists in removing the surface-moisture from the wood by heat, and then saturating it with the vapors of coal-tar, rosin, or other oleaginous substances.

Fig. 7336 illustrates a form of the apparatus employed. *a* is the retort in which the oleaginous material is heated; it is provided with a charging and man-hole *b*, a discharge-pipe *c* for removing the residuum left after distillation, and pipes *d* connecting it with the chambers *e e*, where the wood to be treated is placed; these have closely fitting doors, and pipes *f* at bottom for withdrawing condensed liquid.

The timber being placed in the chambers *e e*, and the retort partially filled with coal-tar, a heat of 212° to 250° Fah. is applied: this expels the surface-moisture from the wood, and it condenses within the chambers, whence it may be withdrawn through the pipes *f*. A greater degree of heat, 300° Fah. or upward, is then applied, causing the oleaginous vapors to permeate the wood until it is thoroughly saturated, and has become impervious to moisture.

In Heinemann's process, patented 1868, the wood is first boiled in a weak solution of carbonate of soda or other alkali, or dilute muriatic acid, until the liquid ceases to abstract color from the wood: the nitrogenous matter is thus ascertained to have been removed, and the wood, after drying, may be employed in situations where it will not be subjected to moisture. For railway ties, etc., it is farther treated by heating in close chambers with rosin and water, the combined steam and resinous vapor penetrate the wood, the latter remaining, while the former is expelled by cooling and sudden reheating. When it is desired to render the timber fire-proof, soluble glass may be substituted for the rosin.

Van Der Weyde employs a dilute solution of silicate of potash; after this has dried, one or two coats of a stronger solution of the same are given.

Blythe's process, said to have been employed with good results in France, consists in treating the timber with steam, intermixed with a proportion of hydrocarbon vapor. This softens it so that its form may be altered to a considerable extent by pressure; the form thus given is permanently retained. A gummy substance is formed in the pores, which in time becomes hard.

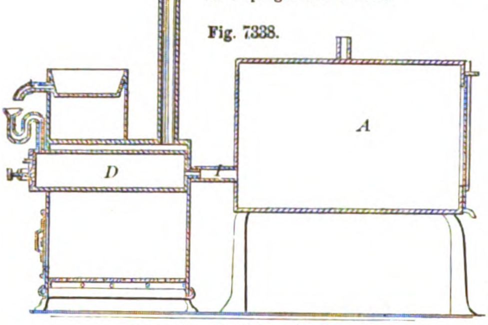
Several forms of apparatus have been devised for impregnating wood with the vapor of tar and other materials.

In Fig. 7337, the cylinder *C*, containing the wood, is within the annular boiler *B*, and is connected at one end with an air-

pump, and at the other with a boiler *I* containing tar, from which the paper is derived.

In Fig 7338, heated air is driven from the generator *D* into the chamber *A*, containing the wood, the vapor escaping from the upper pipe. When the wood is dry, tar is introduced into the generator, and the resulting fumes similarly forced into the chamber impregnate the wood.

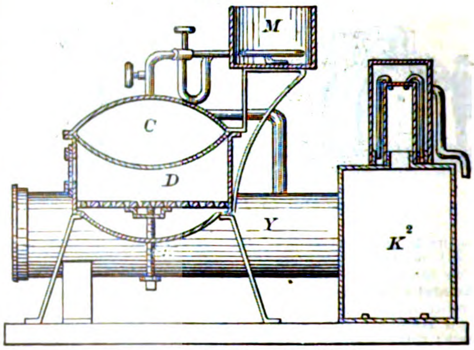
Fig. 7338.



Apparatus for Preserving Wood.

In Fig. 7339, steam and the products of combustion from the fire-chamber *D* are admitted into the chambers *Y* K^2 containing the wood; when the moisture is thus expelled, the wood is subjected to the vapor of oil, carbolic acid, or other antiseptic contained in a tank or tanks *M* and vaporized in the generator *C*.

Fig. 7339.

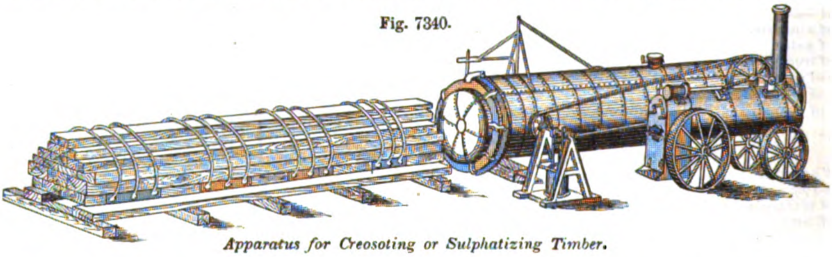


Apparatus for Preserving Wood.

Salt is extensively employed for preserving ship-timber.

Fig. 7340 illustrates an apparatus for preserving timber by one of the above-described or similar processes. The joists, clamped into a pile of proper size, are introduced longitudinally within the cylinder, where they are to be dried and chemically treated.

Fig. 7340.

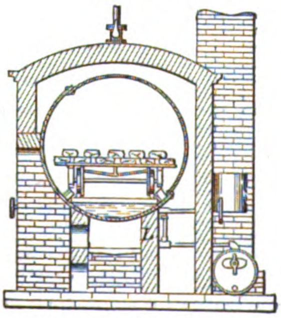


Apparatus for Creosoting or Sulphatizing Timber.

In Voorhees and Custis's apparatus (Fig 7341), the oleaginous or antiseptic vapors are generated in the chamber where the material to be treated is placed. This is surrounded by a cool-air passage, provided with devices for controlling the ingress and egress of the air.

A committee appointed by the Dutch Academy of Sciences to investigate means of protecting timber against the teredo, after a series of experiments, consisting in coating the wood with various substances, as (1) a mixture of tallow, coal-tar, resin, sulphur, and pounded glass, applied warm; (2) paraffine varnish, obtained by dry distillation of peat; (3) coal-tar, alone and mixed with sulphuric acid; (4) paint, composed of linseed-oil, turpentine, chrome green, and verdigris, — reported that none of these materials nor carbonization prevented the ravages of the worm.

Fig. 7341.



Apparatus for Preserving Wood.

Impregnation with sulphates of copper or iron, acetate of lead, and with soluble glass and chloride of calcium, which, by reaction, formed silicate of lime, was found to be ineffectual.

The conclusion was arrived at, that coating with paint, or even metal, affords but temporary protection, as the young teredo will enter through the smallest abrasion. Poisonous salts are not fatal to the animal, as it does not feed upon the ligneous tissue which it perforates, and are liable to be washed out by the water. The density of the wood appears to afford no immunity from its attacks. Oil of creosote seems to be the only effectual preventative; piles saturated with this substance were unattacked after being submerged five years.

The committee did not test petroleum, nor does it appear to have tried other hydrocarbons or their derivatives.

The following United States patents may be consulted: —

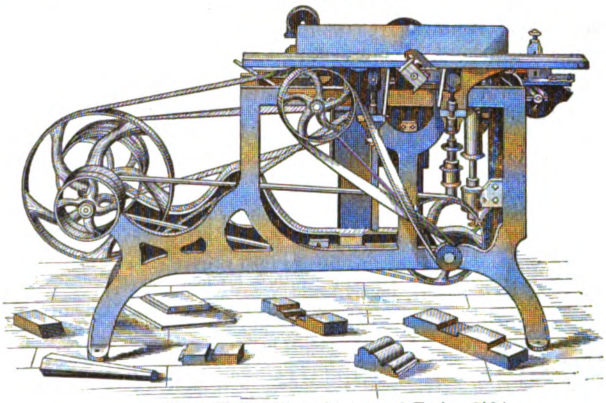
No.	Name and Year.	No.	Name and Year.
4,560.	Von Schmidt, 1846.	91,848.	Hunt, 1869.
47,132.	Robbins, 1865.	94,204.	Heinnemann, 1869.
48,636.	Hamar, 1865.	94,626.	McNair, 1869.
49,146.	Palmer, 1865.	94,704.	Blanchard, 1869.
49 382.	Cooley *et al.*, 1865.	94,869.	Clark, 1869.
52,046.	Holmquist, 1866.	95,473.	Heinnemann, 1869.
53,217.	Eddy, 1866.	95,474.	Heinnemann, 1869.
53,267.	Buell, 1866.	95,583.	Hayford *et al.*, 1869.
54,194.	Myers, 1866.	99,186	Haupt, 1870.
55,216.	Ransome, 1866.	100,380.	Day, 1870.
57,960.	Perry, 1866.	100,608.	De Smedt, 1870.
58,203.	Benjamin, 1866.	101,012.	Hayford, 1870.
60,794.	Samuels, 1867.	101,691.	Williams, 1870.
4,158.	Samuels (reissued), 1870.	102,725.	Stevens, 1870.
62,334.	Holmes, 1867.	103,105.	Van Camp *et al.*, 1870
62,956.	Harvey, 1867.	104,916.	Tripler, 1870.
63,300.	Prindle, 1867.	104,917.	Tripler, 1870.
64,703	Pustkutchen, 1867.	4,837.	Tripler (reissued), 1872.
65,545.	Constant *et al.*, 1867.	4,838.	Tripler (reissued), 1872.
67,104.	Clarke *et al.*, 1867.	106,625	Sheldon, 1870.
68,069.	Harding, 1867.	107,620.	Nickerson, 1870.
69,260.	Seeley, 1867.	107,854.	Beach, 1870.
70,761.	Taylor, 1867.	4,384.	Beach (reissued), 1871.
73,246.	Harmyer, 1868.	107,904.	Hayes, 1870.
73,565.	Beer, 1868.	108,659.	Webb, 1870.
77,777.	Spaulding, 1868.	108,661.	Westman, 1870.
78,514.	Calkins, 1868	109,872.	Cresson, 1870.
84,733	Cowling, 1868.	109,873.	Cresson, 1870.
86,808.	Bridge, 1869.	112,136.	Fowler, 1871.
87,226.	Voorhees *et al*, 1869.		
88,392.	Karmrodt *et al.*, 1869.		

No.	Name and Year.
113,338.	Pelton, 1871.
113,706.	Thomas, 1871.
115,784.	Tait, 1871.
115,931.	Brown, 1871.
116,274.	Constant *et al.*, 1871.
118,245.	Jones, 1871.
118,528.	Gyles, 1871.
120,009.	Sutphen, 1871.
123,009.	Fawcett *et al.*, 1872.
123,467.	Fuechtwanger, 1872.
124,080.	Pelton, 1872.
124,358.	Holmes, 1872.
124,402.	Waterbury, 1872.
124,419.	Cole, 1872.
124,420.	Cole, 1872.
127,482.	Hayford, 1872.
128,387.	Gyles, 1872.

Wood-saw. See SAW; and for varieties, see list on page 2035.

Wood-scrap′ing Ma-chine′. Fig. 7342 is a machine for scraping the surface of wood or veneer. The stuff to be smoothed is laid on the carriage, secured by a clamp, and carried forward by machinery beneath the scraper. When a dog comes in contact with a lever, the pinion falls out of gear, and the carriage is free to be drawn back for the next operation.

Fig. 7344.



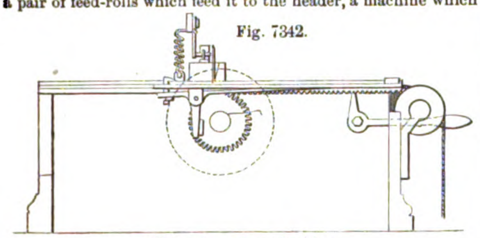
Wood-Worker (Squaring-up and Facing Side).

Wood-screw. A metallic screw for carpenters' and joiners' use in securing pieces of work together. A *wooden* screw, which is *one made of wood*, is used in clamps, carpenter's benches, bedstead-rails, etc.

While there are many machines for this purpose, and several variations in the order of the process, the following may answer, in a general way: —

The wire is placed upon a reel, and the end inserted between a pair of feed-rolls which feed it to the header, a machine which

Fig. 7342.



Wood-Scraping Machine.

cuts the wire into the lengths to which it is gaged, and sets up the heads, which is done by pressing the end of the wire into a die. The screw at this stage is called a *blank*. The next process is that of cleaning the blanks from grease and dirt; they are placed in iron boxes filled with white-pine sawdust. These boxes are revolved rapidly, and the friction of the blanks against each other and the particles of the sawdust cleanses them perfectly and makes them bright. After cleaning, the blanks are placed in the hoppers of the shaving-machines, from which they are picked up by claws, inserted in spindles which turn the heads, cut the slots, and eject them into boxes. They are then placed in the hoppers of the finishing-machines, which automatically complete the process of pointing and cutting the thread.

Wood-screws are classed by the length in inches, and by the number, which indicates the size of the wire, or body of the screw.

The following table of dimensions, derived from measurements of the screws made by the New England Screw Company, at Providence, R. I., will be found convenient for reference: —

No.	Diameter of body.	Head.		Number of threads to 1 inch.
		Diameter.	Thickness.	
	In.	In.	In.	
3	0.10	0.20	0.06	24
4	.11	.22	.065	24
5	.13	.26	.075	20
6	.15	.30	.08	20
7	.16	.32	.085	18
8	.17	.34	.09	14
9	.19	.38	.095	13½
10	.20	.40	.10	13
11	.21	.42	.11	12
12	.22	.44	.12	11
13	.23	.46	.13	11
14	.24	.48	.14	10
15	.25	.50	.15	10
16	.26	.52	.16	9½
17	.27	.54	.17	9
18	.28	.56	.18	8½
20	.30	.60	.20	8
21	.32	.64	.21	8
22	.35	.70	.22	7½
24	.38	.76	.24	7
26	.40	.80	.26	7

The length of thread cut is two thirds the length of the screw.

Wood-split′ting Ma-chine′. One used in many trades, and differing according to the size and purpose of the material. For shoe-pegs, kindling, firewood, etc.

Wood-still. See STILL; TURPENTINE.

Wood-stove. One specially adapted for burning wood. See STOVE.

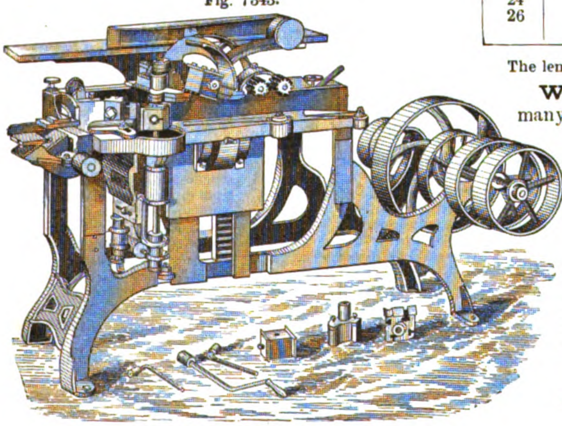
Wood-turn′ing Lathe. See LATHE, and list under that head.

Wood-work′er. A machine-tool having various attachments and adjustments for different kinds of work. Also called a JOINER (which see).

Fig. 7343 is the machine, showing *molding* attachment to work four sides. The squaring-up and facing tables are on the other side.

Fig. 7344 shows the *squaring-up* and *facing-table* side.

Fig. 7343.



Wood-Worker (Molder Side).

Wood-work'ing Ma-chine'. First in the list of inventors of wood-working machinery is General Sir Samuel Bentham, the brother of Jeremy, the political economist. While making a tour of Europe to observe the modes of shipbuilding, and on the occasion of a visit to Russia, he contrived the first planing-machine for wood. Working in the interest of the British Admiralty, he afterward devoted himself to the invention and construction of labor-saving machines.

Professor Willis states that General Bentham's house was converted into and formed the first manufactory of wood-working machines, "including planing, molding, rabbeting, grooving, mortising, and sawing, both in coarse and fine work, in curved, winding, and transverse directions, and shaping wood in complicated forms." The bills for these machines, presented to the Admiralty, specify lathes, saws, machines for cutting tenons, for boring, also for boring-bits and squaring-tools, and "many other machines for different kinds of work." One set of machines was for block making; in this he was joined by a gentleman of equal talent, Mr. Brunel. (See BLOCK-MAKING MACHINES.) Mr. Brunel was allowed as a premium for his inventions the estimated saving over one year's hand labor, equal to $80,000. General Bentham received $100,000 for the machines furnished. Among the machines made by Bentham previous to 1800 may be enumerated: —

Planing-machine.
Molding-machine.
Circular saw.
Segmental circular saw.
Dovetailing-machines, with conical cutters.
Wave-molding machine, with undulating carriage.
Crown and cylinder saws.
Lathes, with slide-rests.
Planing-machines, with cutter-heads, to dress both sides, and with rack-feed.
Mortising-machines, reciprocating and rotary.
Mortising-machines, with pivoted tables.
Segment sawing-machines, with radius arms.
Boring-machines, with annular bits.
Saws, with tracer-guides, for irregular forms.
Bevel-saws.
Curvilinear saws.
Taper-gage, for sawing-machine.
Grooving-machines.
Machines for grinding saw-blades.
Double-grooving saws.
Rabbeting-machines.
Sectional cutter, for planing-machines.
Gage-lathe, with slide-rest.
Screw-thread machines, with rotary cutters.

The *circular* saw is described in Miller's English patent, No. 1152, of 1777.

Hatton patented a planing-machine in England in 1776, but the description is vague.

Wood-work'ing Tools and Ma-chines'. See under the following heads: —

Addice.
Adze.
Auger (varieties; see AUGER).
Axe (varieties; see AXE).
Bark-cutting machine.
Bark-grinding machine.
Bark-planing machine.
Bench.
Bench-clamp.
Bench-hook.
Bench-screw.
Bench-strip.
Bench-vise.
Bending-wood.
Bit. Boring (varieties; see BIT).
Blind-slat cutter.
Blind-slat machine.
Blind-slat tenoning-machine.
Blind-stile making machine.
Blind-stile mortising-machine.
Blind-stile piercing-machine.
Blind-stile spacing-machine.
Blind-stile tenoning machine.
Blind-wiring machine.
Block-letter cutting-machine.
Block-making machine.
Bois-durci.
Bolt sawing machine.
Boring-bit.
Boring and tenoning machine.
Bowls. Machine for making
Box and tap.
Box-making machine.
Box-setting machine.
Box-turning machine.
Brace.
Brad-awl.
Break-iron.
Broadaxe.
Brog.
Broom-handle.
Broom-handle machine.
Broom-splint machine.
Brush-back machine.
Brush-handle machine.
Buhl.
Bung-cutter.
Burnetizing.
Butter.
Butting-machine
Button-lathe.
Button-machine.
Calipers.
Calking-tools.
Cane-polishing machine.
Cane-splitting machine.
Carpenter's gage.
Carpenter's level.
Carpenter's plow.
Carpenter's rule.
Carpenter's tools and appliances (see CARPENTRY).
Carving-machine.
Cauking.
Caul.
Chair-back dressing-machine.
Chair-back rounding-machine.
Chair-back sawing-machine.
Chair-seat boring-machine.
Chair-seat planing-machine.
Chipping-machine.
Chisel (varieties; see CHISEL).
Chit.
Clamp.
Clapboards Machine for gaging
Clapboards. Machine for making
Clapboards. Machine for planing
Clothes-pins. Machine for making
Cocking.
Cork-cutting machine.
Cork-making machinery.
Cutter.
Cutter-head.
Cutter-stock.
Deal-frame.
Dog. Saw-mill
Dovetail-cutter.
Dovetail-machine.
Dovetail-making machine.
Dovetail-marker.
Dowel-making machine.
Drawing-knife.
Drums, etc. Machine for making
Drunken cutter.
Dyewood-cutting machine.
Eave-troughs. Machine for making
Edger.
Edging-machine.
Edging-saw
Embossing wood.
Felloe-bending machine.
Felloe-boring machine.
Felloe-dresser.
Felloe-planing machine.
Felloe-sawing machine.
Files (varieties; see FILE).
Frame-making machine.
Fret-saw machine.
Fret-work.
Frizzing-machine.
Gage (varieties; see GAGE).
Gimlet.
Gouge.
Gunstock-making machine.
Gutters, wooden. Machine for making
Hammer (varieties; see HAMMER).
Handle-making machine.
Hand-mortising machine.
Hatchet.
Head-block for saw-mills.
Hollow auger.
Hollow-mandrel lathe.
Hoop-bending machine.
Hoop-cutting machine.
Hoop-dressing machine.
Hoop-sawing machine.
Hoop-splitting machine.
Hub-borer.
Hub-boxes. Machine for setting in
Hub-centering machine.
Hub-mortising machine.
Hub-turning machine.
Joiner.
Kerfing-machine.
Kindling-wood machine.
Lag-machine.
Last-cutting machine.
Last-making machine.
Last-polishing machine.
Last-turning machine.
Lath-cutter.
Lathe (varieties; see LATHE).
Lath-sawing machine.
Mallet.
Matches. Machinery for making
Match-frame.
Matching-machine.
Match-splint machine.
Miter-box.
Molding-machine.
Molding-mill.
Mortise-chisel.
Mortising-mill.
Nail-extractor.
Nulled work.
Oar-making machinery.
Pail-lathe.
Palm-leaf splitting-machine.
Panel-making machine.
Peg-making machine.
Picket-pointer.
Pin-making machinery.
Pin-tool.
Plane (varieties; see PLANE).
Plane-bit.
Plane-stocks. Machinery for making
Planer and matcher.
Planing-machine.
Planking-clamp.
Planking-screw.
Plow.
Plow-handles. Machinery for making
Plug-machine.
Pointing-machine.
Preserving wood.
Press-work.
Rabbeting-machine.
Rasp.
Rattan-cutting machine.
Rattan-dressing machine.
Rattan-polishing machine.
Rattan-reducing machine.
Rattan-slitting machine.
Rattan-splitting machine.
Rattan-stripping machine.
Riving-machine.
Rod, pin, and dowel machine.
Rossing.
Rossing-machine.
Rule.
Sand-paper holder.
Sand-papering holder.
Sash-bar machine.
Sash-boring machine.
Sash-chisel.
Sash-mortising machine.
Sash-planing machine.
Sash-sticking machine.
Saw (varieties; see SAW).
Sawdust-carrier.
Sawing-machine.
Saw-mill feed-devices.
Saw-mill gate.
Saw-plank feeder.
Scale-board.
Scorer.
Scorper.
Scraper-steel.
Screw.
Screw-box.
Screw-cutting machine. Wood
Screw-driver.
Scribe-awl.
Scribing-iron.
Scroll-sawing machine.
Shaving-horse.
Shavings for stuffing. Machine for making
Shingle-jointing machine.
Shingle-machine.
Shingle-planing machine.
Shingle-riving machine.
Shingle-sawing machine.
Shive-cutting machine.
Shoe-peg making machinery.
Shoe-sole making machinery.
Shooting-board.
Skewer-machine.
Slab-grinder.
Slat-machine.
Slat-tenoning machine.
Snath-bending machine.
Snath-finishing machine.
Snath-rounding machine.
Spacing and boring machine.
Splint-cutter.
Splint-cutting machine.
Splint-plane.
Spoke-auger.
Spoke-driving bench.
Spoke-driving machine.
Spoke-gage.
Spoke-lathe.
Spoke-machine.
Spoke-planing machine.
Spoke-polishing machine.
Spoke-setter.
Spoke-shave.
Spoke-tenoning machine.
Spoke-turning machine.
Spool-making machinery.
Square.
Stave-bilging machine.
Stave-crozing machine.
Stave-dresser.
Stave-howeling machine.
Stave-jointer.
Stave-riving machine.
Stave sawing machine.
Stave-setter.
Tenoning-machine.

Timber-scribe.
Tooling.
Tray-making machine.
Trying-up machine.
Turning.
Veneer-cutting machine.
Veneer-hammer.
Veneer-planing machine.
Veneer-polishing machine.
Veneer-pressing machine.
Veneer-saw.
Veneer-sawing machine.
Veneer-straightening machine.
Vise.
Waney.
Washboards. Machine for making
Whalebone. Machine for working
Wheelwright's machine.
Willow-peeler.
Wiring blind-slats.
Withe-twisting machine.
Wood-bending machine.
Wood-boring machine.
Wood-bundling machine.
Wood-carving machine.
Wood-embossing machine.
Wooden gear. Machine for cutting
Wooden pipe.
Wooden ware. Machine for making
Wooden wedges. Machine for making
Wood-grinder.
Wood-planing machine.
Wood-polishing machine.
Wood-slivering machine.
Wood-splitting machine.

List of factory-machines: —

Planing and matching machine.
Surface-planer (surfacing-machine).
Combination-planer.
Clapboard planer and jointer.
Molding-machine.
Sash and molding machine.
Molding and dovetailing machine.
Shaper and edge-molder.
Shaping-machine.
Tenoning-machine
Blind-slat tenoning-machine.
Mortising-machine.
Car boring and mortising machine.
Hub boring and mortising machine.
Chair boring and mortising machine.
Blind-stile boring and mortising machine.
Buzz-planer.
Saw-table.
Circular-saw bench
Sharpening-machine.
Saw-gage.
Sawing-machine.
Scroll-saw.
Band-saw.
Re sawing machine.
Saw-arbor.
Spoke-lathe.
Spoke-planer.
Spoke and axe-handle lathe combined.
Spoke-throating machine.
Spoke facing and jointing machine.
Spoke-tenoning machine.
Rim-boring, doweling, and felly-jointing machine.
Spoke-polishing machine.
Felly-rounding machine.
Felly-planer.
Wheel-gage.
Wheel-screwing machine.
Hub boring and capping machine.
Rod, pin, and dowel machine.
Boring-machine car.
Boring-machine for agricultural implements.
Boring-machine chair.
Boring-machine furniture.
Blind-stile spacing and boring machine.
Matching-cutter.
Matcher-head.
Wood-turning lathe.
Blind-wiring machine.
Miter-machine
Side-planing and jointing machine.
Butting-machine.
Dovetailing-machine.
Panel-raiser.
Blind-slat crimping-machine.
Door-clamp.
Knife-grinder.
Jointing-iron.
Barrel-machine.
Clothes-pin machine.
Match-machine.
Tub-machine.

Woof. (*Loom.*) The *weft* or *filling* of cloth, carried by the *shuttle* and laid in the *shed*. Also known as the *shoot*, or *tram*.

Wool. 1. The fleece of the sheep. See articles following.

2. A slag of iron blown by steam into a fibrous form. Known as *slag-wool*, or *silicate cotton*. See page 2198.

It is used as a clothing for steam-boilers and steam-pipes, to prevent loss of heat. A blast of steam, water, or air is forced into the stream of viscous slag as it runs from the furnace, when it assumes a fibrous form and appearance, somewhat similar to that of spun-glass.

Wool-bun'dling Ma-chine'. See WOOL-PACKER; FLEECE-FOLDER.

Wool-bur'ring Ma-chine'. A machine for picking the burs from wool. A *wool-picker*. See BURRING-MACHINE, Fig. 993.

Wool-clean'er. A machine for cleaning dust, burs, and other foreign matters from wool.

The material is placed in the feed-box, and carried forward by the endless apron on one side thereof, to the toothed cylinder at the bottom of the box. It is taken from the cylinder by the toothed beaters, and deposited upon the endless apron, by which it is carried to a second beating-cylinder, which throws it upon an apron by which it is carried to the pressure rolls. The sheet is then coiled upon a cylinder, the layers being separated by a cloth, and is retained thereon until fed to the carding-machine. See also WOOL-PICKER, and Fig. 993, page 412.

Wool is also cleaned by treatment in a chamber with petroleum, or with sulphide of carbon; see Fig. 3378. Also Robbins's patent, No. 75,980, March 24, 1868.

Wool-comb'ing. Said to have been invented by Bishop Blaize, who gave the name to St. Blazy, a village of Cornwall. He was bishop of Sebastia, in Armenia, and was decapitated in the Diocletian persecution, in 289. Processions in his honor are still celebrated in some parts of England, on the 3d of February.

For early English patents, see Cartwright, 1790; Wright and Hawksley, 1793; Toplis, 1793.

Wool-comb'ing Ma-chine'.

Lister's (English patent) circular machine is for separating the long from the short fibers of the wool. It is specially designed for long wool. The long fibers are also laid in regular order, so that they can be readily spun into yarn. Lister's apparatus clears the long fibers by drawing them through a series of teeth by means of a nipper. A pair of jaws seizes a mouthful of wool, and conveys it into a carrier, which, in its turn, deposits upon the comb a brush, pressing it down on the teeth to a proper depth. Having cleared one end of the staple, it transfers the uncleared end to the rotating comb, from which it is extracted by drawing-rollers. The *noil*, or short portion of the wool, is left in the comb, and is removed by another set of drawing-rollers. The long, cleared wool is delivered in a continuous sliver from the machine at one point, the *noil* being passed away at another. See COMBING-MACHINE.

Noble's machine is for combing short wool. It separates the long fibers from the *noil* by means of two circular separating-combs. These combs work together, and at the point of junction the wool is placed on their teeth. As they travel apart from each other, the fibers are cleared, and each comb presents a cleared fringe, which is drawn off in a sliver by drawing-rollers; the *noil* being passed away into a receptacle.

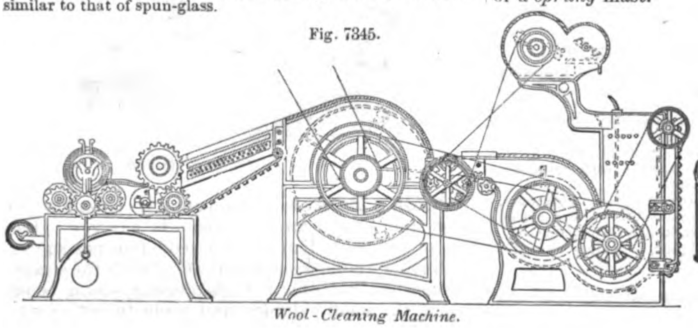
Wool'der. 1. (*Nautical.*) A stick used for tightly winding a rope round another object, as in *fishing a spar*. A *woolding-stick*. The action is analogous to *serving*.

2. (*Rope-making.*) One of the handles of the *top*, which occupies the angles of the strands, in laying up strands into ropes or ropes into hawsers, and which confines the twist, receding before it at the rate necessary to give the required hardness of twist.

Wool'ding. Wrapping. As of the yarn in serving a rope. A wrapping of hemp or yarn around a piston or plunger, acting as a packing.

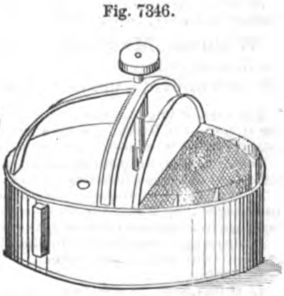
A wrapping of rope or cord around a splice, scarf, or a *sprung* mast.

Fig. 7345.



Wool-Cleaning Machine.

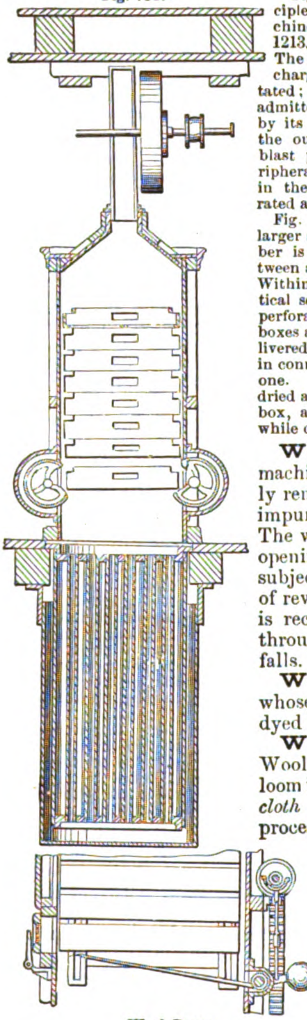
Fig. 7346.



Dryer for Wool, etc.

Wool-dry'er. A machine for removing the moisture from wool after washing, dyeing, or what not.

Fig. 7347.



Wool-Dryer.

Fig. 7436 is on the principle of the centrifugal machine, illustrated at Figs. 1213, 1214, and elsewhere. The foraminous cylinder is charged with wool and rotated; superheated steam is admitted above and ejected by its own pressure toward the outlet, assisted by the blast produced by the peripheral fans. The moisture in the wool is thus evaporated and removed.

Fig. 7347 is on a much larger scale. A drying-chamber is placed vertically between a heater and a blower. Within the chamber is a vertical series of boxes having perforated bottoms. These boxes are supported and delivered one at a time by cams in connection with the lower one. The matters to be dried are placed in the upper box, and gradually descend while drying.

Wool-dust'er. A machine for mechanically removing the coarser impurities from wool. The wool is fed into an opening at one end and subjected to the action of revolving beaters; it is received on a grate, through which the dirt falls.

Wool-dyed. Cloth whose fiber has been dyed before weaving.

Wool'en Cloth. Woolen cloth from the loom is made into *broad-cloth* by a succession of processes: —

Scoured in soapy water, to remove grease.

Tented, or stretched on tenter-hooks to dry in the open air.

Dyed, unless it was wool-dyed before spinning.

Burled, or freed from irregular threads or hairs.

Fulled, to cause the fibers to interlace and become felted among each other, strengthening, condensing, and lessening the area of the fabric.

Teaseled; teasels, or wire brushes, in imitation of them, are made to bear forcibly upon the cloth as it passes in front of them, raising a nap thereon.

Sheared; the nap is reduced to an even length and smooth surface by shears, cutter, or fire.

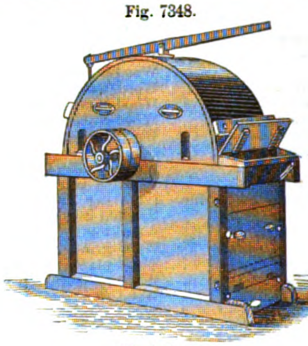
Wool'en Man'u-fac'ture. The treatment of wool is according to its staple, *long* or *short*, *combing* or *carding* wool; producing *worsted* or *woolens*.

The wool of England has always been celebrated; and even in the times of the Romans, a manufacture of woolen cloths was established at Winchester, for the use of the emperors.

The processes, in brief, are about as follows, each being described under its alphabetical arrangement: —

1. *Sorting*, as to fineness, softness, strength, color, cleanness, and weight; by which the various qualities of wool are placed together to avoid unevenness in the working and the fabric.
2. *Scouring:* washing in alkaline liquor, to remove *suint* and grease; followed by clean water.
3. *Dyeing.*
4. *Willowing*, or *deviling;* to loosen out the locks and bunches.

Fig. 7348.



Wool-Duster.

5. *Picking* (also known as *moting*, i. e. removing *motes*), or *burring:* to remove burs and other impurities.
6. *Oiling;* to prevent felting of the fibers in the subsequent operations.
7. *Scribbling;* a preliminary carding, to disentangle the fibers.
8. *Carding;* to form the wool into a *fleece*, *slivers*, *rolls*, or *rovings*, as the case may be.
9. *Slubbing;* to join the rovings in lengths.
10. *Drawing* and *spinning;* to attenuate the rovings and give the twist.
11. *Spooling;* winding on bobbins.
12. *Weaving;* to form cloth.
13. *Fulling;* to compact and felt the cloth.
14. *Teazeling;* to draw out a nap.
15. *Shearing;* to cut the nap to an even length.
16. *Pressing* between hot plates, to give glossiness.
17. *Brushing.*

For specific list of appliances in the treatment and manufacture of wool and other fiber, see COTTON, FLAX, WOOL, HEMP, etc., appliances.

The Argali, or *Ovis ammon* (Linn.), is supposed to be the progenitor of the stock of the domestic sheep. The steppes of Central Asia are its home, and thence it has spread. Among the bones of quadrupeds found in ancient caves throughout Europe, those of the sheep are not noted by Cuvier, Buckland, or De la Beche. We read in Pliny, Varro, and Columella of breeds of sheep of gray, brown, russet, black, and golden colors.

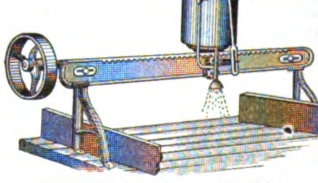
The spinning of wool was well known in the time of Moses, and was practiced among the Egyptians, Phœnicians, Greeks, and Romans at early periods of their respective histories.

The Romans are believed to have introduced the art into Britain, and to have had a wool factory for the supply of the Roman army in Britain, at Winchester.

Sheep are mentioned in an English public document of 712, in which their price is fixed at one shilling. The mother of the renowned Alfred the Great was skillful in the spinning of wool, and instructed her daughters in the art.

"Mr. John Coxetter of Greenham Mills, Newbury, had two Scotch Southdown sheep shorn at his factory, at exactly five o'clock in the morning, from the wool of which, after passing its various processes, a complete damson-colored coat was made, and worn by Sir John Throckmorton, at a quarter past six in the evening, being $2\frac{1}{4}$ hours within the time allotted, for a wager of 1,000 guineas. The sheep were roasted whole, and a sumptuous dinner given by Mr. Coxetter." — *Old English paper.*

Fig. 7349.



Wool-Oiler for Carding-Machine.

Woolff's En'gine. A compound steam-engine, so called from its inventor's name. It has two cylinders of different diameter, the eduction-passage of the smaller cylinder communicating with the steam-passages of the other; high-pressure steam being used in the small cylinder, and made to act expan-

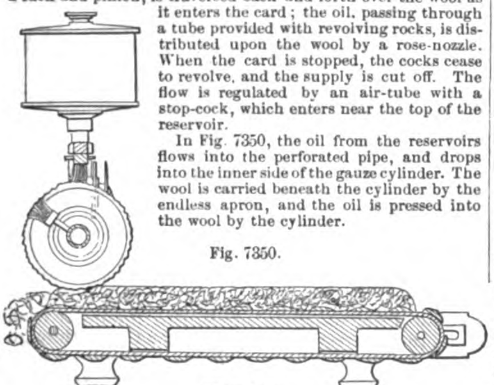
sively in the large one, the steam being afterward condensed in the usual manner.

Wool-oil'er. (*Woolen Manufacture.*) A device for attachment to the first breaker over the feed-apron, and immediately in front of the feed-rolls of the carding-machine.

The reservoir contains oil or composition, and, by means of a rack and pinion, is traversed back and forth over the wool as it enters the card; the oil, passing through a tube provided with revolving rocks, is distributed upon the wool by a rose-nozzle. When the card is stopped, the cocks cease to revolve, and the supply is cut off. The flow is regulated by an air-tube with a stop-cock, which enters near the top of the reservoir.

In Fig. 7350, the oil from the reservoirs flows into the perforated pipe, and drops into the inner side of the gauze cylinder. The wool is carried beneath the cylinder by the endless apron, and the oil is pressed into the wool by the cylinder.

Fig. 7350.

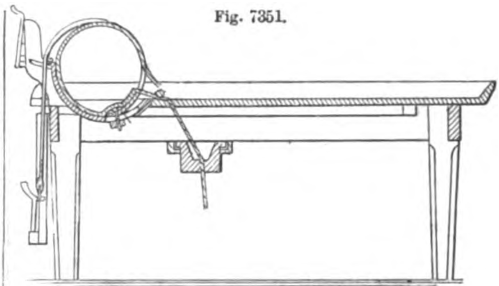


Wool-Oiler.

Wool-pack'er. A machine for compressing and tying fleeces. There are several forms.

In Fig. 7351, the tie-cords are hitched to the catches at the edge of the concave bed, and pass under the wool and through

Fig. 7351.



Wool-Packing Table.

the slots of the apron and holes in the bed beneath. The slotted apron is passed over the wool and attached to a treadle-lever, by which the wool is compressed, drawing it into the concave bed in position to be tied by the cord.

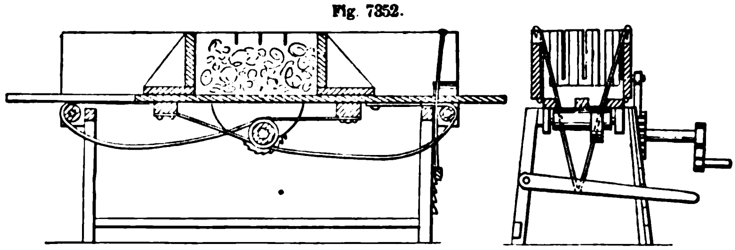
In Fig. 7352, the hinged sides are thrown up and held by cord connection to the treadle. The ends are then mutually advanced by strap connection to the drum beneath, which is rotated by a crank and sustained by a pawl.

In Fig. 7353, the folded fleece is laid on the packing-head; the two opposite long flaps are turned up, entering the pins of one into the holes in the other, the position being sustained by clamps. The short flaps are then raised, being locked by springs on the former. The head is raised by the treadle, the fleece tied both ways and then released. See also FLEECE-TYER, Fig. 2020.

Wool-pick'er. A machine for burring wool.

Fig. 7354 is on the principle of the saw-gin. The journal-boxes of the roller have a lateral adjustment so as to set the revolving brushes in such a position as to sweep the edges of

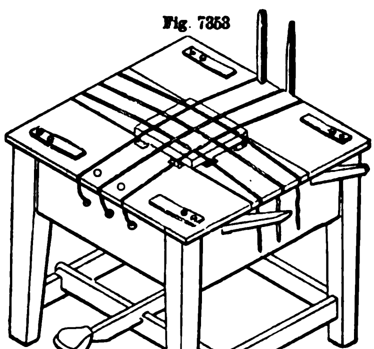
Fig. 7352.



Wool-Press.

the revolving blades on the cleansing cylinder, and clear them of adhering particles of wool. The floor is slotted to permit the dirt separated from the wool to pass down into the apart-

Fig. 7353



Wool-Packing Table.

ment below. See also WOOL-CLEANER; and BURRING-MACHINE, Fig. 993.

Wool-press. See WOOL-PACKER.

Wool-sort'ing. In the systematic sorting of wool, the bales are opened, spread on a table, and sorted according to quality and condition. The technical names of the sorts are, *pick-locks, prince, choice, super, head, downright, seconds, fine-abb, coarse-abb, livery, short-coarse, breech.* These may not all be found in the same bale, but occur in the various grades and kinds.

Wool-stock. A heavy wooden hammer, used in fulling cloth.

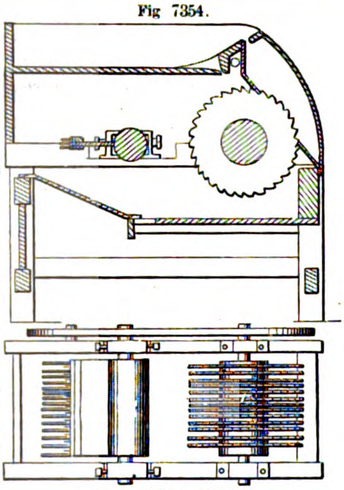
Wool-ta'ble. See WOOL-PACKER.

Wool-wash'ing Ma-chine'. A machine for cleansing fleece-wool in the factory.

McNaught's machine (United States patent, April 27, 1869) has a series of rakes for traversing the wool along the cistern to an inclined plane, up which it is moved by a cradle *g*, and delivered to a series of rollers, which convey it to the squeezers *i i*. The cradle *g* has a four-motioned action, down, forward, upward, and return; the teeth on its lower side catching the wool and drawing it up the incline.

In Clark's machine, 1865, the wool is conveyed into and out of the trough by endless aprons, and passed through the trough between two other endless aprons, under one of which is a bed of rollers, and over the upper of which a series of vertical beaters or stampers is arranged, one above each roller. These stampers are successively operated by a revolving shaft having thereon a set of lifters, spirally arranged. An inclined shelf under the rollers carries off the dirt as it is washed from the wool into an adjoining compartment, preventing its falling upon the lower portion of the lower apron. Provision is also made for picking the wool as discharged, by means of a revolv-

Fig 7354.



Wool-Picking Machine.

ing cylinder, with radially advancing and receding teeth in conjunction with a set of stationary teeth.

In Murkland's machine, the wool is fed from an apron between a toothed roll and a concave, and caught by the spikes on the oscillating cylinder; the latter works above a perforated concave in the tank, and advances the wool toward the discharge end, where it is caught by a revolving picker and transferred by a belt to the squeeze rolls, which deliver it. Other wool-washers are like *centrifugal machines*, or resemble some of the numerous forms of *washing-machines*.

Wool-work'ing. See WOOLEN MANUFACTURE.

Wootz. A very superior quality of steel, made in the East Indies, and imported into America and Europe for superior edge-tools. It is used in the manufacture of the celebrated sword-blades of the East. Professor Faraday attributed its excellence to the presence of a small quantity of aluminium.

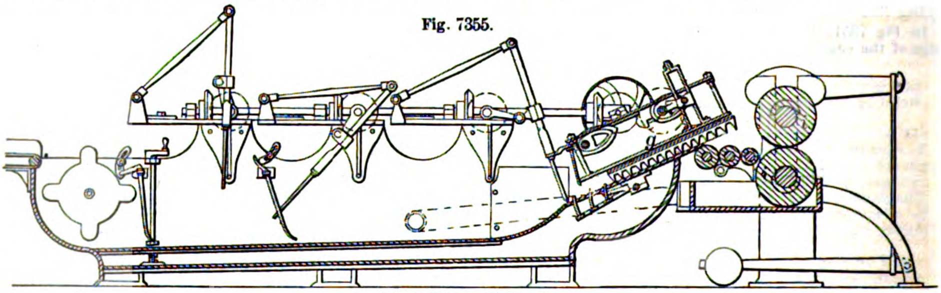
A more recent analysis by Rammelsberg gives in the 100 parts, carbon, 0.867; silicon, 0.136; phosphorus, 0.009; sulphur, 0.002; no aluminium. Samples probably differ. The specific gravity of Rammelsberg's specimen was 7.822.

Wootz is believed to be made by a process direct from the ore. See STEEL.

Wor'dle. One of the pivoted cams in a draw-head, which form the throat of a die, and which are capable of simultaneous adjustment toward or from each other, to regulate the size of the throat through which the tube or wire is drawn. The draw-head die, thus formed, may be considered equivalent to an adjustable *draw-plate* or *triplet*.

Wordles are used in drawing wire and lead-pipe.

Fig. 7355.



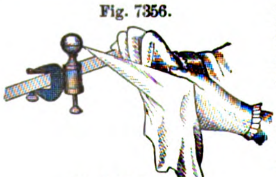
Wool-Washing Machine.

Work. (*Mining.*) Ores before they are cleaned or dressed.

Work-box. A case to hold sewing, spools of thread, and other accessories of a lady's work-table.

Work'er. One of a pair of small cane cylinders, called *urchins*, which are arranged around the large card-drum of the carding-machine. The *worker* is larger than its fellow-*urchin*, the *cleaner*. The former takes the fiber from the large card-cylinder, parts with it to the *cleaner*, and the latter returns it to the card-cylinder. See CARDING-MACHINE.

Fig. 7356.



Work-Holder.

Work-hold'er. A device for holding work while being sewed. That illustrated is clamped to a table. The upper part consists of a fixed and a movable hemisphere, which act as jaws to hold the work, the upper one being raised or lowered by a screw beneath.

Work'ing-bar'rel. (*Mining.*) The pump-barrel, in which the piston works.

Work'ing-beam. The oscillating-beam, at one end of which is the vertical piston-rod, and at the other the pitman or pump-rod. See CORNISH ENGINE, Fig. 1467, *b*; PUMPING-ENGINE, Plate XLIV.

Work-roll'er. (*Knitting-machine.*) A weighted roller which automatically winds up the work as performed. (Not used in hose and other small work.)

Worm. 1. (*Ordnance.*) An implement for withdrawing the cartridge from a cannon, when it is not desired to fire the charge.

It consists of two branches of iron or steel twisted in reverse directions, and attached to a staff. They are made of two sizes, one for field-guns and the other for siege and garrison guns.

2. (*Fire-arms.*) A spiral wire on the end of the ramrod, for withdrawing a charge. A *wad-hook*.

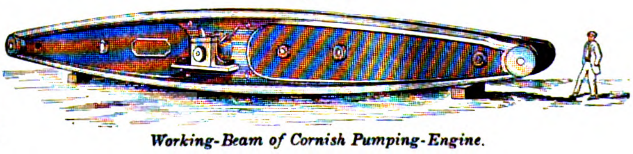
3. The thread on the *shaft* or *core* of a screw.

4. (*Still.*) A spiral pipe in a condenser; a continuation of the neck or beak.

5. The spiral of a cork-screw.

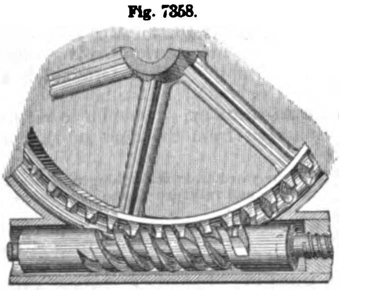
6. A sharp-pointed spiral tool, used for boring soft rock; that which is too hard to be pierced by the *auger*, but not hard enough to require the *jumper*.

Fig. 7357.



Working-Beam of Cornish Pumping-Engine.

Fig. 7358.



Worm-Gear.

Worm-gear. (*Machinery.*) A combination consisting of an endless screw and spirally toothed wheel; used for transmitting rotary motion from one shaft to another, placed at right angles to it.

Worm'ing. 1. (*Nautical.*) *a.* Filling up the *contlines*, or vacant spaces between the strands of the rope, with spun-yarn or small rope, in order to strengthen it and render the surface smooth for *parceling* or *serving*.

b. Link-worming is by means of chains inserted in the interstices of the strands.

2. The turning of the thread on the barrel of a wood-screw.

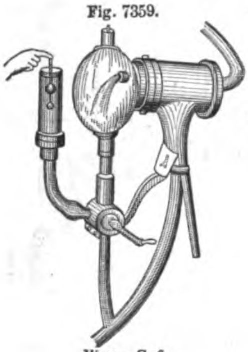
Worm'ing-pot. (*Pottery.*) A pot for the ornamentation of pottery in the lathe, by the exudation of color upon the ware as it rotates. The *worming-pot* has three compartments which have quill-tubes emitting the colors at one orifice, so as to give parallel stripes. Curious serpentine ornaments are thus made.

Worm-safe. An apparatus to enable the specific gravity of spirits to be ascertained, as they flow from the still, without withdrawing any portion thereof.

The nose-pipe of the worm-tub enters a glass-globe, from the bottom of which the discharge-pipe descends vertically. This has a stop-cock and an upward branch-pipe, surmounted with a glass-cylinder, which, when the stop-cock is opened, becomes filled with spirit, and which receives a hydrometer. The cock mechanism is so arranged that only sufficient to fill the cylinder can be drawn at one time.

Worm-wheel. (*Machinery.*) A wheel which gears with an endless screw or *worm*, either receiving or imparting motion. See also WORM-GEAR.

Fig. 7359.



Worm-Safe.

By this means a powerful effect with a diminished rate of motion is communicated from one revolving shaft to another by the action of the worm or spiral upon the spur-wheel. It is a motion common in measuring and calculating instruments, meters, and odometers, a revolution of the worm-wheel moving the spur-wheel to the extent of one cog.

Fig. 6817.

Worm-Wheel.

Wors'ted-ma-chin'er-y. Machinery for the manufacture of *combing* or *long-stapled* wool, as distinguished from ordinary *woolen*-machinery (which see), which works staple of the ordinary length, and in which the felting quality is much more developed (see FELTING). The breeds of sheep yielding the two are different. The *Leicester* may be considered the type of one and the *Merino* of the other, though the distinct processes are older than the former name, as a variety, and possibly older than that of the latter kind, which originated in Spain. See MERINO.

Examined under the microscope, *short* wool presents the appearance of being serrated and imbricated. In a fiber of *merino* wool an inch in length, there may be 2,400 of these serrations; in one of *Saxony*, 2,700; in *Southdown*, 2,080; in *Leicester*, only 1,860. In *long* wool these saw-like cusps, or points, are less developed; indeed, in some sorts they are nearly altogether wanting. For the production of woolen cloth that wool is most suitable which possesses the greatest number of these serrations, because it is by means of these that the *felting* process, which is the essence of such cloth, is accomplished. On the other hand, in worsted fabrics this felting operation is avoided, or takes place only to a very limited extent. The fibers are drawn and spread out separately and evenly, by means of the *comb*, which, in all its forms, aims at disjointing each separate lock or ringlet of wool, and arranging the fibers longitudinally. See COMB, 2, page 597.

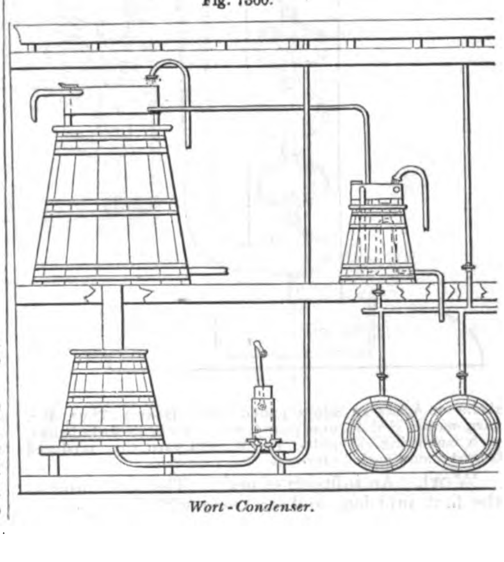
The wool, being *sorted*, is next *washed*. Iron tanks, full of soap and water, are kept by steam constantly at a high temperature. Into these the wool is thrown, and repeatedly drawn through the liquid by iron rakes, which, moved by machinery above, expose it completely to the action of the detergent mixture. The water is then squeezed out by passing the wool between rollers heavily weighted, and the drying process is completed by quickly revolving fans, or drawing the atmosphere through it.

The white and clean wool is then run through *screw-gills*, or revolving leather straps armed with fine iron teeth. It is thus made ready for *combing*. This separates the fibers and lays them parallel. It is analogous to the carding of short wool (*carduus*, a thistle); a *teazle* was first employed, now iron wire. (See CARDING-MACHINE.) The operation of *combing* also removes the shorter fibers which are found even with long wool; these are *bits*, *nibs*, *noils*, according to the custom of a country or district. The process was formerly done by hand, and is shown at Fig. 1895, page 597. It was necessary that the combs should be heated, and for this purpose they were placed in an earthenware stove, or *pot*, as it was called, which was kept at a high temperature by burning charcoal in it. The wool was oiled to render it more pliable.

In the combing-machine, the wool is passed under the action of the long thin spikes of the comb: the locks of wool are drawn out in perfectly parallel lines, each fiber laid smoothly and the *noil* passed over into its appointed receptacle.

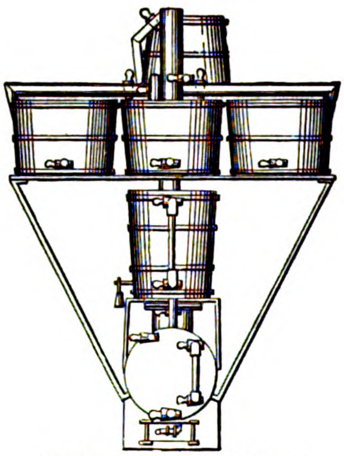
The wool, thus combed, is made up into balls called *tops*, a sort of round *heads*. It is now prepared for spinning by passing the *slivers* or ribbons of combed wool between a series of pairs of rollers, moving with regulated and gradually increasing degrees of velocity, and brought, with corresponding gradations, closer to each other, thus diminishing the space between them through which the wool has to move. The result is to draw out the fibers more completely. This is repeated from six to ten times. The strips of slightly cohering wool thus gain length at the expense of thickness, and are called *rovings*; the word is probably cognate with the sailor's *reefing*, from the Anglo-Saxon *reafian*, to pull. The bobbins on which

Fig. 7360.



Wort-Condenser.

Fig. 7361.

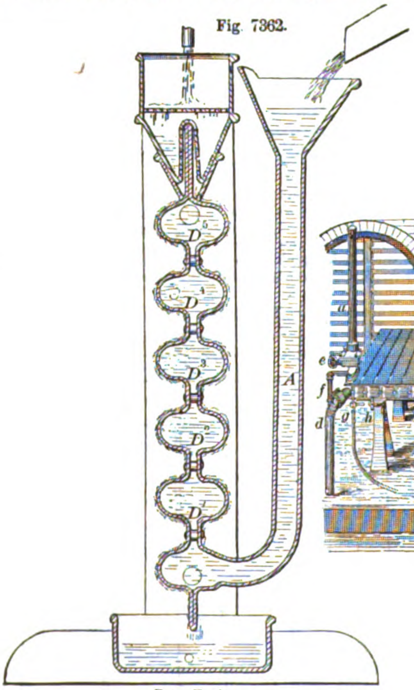


Apparatus for Brewing Malt-Liquor.

these rovings are wound, while revolving, impart a slight amount of twisting to the wool, and a sort of light woolen rope is produced with the smallest possible amount of strain. It is immediately from these *rovings* that *yarn* — literally, *prepared* wool (Anglo-Saxon, *gyrnan*, to make ready) — is produced.

The yarn varies according to the quality of the wool from which it is produced, and according to the fineness of thread to which it is spun. In what is called the *fly-frame*, for spinning long wool, the spindles have a velocity of 2,500 revolutions per minute. In the *cop-frame* they attain the speed of 6,000 per minute, or 100 revolutions per second. The tenuity of the yarn is indicated by the *number*, which represents how many

Fig. 7362.



Beer-Cooler.

skeins or *hanks* go into a pound. (See HANK.) Thus, 40 *s.* yarn means that in one pound weight there are forty hanks, each measuring 560 yards. The worsted yarn thus produced is used almost entirely for weft.

Wort. An infusion of malt. The sweet wort is the first infusion, and is made with one portion water at 140° to 160° Fah., and a second portion at 194°, producing about 167°. A second and a third mash at a higher temperature dissolve other soluble portions of the malt. When fermented, the *wort* becomes *beer*; or *wash* for distillation.

Wort-con-dens'er. One for condensing the vapor which rises from the wort in the process of boiling.

In Fig. 7360, the vapor from the boiling wort is condensed in a surface-condenser and returned to the wort before fermentation.

In Fig. 7361, the steam rising from the brewing-boiler during the process of brewing is used for the purpose of heating and preparing the wort for the succeeding brewing.

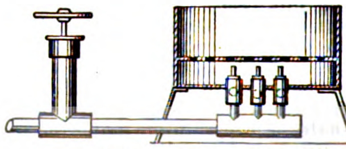
Wort-cool'er. Usually a shallow vat of large area, in which the infusion of malt is placed to cool.

Various apparatus have been invented to expedite the process and economize room.

In Fig. 7362, the wort is cooled by dribbling or trickling over the outside of a conduit or receptacle of ice-water. The ice-water descends in tube *A* and rises in the successive chambers D^1 D^2, etc., flowing out at D^5. The wort trickles over the outside of the column, meeting at first the chambers which are about to part with their partially warmed water contents, and reaching last the coldest body of water. See also Fig. 631, page 264; and Figs. 2966 - 2968, page 1326.

In another form, the beer flowing over the bottom of troughs, which are kept cool by water flowing under them in an opposite direction, is agitated by paddles, which cause all the particles to come in contact with the cooling surface. See also WORT-REFRIGERATOR.

Fig. 7363.

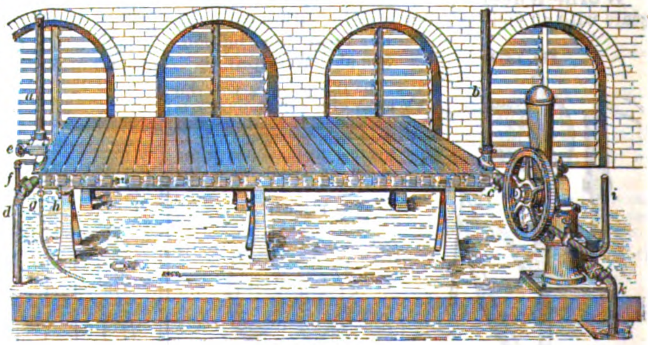


Air-Exhaust for Extracting Wort.

Wort-fil'ter. One for extracting the clear liquor from the boiled mash.

Fig. 7363 shows the application of a partial vacuum in the sub-compartment of a mash-tub, to cause the wort to accumulate more quickly, and to cause its extraction more thoroughly out of the mash.

Fig. 7364.



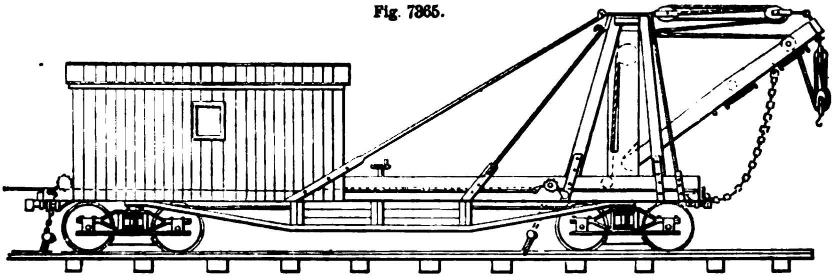
Wort-Refrigerator.

Wort-re-frig'er-a-tor. An apparatus for cooling wort after boiling with hops and previous to fermentation, in the manufacture of beer.

It is desirable that this process should be effected as soon as possible, in order to preserve the flavor of the liquor, and prevent it from turning sour: and for this purpose it is ordinarily run into shallow vats of large extent, where it remains until its temperature falls to 55° or 60° Fah.

The refrigerator, Fig. 7364, is designed to prevent the formation of sediment and the escape of the aroma, and to avoid loss by evaporation. It consists of a number of long boxes

Fig. 7365.



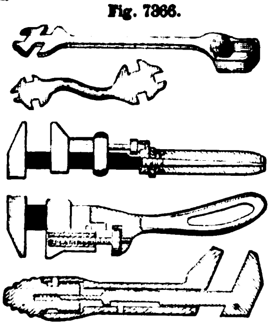
Wrecking-Car.

placed side by side, or otherwise if convenient, each having a flow and return passage for the water by which it is cooled, and is provided with copper tubes through which the wort passes.

The hollow covers at the ends of the boxes afford communication for the wort, between one tier of tubes and another, each box being thus complete in itself, and forming a unit of the whole.

By removing the covers a cleaning-brush may be passed through the tubes. *a*, cold-water inlet; *b*, water-outlet; *c*, wort-inlet; *d*, wort-outlet; *e*, water-regulator; *f*, thermometer; *g*, drain-cock; *h*, sample-cock; *i*, steam-pipe; *k*, wort-suction; *l*, tube-brush.

Fig. 7366.



Wrenches.

Wo'ven Pa'per. Paper made smooth; not ribbed, like *laid* paper.

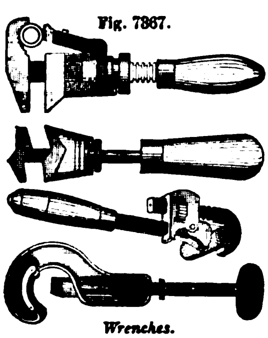
Wrain-bolt. (*Shipbuilding.*) A ring-bolt with several forelock holes, used in setting the planks; that is, straining them to their places.

Wreath. The *guilloche*, or wreathed chain, like the modern curb, is seen on ancient marble columns and in the Herculanean paintings. It is possibly referred to in Exodus and the Book of Kings, in temple decorations.

Wreck'ing-car. One carrying devices for removing obstructions from the track, such as wrecked cars or locomotives, fallen rocks or trees.

In Fig. 7365, the crabs fasten the car in its position on the track. The boom is stepped into the mast, and moved by tackle which connects their respective upper ends. The mast is stepped in the car-platform, and braces by framing and stay-rods.

Fig. 7367.



Wrenches.

Wreck'ing-pump. A steam-pump specially designed for pumping the water out of bilged or sunken vessels, in order to raise them. The suction and discharge pipes are of great capacity in proportion to the size of the machine, and the valve-passages and valves of the water-cylinders are large, enabling the pump to work up to high speeds when necessary.

See Steam-pump; Centrifugal Pump; and, for varieties, see list under Pump, page 1827.

Wrench. A bar having jaws adapted to catch upon the head of a bolt or upon a nut to turn it, or to hold the latter from turning in some cases when the bolt is being rotated.

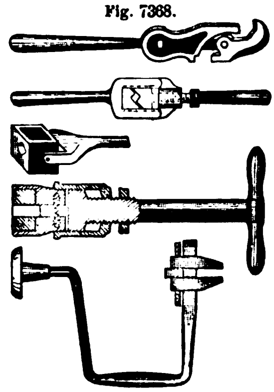
Some wrenches have a variety of jaws to suit different sizes of nuts and bolts.

The monkey-wrench, which has an adjustable inner jaw, is the best form of the wrench, and many patents have been granted for new and improved forms of the tool. See Fig. 3214, page 1473.

See also Pipe-wrench, Figs. 3735-3738, page 1711.

Figs. 7366-7368 show several forms of wrenches, for various purposes and adapted to different situations.

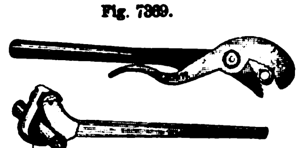
Fig. 7368.



Wrenches.

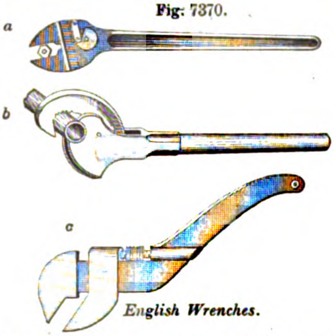
In the self-adjusting wrenches and pipe-tongs (Fig. 7369), the curved inner faces of the jaws are serrated; various sizes of pipes may be firmly grasped by opening the jaws to a greater or less extent and inserting the pipe to a proper distance within the opening, one hand being employed to compress the handle of the movable jaw, and the other to operate that of

Fig. 7369.



Pipe-Wrench and Pipe-Tongs.

Fig. 7370.



English Wrenches.

the fixed jaw, which acts as a lever when the implement is used as a wrench.

a (Fig. 7370), self-acting spanner. *b*, tube-wrench.
c, oblique-jaw spanner.

See under the following heads: —

Bedstead-wrench.	Monkey-wrench.
Breech-wrench.	Nut-wrench.
Carriage-wrench.	Pipe-wrench.
Claw-wrench.	Ratchet-wrench.
Cramp-wrench.	Screw-wrench.
Cylinder-wrench.	Spanner.
Diagonal wrench.	S-wrench.
Double-headed wrench.	Tap-wrench.
Hook-wrench.	Wrench-hammer.
Key-screw wrench.	Wrest.

Wrench-ham'mer. A hammer having a movable member to form a spanner.

Wrest. 1. A turning-instrument, such as a wrench, tuning-key, bedstead-key, spanner, etc.

2. (*Hydraulics.*) The partition in a water-wheel by which the form of the buckets is determined.

Wrest-pin. (*Music.*) A pin around which a piano-string is wound, and by turning which it is tightened or loosened as the case may be.

Wrest-plank. (*Music.*) The part of the string-frame of a piano into which the *wrest-pins* are inserted.

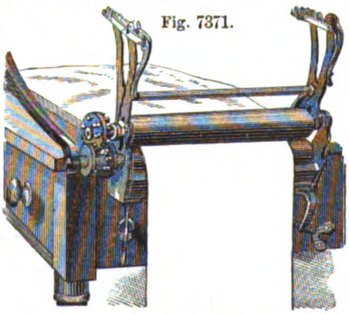
Wring'er. See WRINGING-MACHINE.

Wring'ing-ma-chine'. A machine for pressing or otherwise draining the water from cloth or clothes.

Bullman's washing and wringing machine (English patent, about 1828) had a pair of rollers, of which the lower one was turned by a crank, and the clothes passed between the two. The inventor of over forty years since very justly remarks that the ordinary wringing injures fine apparel; it is but very lately that the implement has been fairly introduced and then appeared as a novelty.

The vulcanized rubber for an elastic non-absorbing surface was the great need of the Bullman rollers.

Fig. 7371.

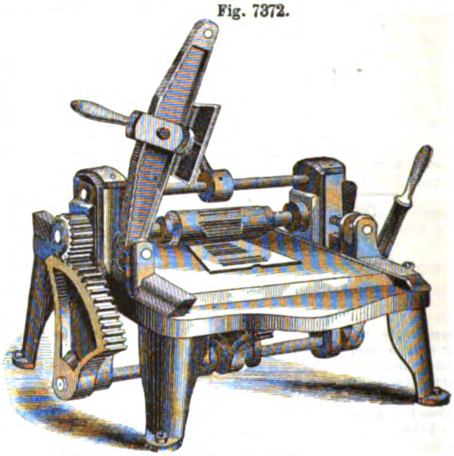


Palmer's Combined Wringer and Mangle.

Wrink'ling-ma-chine'. (*Leather.*) One to wrinkle transversely the upper leathers of boots and shoes (Stimpson's patent).

Wrist. 1. A stud or pin projecting from a wheel, and to which a pitman or connecting-rod is attached. The wrist and so much of the radius of the wheel constitute a crank.

Fig. 7372.

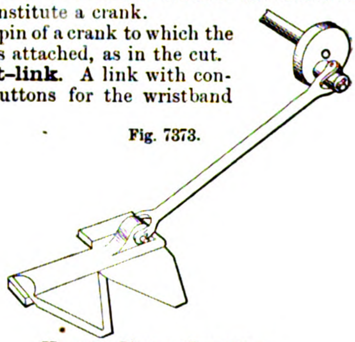


Wrinkling-Machine.

2. The pin of a crank to which the pitman is attached, as in the cut.

Wrist-link. A link with connected buttons for the wristband or cuff.

Fig. 7373.

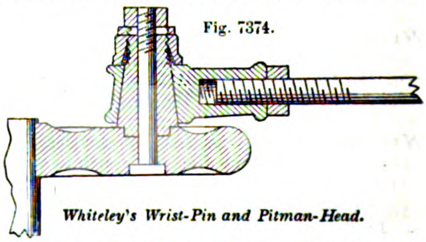


Harvester Pitman-Connection.

Wrist-pin. A pin passing through the axis of a wrist-connection.

In Fig. 7374, the wrist-pin is a truncate, conical, tubular piece attached to the crank-wheel by a bolt. The head of the pitman-rod is bored to fit this piece, and may be adjusted thereon to take up lost motion. The nut in contact with the head is recessed to form an annular oil-space.

Fig. 7374.



Whiteley's Wrist-Pin and Pitman-Head.

Wrist-pin Turn'er. A machine for turning wrist-pins while remaining in their places in locomotives or other engines; or the turning of journals on the end of a shaft. The machine can be applied for dressing and turning the pins when worn, or requiring renewing, without the necessity of removing them from the engine.

Writ'ing-case. A portable writing-desk or portfolio.

Writ'ing-desk. The writing-case, or *scrinia*, of the Romans was a place to hold the tablets, reed-pens, and styles. Usually a square or cylindrical box.

Figs. 7375, 7376, show the Wooton desk, made at Indianapolis, in its open and closed positions. The front portions opening to right and left have file boxes and shelves. The writing-table lets down, exposing a number of drawers, shelves, and pigeon-holes. Book-cases and drawers are below. It is a neat, handsome, and compact affair.

Fig. 7375.

(*Open.*)

Fig. 7376.

(*Closed.*)

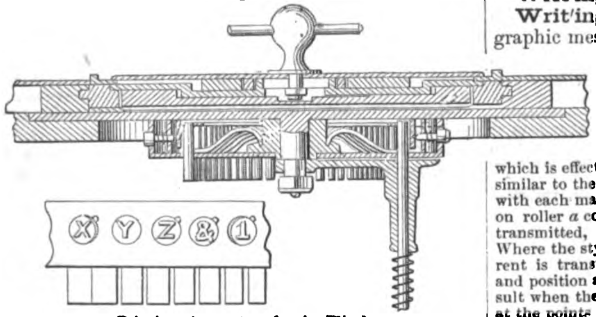
The "Wooton" Cabinet-Secretary.

Stiles's combination-desk is a Philadelphia invention. It is specially adapted for reading-rooms, and shuts up closely when out of use. When displayed, it has two writing-desks; the doors afford hooks for paper-files; cupboards and drawers hold archives, books, magazines.

Writ′ing-frame. Writing-frames for the blind consist of a frame in which a sheet of paper may be placed, and a horizontal straight-edge, which forms a guide for the hand in making a row of letters. The line being completed, the straight-edge is lowered one notch, and forms a guide for the next line, and so on.

The writing-frame adapted for the punctured alphabet of Louis Braille has a frame of the same character, but the brass-guide has two rows of oblong spaces, in each of which is punctured the system of dots, which represents a letter. The space is capable of holding six dots at such distances as to be readily

Fig. 7377.



Printing-Apparatus for the Blind.

distinguished by the touch, and the letters are expressed by the number and position of these dots in the parallelogram: —

o	o	oo	oo	o	oo	oo	o	o	o	oo
	o		o	o	o	oo		o	oo	o
							o	o	o	oo
a	b	c	d	e	f	g	k	o	t	y

The above are a few of the characters of Braille's alphabet, and the number of possible combinations is abundantly sufficient for the alphabet, punctuation-marks, accented letters, numerals, etc.

The advantage of Braille's system is that while it may be written with tolerable speed, it may be *read by the blind*, which is an important feature.

Johnston's printing-apparatus for the blind (February 19, 1867) is a machine for enabling a blind person to impress characters in rows and lines so as to be read by the sense of touch. The disk has a circular series of vertical plungers with raised letters on their lower ends to imprint the paper, which is properly fed beneath. Corresponding with the series of vertical plungers are horizontally moving plungers whose raised letters are exposed on the periphery to the touch of the operator. The letter being selected is pressed inward, and the rotation of the disk brings it to the stopping-place, at which an impulse is given to the vertical corresponding plunger. Each selected letter is brought to the same spot, being arrested by engagement with a depression in the stationary ring.

After an impression of a letter is delivered, the paper-frame is moved along one space, so that the next selected letter is impressed in proper succession. When the end of the line is reached, the paper-frame is fed upward, at right angles to its former motion, so as to open up a new space for another line of characters. The frame is also moved back in its former path so as to bring the initial point of the new line opposite to the opening at which the letters are presented. See PRINTING FOR THE BLIND, pages 1794, 1795.

Gall's apparatus, for enabling the blind to write, consisted of a frame on which the paper was placed, a cover with bars to guide the lines, which are written from the bottom upward, and of small stamps with the letters formed of common pins, which are pricked through the paper and read on the opposite side.

See United States patents, Nos.

62,206,	62,156,	71,084,
15,164,	125,024,	121,026.
132,370,		

Writ′ing-ink. This does not properly belong to our class of subjects, but we may spare room to state that

Good ink is made of a solution of per-tannate of iron. This salt is obtained by bringing a solution of tannin in contact with salts of the sesquioxide of iron, which yields a deep bluish-black precipitate.

Common writing-ink is made by adding to a clear infusion of nutgalls a solution of protosulphate of iron (green copperas). Mucilage is added to thicken and to prevent settling. This being a tannate of the protoxide is pale at first, but absorbs oxygen, and becomes a tannate of the sesquioxide, becoming black.

Oil of cloves or creosote will prevent molding.

Infusion of galls will restore faded writing.

The Scottish Society of Arts indorses the following to make a gallon of ink: —

Powdered nutgalls	12 ounces.
Sulphate of indigo	8 ounces.
Copperas	8 ounces.
Cloves	2 or 3 ounces.
Gum arabic	4 ounces.

Writ′ing-ma-chine′. See TYPE-WRITER; TYPOGRAPHER.

Writ′ing-pa′per. See PAPER, table, page 1610.

Writ′ing-tel′e-graph. One which sends autographic messages.

In one, a roller is covered with a ribbon of tin-foil, on which the message is written with a non-conducting varnish, and the roller is caused to revolve at the same time, having a slow endwise motion by means of a screw. A similar roller at the other end of the line is covered with a paper prepared with a solution which is effected by the electric action; this roller has a motion similar to the former. As the rollers rotate, a stylus in contact with each makes a spiral line around them. Where the stylus on roller *a* comes in contact with the tin-foil, the current is transmitted, and the effect is to make a mark on roller *b*. Where the stylus on roller *a* crosses the insulating ink, no current is transmitted, and a white mark of corresponding size and position appears on the prepared paper of roller *b*. The result when the paper is unrolled is a paper ruled all over except at the points where the lines of the message occur, these being white. See AUTOGRAPHIC TELEGRAPH.

Wrought. A term used by masons and carpenters in contradistinction to *rough.*

The dressing of stone is done by the pick, stone-hammer, mallet, and chisel.

The dressing of boards, by planer, etc. In this, the terms are expressive of the kind of work, as,

Wrought and framed.
Wrought, beaded, and framed.
Wrought, two sides and framed.
Wrought, framed, and rabbeted.
Wrought, framed, rabbeted, and beaded.
etc., etc.

Wrought-ir′on Fur′nace. See PUDDLING-FURNACE.

Wrought-ir′on Pipe. See TUBE.

Wye. A Y or crotch. Used in many ways as a temporary shore or brace. Also a name applied to a stem or pipe with branches, as a stand-pipe or delivery-pipe with two issues from its summit.

Wynd. A truck or low carriage.

X.

Xe'bec. (*Vessel.*) A small three-masted vessel with lateen sails, used for coasting voyages in the Mediterranean and on the ocean-coasts of Spain and Portugal.

Xy-log'lo-dine. An explosive compound invented by Carl Dittmar of Charlottenburg, Prussia.

It is a fluid of milky, reddish, or white color, of a consistency varying from that of ordinary sirup to thick broth, and is intended to be mixed with cellulose or other porous substance to form *dualin*, though it may be used singly.

It is composed of nitric and sulphuric acids, and either glycerine-starch, glycerine-cellulose, glycerine-mannite, glycerine-benzole, or analogous substance.

In its preparation commercial sulphuric acid is boiled with pulverized charcoal until it is freed from nitrogen and attains the density of 67° B. 1½ parts of this, or 1 part of the purified acid and ½ part of fuming sulphuric acid, are mixed with 1 part of thoroughly purified nitric acid, specific gravity 48° to 50° B., and the mixture is allowed to stand in a close vessel for from eight to fourteen days, during which time it is subjected to blasts of hot dry air, for the purpose of freeing it from nitrogen.

Glycerine-starch is prepared by roasting starch on iron plates until it turns reddish or yellowish brown, and mixing it with glycerine of 30° B. or upward, free from fatty acids, lime, and chlorine.

Glycerine-cellulose is prepared by treating sawdust, preferably from soft wood, with dilute acid, as hydrochloric, boiling it with an alkali, and afterward drying, pulverizing, and roasting until it turns of a yellowish brown color; it is then mixed with anhydrous glycerine.

Glycerine-mannite is prepared by thoroughly drying and pulverizing mannite, and mixing it with anhydrous glycerine of 30° B.

Glycerine-benzole is prepared by mixing benzole, or benzole-toluole, with anhydrous glycerine of 30° B.

Either of the above, or other suitable substance, analogously prepared, is mixed with the acid mixture above described, in the proportion of about 1 part to 8 or 10 of the acids, and the compound treated to a bath of pure water, or placed in an iron or leaden vessel, when the acids separate from the nitrated compounds; the former being drawn off may be made serviceable for other purposes.

The nitrated substances freed from acid are placed in a bath of soda-lye and stirred until they impart a blue color to reddened test-paper.

They are again washed in pure water, and then rendered anhydrous by being placed in flat chambers and dried with sulphuric acid and chloride of calcium, at a temperature not exceeding 50° C.

A simple apparatus, consisting of a tank, with chambers or worms, and provided with suitable connecting-pipes, has been contrived by the inventor, for mixing and cooling the compound.

Dittmar's patent, for *dualin*, January 18, 1870, embraces "cellulose, nitro-cellulose, nitro-starch, nitro-mannite, and nitro-glycerine, mixed in various combinations, depending on the degree of strength which it is desired the powder should possess in adapting its use to various purposes.". See DUALIN.

Xy'lo-graph. 1. A WOOD-ENGRAVING (which see).

2. Specifically, a mode of printing or graining from the natural surface of the wood.

A piece of wood is selected of fine quality, having the pattern of grain desired. The surface is treated chemically to open the pores. After it is dry the surface is painted and a sized sheet of paper laid over the board, and both run together between rollers in the manner of copperplate-printing. The paint is then transferred to the board, the differences in the absorbent qualities of the board determining the depth of color. The paper is laid face downward on the article to be ornamented, and rubbed on the back with a soft pad to transfer the impression.

Xy-loid'ine. Another name for XYLOGLODINE (which see).

Cotton or other woody fiber treated with sulphuric and nitric acids. See GUN-COTTON; also, Spill's patents, Nos. 91,377 and 101,175.

Xy'lo-phone. See HARMONICON; WOOD-HARMONICON.

Xy'lo-py-rog'ra-phy. Sometimes called *poker-painting*.

When a hot iron is applied to the surface of the wood, it chars or scorches the wood wherever it touches; and if the operator possesses artistic taste, he can so manage these charred lines as to give them a pictorial arrangement. There were some specimens of this kind in the Great Exhibition, which displayed surprising skill, especially where the surface was charred all over, and then scraped to produce the picture, as in mezzotint.

Copies from Landseer's pictures, and other subjects, have been thus produced with much boldness of effect. The production of designs by pressure depends upon a singular circumstance. If wood be pressed by suitable instruments, it does not recover its original evenness of surface until it has been steeped in water. The artist produces a sort of design on wood, by strong pressure in particular parts; he planes down the protuberant portions, and then soaks the whole in water; this brings up the pressed, or hardened lines, which thereafter stand up as a sort of bas-relief. It is impossible, however, to produce such effectual results by this as by the charring process.

Xys'ter. A surgeon's bone-scraping instrument.

Xys'tus. A long piazza or walk, covered or uncovered.

Y.

Yacht. A decked pleasure-vessel.

There are about 1,300 yachts in Great Britain, averaging 30 tons. The rigs are various, and many American and European yachts now have steam-power as an accessory, or for use during calms.

The name *yacht* first occurs in English naval records, 1660.

The *thalamegus* of the ancients.

Yan'kee Gang. An arrangement in a saw-mill (Canada) adapted for logs of 21 inches diameter and under. It consists of two sets of gang-saws, having parallel ways in the immediate vicinity of each other. One is the *slabbing-gang*, and reduces the log to a balk and slab-boards. The balk is then shifted to the *stock-gang*, which rips it into lumber. See SLABBING-GANG; STOCK-GANG.

Yard. 1. (*Nautical.*) A spar slung from a mast and serving to extend a sail.

Square sails on yards are shown in the paintings of Eléythya, and elsewhere in Egypt.

Yards are either square, lateen, or lug-sail. Yards for square sails are suspended across the mast at right angles, and are of a cylindrical form, tapering from the middle, which is termed the slings, toward the extremities, which are called the yard-arms. At the slings is the place of the given diameter. The distance between the slings and the yard-arms on each side is quartered, the divisions being distinguished as the first, second, and third quarters, and yard-arms.

They are connected with the mast by a *truss*, or *parral*, which slips up and down the mast, at the slings or midlength.

A yard is named from the mast to which it is attached, and its position thereon, as *fore* or *main yard*; *fore*, *main*, or *mizzen topsail yard*, *topgallant*, or *royal yard*, etc. The *jack-stay* runs along the upper edge of the yard, and has a rod, or perforations, to which the sail is bent. Beneath the yard are *stirrups*, by which the *horse*, or *foot-rope*, is suspended.

The lower yard on the mizzen-mast is called a *cross-jack yard*; it is occasionally carried by a cutter for using a square sail when running before the wind.

A *spritsail-yard* is a spar sometimes carried by vessels, crossing below the bowsprit, a short distance abaft the *dolphin-striker*. It is used for securing the rigging of the jib-boom and flying jib-boom.

Studdingsail-yards are slung from the *studdingsail-booms*, and from the fore and main topgallant yard-arms.

The *ring-tail yard* is slung from the peak.

The sails bent on to yards are known as *square*, *lug*, *lateen*, and *settee* sails. See SAIL.

The lug-sail yard is slung at about $\frac{1}{3}$ of its length from the *peak*.

A *settee* is intermediate in this respect between a *lug*-sail and a *lateen*.

A *lateen*-yard is slung at a point about $\frac{1}{4}$ of its length from the peak, and assumes an angle of about 45°.

A yard is

Swung: that is, raised and secured by its truss, or parral.

Struck; unfastened and lowered.

Trimmed; adjusted to the state of the wind, or for parade occasions brought to a position exactly athwartships.

The main-yard of a first-rate is about 100 feet long and 2 feet in diameter at the slings.

2. A measure of length, equal to three feet, into which it is divided; for the yard is the unit, and is equal to [illegible] parts of the length of a second's pendulum vibrating in vacuo in the latitude of London at the level of the sea in a temperature of 60° Fah.

Yard-tack'le. (*Nautical.*) A *threefold* tackle depending from the end of a lower yard-arm, for lifting boats and other weights.

Yarn. Thread prepared for weaving.

1. Cotton yarn is numbered according to the number of hanks contained in a pound of 7,000 grains. Each *hank* or *skein* measures 840 yards.

At the great exhibition of industry, London, 1853, Mr. Houldsworth of Manchester exhibited cotton yarn Nos. 100 to 2,150.

No. 100 single cotton yarn weighs 70 grains.

No. 500 single cotton yarn weighs 14 grains.

No. 700 single cotton yarn weighs 10 grains.

One pound weight of No. 2,150 extends upwards of 1,000 miles in length.

Houldsworth is said to have attained a fineness represented by No 10,000, one pound of which would extend 4,770 miles. This is marvelous.

Yarn is made into hanks on a reel $1\frac{1}{2}$ feet in circumference, 80 revolutions of which make a *lay* of 120 yards; 7 *lays* to a *hank* of 840 yards.

Previous to the invention of the mule, the limit of fineness ordinarily reached in England was No 200. The natives of India reached from Nos. 300 to 400. As appears by the above figures, the *mule* has revolutionized this matter, leaving all mere hand skill far in the rear.

2. Worsted yarn has 560 yards to the *skein*.

Woolen yarn has 1,600 yards to the *skein* or *run*.

3. Linen yarn is wound upon reels, and made up into *leas*, *hanks*, and *bundles*.

The reels differ in size, being respectively $2\frac{1}{2}$ and $1\frac{1}{2}$ yards round.

120 threads of $2\frac{1}{2}$ yards	= 300 yards	= 1 *lea*.
10 *leas*	= 3,000 yards	= 1 *hank*.
20 *hanks*	= 60,000 yards	= 1 *bundle*.
3 *bundles*	= 180,000 yards	= 1 *bunch*.

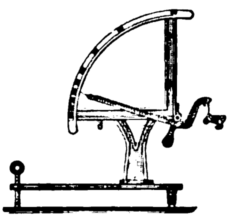
Of the smaller reel: —

100 threads of $1\frac{1}{2}$ yards	= 150 yards	= $\frac{1}{2}$ *lea*.
$10\frac{1}{2}$ *leas*	= 1,500 yards	= $1\frac{1}{2}$ *hanks*.
$40\frac{1}{2}$ *hanks*	= 60,000 yards	= 1 *bundle*.

The fineness of linen yarn is reckoned by the number of *leas*, of 300 yards to the pound (cotton, it will be recollected, is reckoned by the number of *hanks*, of 840 yards to the pound), so that 25 or 400 *leas* represent that those rather extreme numbers have that number of *leas* in the pound weight; 7,500 yards and 120,000 yards, respectively, in length of thread.

Another mode of reckoning the grade of a linen yarn is by the weight of the bundle of 60,000 yards. Thus, a bundle of 25 *leas* to the pound weighs 8 pounds; a bundle of 100 *leas* to the pound weighs 2 pounds; etc.

Fig. 7378.



Yarn-Assorter.

Fig. 7379.

Yarn Guide and Clearer.

Yarn-as-sort'er. A kind of bent-lever balance used for ascertaining the size of yarn. A skein is placed in the pan, and a pointer indicates its number on the graduated arc. The assorter for cotton requires a different graduation from that for woolen yarn.

Yarn-beam'ing Ma-chine'. A machine for winding the warp-yarn on to the beam. See WARPING-MACHINE.

Yarn-clear'er. A fork or a pair of blades, set nearly touching, so as to remove burls or unevenness from yarn passing between them.

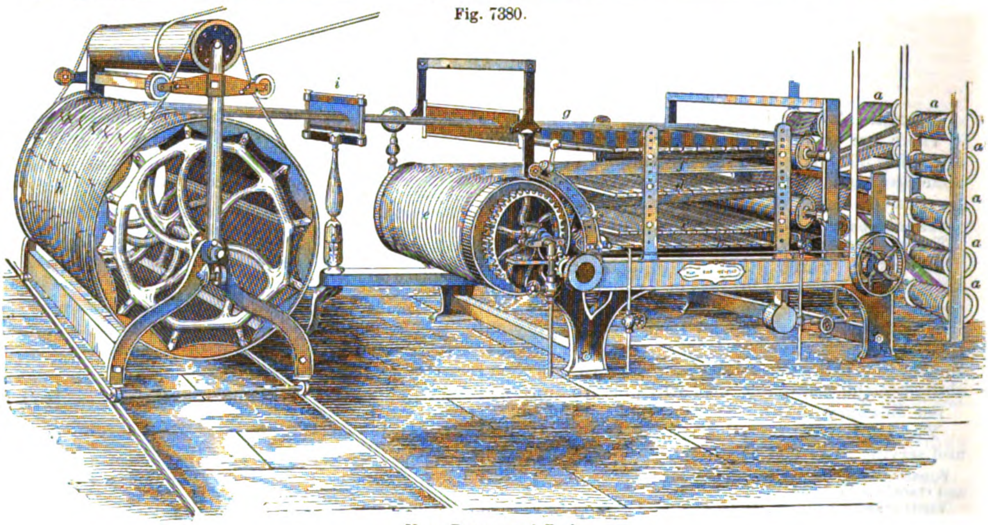
Yarn-dress'er. A machine for sizing and polishing yarn.

In the example (Fig. 7380), it consists of a creel carrying rollers *a a*, which deliver their yarn over another roller, from which it dips beneath the surface of the size in a size-box and is thence led upward, passing devices which whip or brush it to remove superfluous size and give it a polish; it thence is conducted over rollers back and forth, above and below several series of steam-heated pipes arranged flatwise in stories. The letters *b c d e f g* show the course of the yarn which passes through a reed *i*, and is then wound upon a reel *h* in separate hanks, representing the contents of the separate rollers *a a*.

Yarn-me'ter. A counter to show the quantity of yarn each spindle has been making.

Brown, Sharpe, & Co.'s yarn-meter indicates the quantity in hanks and decimal parts They are attached to the front side of one end of the head-rail of a slubber, fly-frame, spinning-frame, or mule. A worm is attached to the end of the front roll, which gears into a wheel on the shaft. A wheel of 77 teeth

Fig. 7380.



Yarn Dresser and Reel.

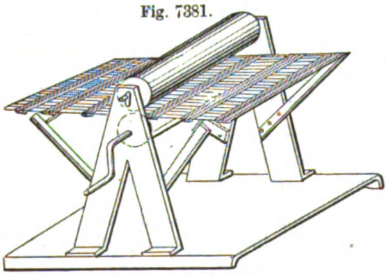
is suitable for a front roll $1\frac{1}{4}$ inches in diameter, 86 teeth for $1\frac{1}{8}$ inches roll, 96 teeth for 1 inch roll.

Yarn-print′er. A machine for printing warps previous to weaving. This plan is adopted with some kinds of cheap goods to make stripes across the fabric, as with common carpets. A cheap kind of figured tapestry-carpet is also made by printing in the patterns so as to come right when the warp is raised up in loops upon the face of the goods.

In Fig. 7381, the desired number of skeins are stretched upon the wire-netting so as to be firmly held thereon, the coloring-matter being allowed to penetrate the yarn, so as to leave an even impression upon both sides of the fold.

In Fig. 7382, the yarn is printed between fluted or engraved rollers. The yarn is only exposed to pressure between the

Fig. 7381.



Machine for Printing Yarn.

ridges of the fluted roller and the opposite portions of the smooth roller, and takes up the color only at those points from the surface of the printing-rollers.

In patent 83,103, means are employed for causing the color-feeding rolls to skip, during the revolution of the printing-cylinder, all those ribs which are to be furnished with some color other than that which they supply respectively.

Yarn-reel. A machine for winding yarn from the cop or bobbin.

The bobbins are placed on the skewers, and, the index-finger on the counter being placed at zero, the ends of the yarns are attached to a bar of the reel, which is then rotated until a gong sounds or the finger has made a revolution of the dial. The *cuts* or *leas*, of a determinate length, say 80 times the circumference of the reel, equal to 120 yards (80 threads of $1\frac{1}{2}$ yards each, or $^1/_7$ of a *hank*), are then weighed.

Yarn-scale. One for showing the weight of a certain length of yarn, say a *hank*.

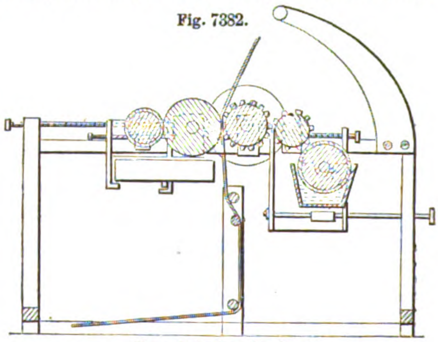
Brown and Sharpe's shows the weights of all numbers in troy grains.

Yarn-spool′er. A winding-machine for filling spools or bobbins for shuttles or otherwise. The yarn is on a beam, which has a brake to determine the tension. The yarn is led between rollers and through eyes to the spindles, which are rotated by gearing in the box beneath.

Yarn-test′er. An instrument for determining the strength of yarns.

A cut of the yarn to be tested is passed over two hooks, one of which, by turning a hand-wheel *a* that operates a screw,

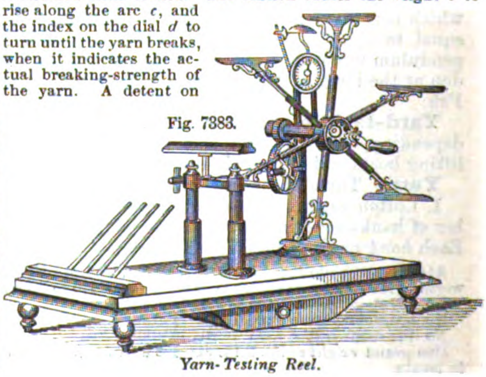
Fig. 7382.



Yarn-Printing Machine.

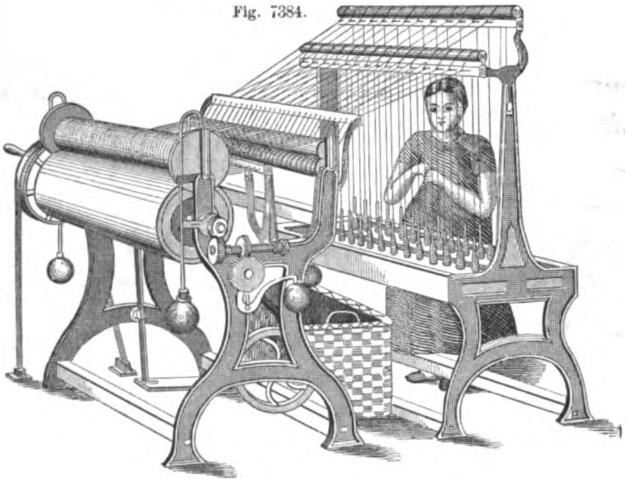
is caused to recede from the other. By this means the yarn is strained until broken. The tension causes the weight *b* to rise along the arc *c*, and the index on the dial *d* to turn until the yarn breaks, when it indicates the actual breaking-strength of the yarn. A detent on

Fig. 7383.



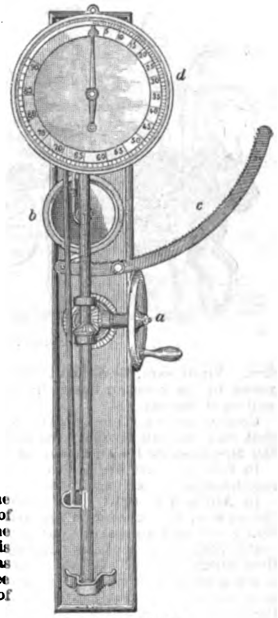
Yarn-Testing Reel.

Fig. 7384.



Yarn-Spooler.

Fig. 7385.



Yarn-Tester.

the weight engages one of the teeth on the arc *c* and prevents it from falling. An attachment also indicates the range of elasticity of the yarn.

Yarn-wind'er. See YARN-REEL; YARN-SPOOLER; etc.

Yas'mas. A dyed and printed Swiss fabric.

Yawl. (*Nautical.*) *a.* A decked boat carrying two masts, one of which is near the stern. It is usually lugger or cutter rigged, the after-mast, called a *jigger*, being the smaller.

b. A ship's boat. A *jolly*-boat, usually from 23 to 28 feet long, and ¼ to ⅓ that breadth of beam.

In the British navy it is the fifth boat in point of size; the others being the *launch*, *long-boat*, *barge*, and *pinnace*.

Yel'low-ing. A process in the manufacture of pins: boiling in an aciduous solution, previous to nurling and tinning.

Yel'low-met'al. A sheathing alloy of copper, 2; zinc, 1.

Yer'gas. A coarse woolen fabric for horse-cloths.

Y-lev'el. An instrument for measuring distance and altitude.

Yoke. 1. A bar which connects two of a kind, usually; as the *ox-yoke*, fastened by bows on the necks of a pair of oxen, or by thongs to the horns or foreheads of the oxen in some countries.

"The most approved kind of harness for cattle," says Loudon, "is little different from that of the horse, excepting in the shape of the collar. In many places, however, and especially on the Continent, the ox draws solely by the withers, by means of what is called a *yoke* and *bows*."

He recommends saddles for hitching singly in carts; also breeching, bridles, halters, and reins.

Post's ox-yoke has hinged plates secured to the top of the yoke, the free ends engaging in notches in the bows. They are substitutes for keys and are not apt to be lost off.

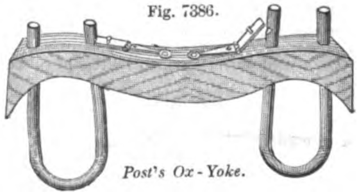
The cattle-yoke of ancient Egypt was various in construction. Sometimes a cross-bar, fastened at the end of the tongue, was lashed to the horns, and at other times we see an angular frame, with openings which fit around the necks, bearing against the shoulders of the animals; a very rough form of double collar for the span of animals. A much more ingenious and complicated contrivance is shown in the cut, which is of a yoke taken from an ancient tomb, and now in the collection of D'Anastasi. The long bar was attached to the end of the tongue and rested on the withers of the cattle, each end being lashed to a pair of cross-pieces shown in the other figure. These lay on each side of the shoulder, and had pads of matting to prevent galling. The strap went under the throat, and served to keep the yoke in place.

All draft animals in old Egypt pulled by the yoke, whether cattle and asses in the fields, or horses to the chariots. In the latter case, the yoke was a splendid affair, having two concavities, which rested on the withers of the horses, the yoke being held in place by neck-bands and girths. See CHARIOT.

Elijah found Elisha in the field, with twelve yoke of cattle before him, and he with the twelfth. This means twelve plows and as many yoke of oxen. (See PLOW.) Job had 500 yoke of cattle.

Horses were yet *yoked* to the poles of the chariots in the time of Xerxes. The sacred chariot of Jupiter (Ormusd), mentioned by Xenophon in his description of the train of Cyrus, had golden yokes and was drawn by white horses. The Persian monarchs fought from chariots down to the time of the Macedonian conquest. The white horses were raised on the Nicæan plain, in Media, and were a peculiar breed belonging to the king. The Greeks captured them from Xerxes after the defeat at Salamis. The curious yoke over the withers of the Russian horses is probably a survival of an old type. Oxen (1000 B. C.) were yoked by the horns in Greece (HOMER).

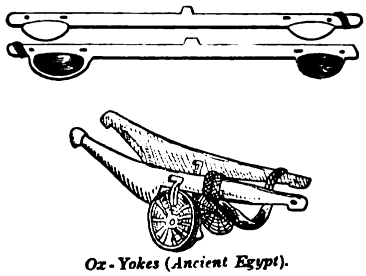
Fig. 7386.



Post's Ox-Yoke.

A knotted thong secured the yoke to the pole of the chariot of Gordius, king of Phrygia. It was a complicated tie, and formed the famous Gordian knot which was cut asunder by the sword of Alexander; his favorite mode of solving a difficulty.

Fig. 7387.



Ox-Yokes (Ancient Egypt).

Varro (50 B. C.) recommends that in breaking oxen "their necks should be put between forked stakes, one for each bullock," and be gentled while thus fastened by hand-feeding. "Then join an unbroken one with a veteran"; load light at

Fig. 7388.

Cheetah-Cart.

first. Virgil says, begin with them when calves. They were yoken by the horns or neck, the latter being preferred by the writers of the day.

Columella (50 B. C.) condemns yoking by the horns, and states that they can pull better by the neck and breast, which is true. His directions for the treatment of oxen are full and excellent.

In Tuscany, oxen are guided by reins attached to rings passing through the cartilage between the nostrils.

In Africa, a straight stick takes the place of the ring, and the ends of the bridle-rein are attached to it. The ox is the riding and pack animal of Central Africa.

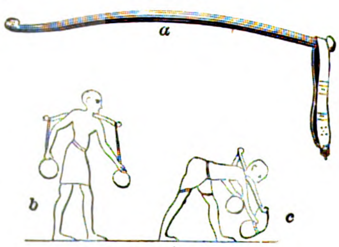
Fig. 7388 is a view of the cheetah, or hunting-leopard cart, from which he is let loose when the prey is seen. The drawing is taken from a model made in the Bombay Presidency, India, and exhibited at the World's Fair, London, 1851. It shows the heavy tongue, which forms a seat for the driver.

2. The *neck-yoke*, by which the fore end of the tongue is suspended from the hames or collars of a span of horses. See NECK-YOKE.

3. A frame to fit the shoulders and neck of a person, and support a couple of buckets suspended from the ends of the yoke.

The ordinary yoke, worn upon the shoulders, and used so commonly in Europe for suspending buckets, etc., in carrying, is found represented very frequently in the Egyptian tombs.

Fig. 7389.



Yokes (from Thebes).

The figures *b c* in the accompanying cut are represented carrying water to irrigate plants.

a represents a wooden yoke and leather strap found by Mr. Burton at Thebes, and brought by him to Europe.

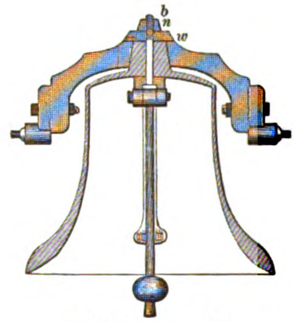
4. Devices to be attached to breachy animals, to prevent their crawling or breaking through or jumping over fences, are sometimes called *yokes*. They are also known as *pokes*, the term *yoke* being more properly applied to the draft attachments of animals, as *ox-yokes*, *neck-yokes*, *shoulder-yokes*.

5. (*Nautical.*) A bar attached to the rudder-head and projecting in each direction sideways; to its ends are attached the steering-ropes or *yoke-lines*, which are handled by the coxswain or steersman, or pass to the drum on the axis of the *steering-wheel*. The *yoke* is principally used in rowing-boats.

6. A cross-bar from which a bell is suspended.

Hildreth's rotary yoke is adapted to a round-shank bell. It contains a conical aperture into which the shank enters, the bell being secured to the yoke by a screw-threaded bolt *b*, to which the clapper is hinged; *n* is a nut, and *w* a washer. This device admits of the bell being turned, so that the clapper may be made to strike at any point of its circumference, thus avoiding the constant wear at two opposite points, which results from the common mode of hanging, and which ultimately destroys the bell.

Fig. 7390.



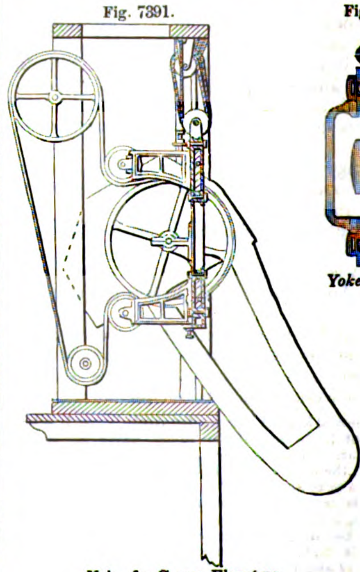
Hildreth's Rotary Yoke.

7. A branching coupling-section, connecting two pipes with a single one, as the hot and cold water pipes, with a single pipe for a shower-bath.

8. A head-frame of a grain-elevator, where the belt passes over the upper drum and its cups discharge into the descending chute.

In Fig. 7391, the head-frame of the elevator is vertically adjustable in guides; its lower end entering the hold of the vessel. The belt is passed beneath one pulley of the adjustable frame and over another of the same, so as to allow of vertical movement of the same without affecting the belt. See also ELEVATOR.

Fig. 7391.



Yoke for Grain-Elevators.

Fig. 7392.

Yoke-Arbor.

9. A form of carriage clip which straddles the parts, and is tightened by nuts beneath the plate.

Yoke-ar'bor. A form of double journal-box for pulley-spindles, in which a curved branch extending from one bearing to the other on each side of the pulley serves to protect the belt from being chafed or otherwise injured.

Yok'ings. (*Mining.*) Pieces of wood used for designating possession. *Stowces.*

Yufts. A kind of Russia leather.

Z.

Zam-pog'na. The Italian bagpipes; probably allied to the *sumphonia*, of the Book of Daniel, in the Hebrew version. It was probably a syrinx with bellows, the original type of the organ.

The bagpipes in the *tibia utricularis* of the Romans. See BAGPIPES.

Zawn. (*Mining.*) A cavern.

Zax. A slater's hatchet, with a sharp point on the pole, for perforating the slate to receive the pin. *Sax; saixe.*

The zax is about 16 inches long and 2 in width; it is somewhat bent at one end, and the spur is 3 inches long.

Ze'nith-sec'tor. Invented by Hooke, about 1699, to ascertain whether or no the earth's orbit had any sensible parallax. As modified by Airy, it is principally used in geodetical operations. It serves to determine the zenith point and the zenith distances of stars.

Ze'nith-tel'e-scope. A geodetical instrument, invented by Captain Talcott, United States Engineer, for measuring the difference of the zenith of two stars, as a means of determining the latitude. Two stars are selected which pass the meridian about the same time and at about equal distances from the zenith, but on opposite sides of it. It has adjustments in altitude and azimuth, has a graduated vertical semicircle and a level, and a micrometer for measuring the distances between the stars.

Ze'nith-tube. Invented by Airy. It is used at Greenwich for stellar observations.

Zig'zag. 1. (*Fortification.*) One of the trenches leading toward the besieged works, and communicating between the several *parallels*.

It turns to the right and to the left, but with a general curved course, in such a manner as not to be enfiladed by the guns of the fort.

The *approaches* to Sebastopol, including the *zigzags* and *parallels*, embraced 70 miles of sunken trenches, and required no less than 60,000 fascines, 80,000 gabions, and 1,000,000 sand-bags, to protect the men working in the trenches and at the different batteries.

2. A winding chute on the face of a dam to enable fish to ascend. A *salmon-stair; fishway; fish-ladder*.

Zinc. Equivalent, 32.5; symbol, Zn.; specific gravity, cast, about 6.8; rolled, 7 to 7.2; fusing-point, 773° Fah.

A rather hard bluish-white metal, tough and not easily broken by blows of the hammer, in its ordinary state at common temperatures, but when heated to a point approaching that of fusion it becomes brittle. At temperatures between 210° and 300° it is ductile and malleable, and may be rolled into thin sheets and drawn into moderately fine wire, which, however, possesses but little tenacity. It preserves its malleability after rolling. Sheet-zinc is largely used as a covering for roofs and for other purposes, and the metal is also used for coating iron, which is then commonly said to be *galvanized*. For this purpose the iron is dipped into dilute sulphuric acid to remove scale, and then plunged into a bath of molten zinc, covered with sal-ammoniac. Combined with copper it forms brass; with the addition of tin and other metals various similar alloys are formed, some of which are distinguished by specific names. The prepared oxide is extensively used as a pigment, and the sulphate is the *white-vitriol* of commerce. It is not found native. Its principal ores are the *red oxide*; the carbonate, or calamine; the sulphide, or *blende*, the dark varieties of which are termed *black-jack* by the English miners; and the silicate, which is usually found associated with the carbonate. The metal itself was unknown to the Greeks, Romans, and Arabians, and in fact in Europe previous to about the middle of the sixteenth century, though it is said to have been used in India and China from an early period.

It is produced in England, France, Belgium, Germany, and in New Jersey and Pennsylvania.

The fact that certain ores yielded a yellow copper (brass) was early known, and the product was highly esteemed; but it was not understood that it was a true alloy, nor was zinc obtained distinctly. This was partly owing to the fact that zinc vaporizes at a certain heat, and the sublimed portions which adhered to the sides of the furnace had no appearance of metal. Mines yielding this gold-colored metal were highly esteemed, and when exhausted the fact was lamented; but in course of time it was discovered that the addition of a certain stone (calamine) to copper, when melting, gave it the desired yellow color. This earth was used for the specific purpose, but it was long ere the truth was elicited that calamine was a metallic ore, and yielded its base to form an alloy with the copper. See BRASS.

Aristotle, Strabo, and various other writers refer to an earth which conferred a yellow color on copper. Brass was considered a more valuable kind of copper.

Ambrosias, Bishop of Milan in the fourth century, Promasius, Bishop of Adrumetum, in Africa, in the sixth century, and Isidore, Bishop of Seville in the seventh century, mention an addition by which copper acquired a gold color. This was, undoubtedly, calamine.

Albertus Magnus (1205–1280) speaks of calamine as a semi-metal.

The *furnace-calamine*, or sublimated zinc, with which the furnaces and chimneys were lined, where zinc-yielding ores were smelted, was thrown aside as useless until the middle of the sixteenth century. It had a place in the pharmacopœia, but this use required but a small portion of the quantity produced.

Erasmus Ebener, who died in 1577, used the furnace-calamine instead of native calamine for making brass. This was introduced at Rammelsberg about 1557. Its use in this connection had been previously described by Albertus Magnus.

White vitriol, the sulphate of zinc, was long prepared, used, and employed before it was known that it was a salt of zinc. It is said to have been first made by Duke Julius at Rammelsberg, in 1570. Its application to make an eye-water is its first recorded use.

The ore (calamine) whose effect on copper had been known for so many centuries is first described as a distinct metal by that brilliant absurdity Paracelsus (died 1541), and is called *zinc*. He says: —

"There is another metal, zinc, which is in general unknown. It is a distinct metal of a different origin, though adulterated with many other metals. It can be melted, for it consists of three fluid principles, but it is not malleable. In its color it is unlike all others, and does not grow in the same manner, but with its *ultima materia*. I am as yet unacquainted, for it is almost as strange in its properties as argentum vivum" (quick-silver).

In the preparation of metallic zinc, as practiced in this country, by what is known as the Belgian method, the ore, having been broken and calcined, is mixed with 33 per cent of crushed coal, and the mass is distributed in charges of 27 pounds to retorts, of which there are 56 in each furnace, arranged in tiers. The orifices of the retorts are cemented in conical tubes of fire-clay, projecting 18 inches beyond the sides of the furnace, and the interspaces sealed with fire-clay. The furnace is then fired up until a heat of 2160° Fah. — the vaporizing point of zinc — is attained. The carbon combines with the oxygen in the ore, and the metallic vapor is condensed into the liquid form by the projecting tubes, which have a temperature below that of the vaporizing point of the metal.

At intervals the molten metal is withdrawn from the retorts, by means of iron hooks or scrapers and is received in large ladles, from which it is poured into iron molds, forming slabs weighing 30 pounds each. The gases issuing from the orifices in the condensers during the process burn with the most vivid flames and varied colors. Two charges are worked each day. While still hot, the slabs of zinc are taken from the molds and rolled into rough thick plates, 10×18 inches; from nine to twelve of these are placed in an iron box, and, the boxes being placed in a furnace, the pack of plates is removed from the furnace and the whole rolled out together, each plate forming a sheet, when trimmed, 7 feet long by 3 feet wide.

In making oxide of zinc, or *zinc-white*, the carbonate and silicate of zinc, as they come from the mine, are crushed, mixed with 33 per cent of coal, and heated in large fire-brick furnaces, provided with an air-blast, the oxygen from which combines with the metallic vapor as fast as it is liberated. The oxide thus formed is conveyed by a blast into a shaft, whence the white flocculent vapor, which is contaminated with various impurities, is driven by blowers through a series of chambers connected by pipes. The impurities are successively deposited, the purest vapors passing through pipes and being finally condensed, as an almost impalpable white powder, in muslin bags attached to the pipes.

It has been proposed to employ zinc for extracting gold from auriferous rocks. The pulverized rock is gradually introduced into a bath of molten zinc, which combines with the precious metal, while the refuse rises to the top and can be skimmed off. The gold may be subsequently separated by distilling the alloy, the zinc passing over and leaving the precious metal behind.

ZINC-SHEETS.

Thickness and Weight per square foot.

Inch.		Inch.	
.0311	= 10 ounces.	.0611	= 16 ounces.
.0457	= 12 ounces.	.0686	= 18 ounces.
.0534	= 14 ounces.	.0761	= 20 ounces.

Zinc-cem′ent.

Soret's cement is formed by making oxide of zinc into a paste with a solution of chloride of zinc. This paste quickly sets into a hard mass, which may be applied for stopping teeth and a variety of useful purposes. Dr. Tollens gives a cheaper form of the same cement, which may be used for stopping cracks in metallic apparatus, and cementing glass, crockery-ware, and other materials. He mixes equal weights of commercial zinc-white and very fine sand, and makes the mixture into a paste with a solution of chloride of zinc, having the density 1.26. The mixture sets rapidly, but allows plenty of time for its application. As it resists the action of most agents, it is very useful in the chemist's laboratory.

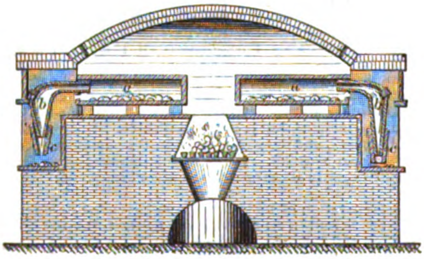
Zinc-fur′nace. The carbonate of zinc (*calamine*) and the sulphuret of zinc (*blende*) are smelted by mixing with charcoal in a crucible or retort, and then heating. For the production of the white oxide a process of dry distillation is instituted, and the fumes of the metal are conducted off, condensed and collected for a pigment. For the metal air is excluded from the chambers. See ZINC-WHITE.

Benecke and Shear's zinc-furnace (English) is intended for the distillation of zinc by the process following: —

The ores are roasted in the ordinary way, by stratifying them with fuel and setting fire to the pile.

The ore is then spread out in the air and lixiviated to remove the sulphate of zinc. It is then dried, pulverized, roasted to extricate the sulphur, powdered, mixed with carbonaceous matters, and saturated with an alkaline lye.

Fig. 7393.



Zinc-Furnace.

The prepared ore is then placed in the fire-clay retorts *a*, being introduced at the opening, which is afterward occupied by the neck of the head-piece *b*. *d* is an opening at which spent ores are removed, and is closed and luted during the firing. A lengthening tube *c* is added to the head-piece *b*. The vapor which is sublimated from the ore becomes cooled in the head-piece *b*, and is condensed upon an iron plate beneath. This condensing-chamber is separated by partitions from those of the neighboring retorts, and all points of access are carefully luted. The operation is observed by a glazed eye-hole. The retorts are arranged in two ranks and heated by the fire between them.

See zinc-furnace patents: —

No.	Name.	No.	Name.
91,051.	Thoma.	99,145.	Adams.
91,052.	Thoma.	145,450.	Richter.
46,198.	Webster.	16,594.	Kent.
6,180.	Boyden.	17,333.	Mamier.
32,840.	Müller.	25,267.	Kalbach.

See also ZINC-WHITE.

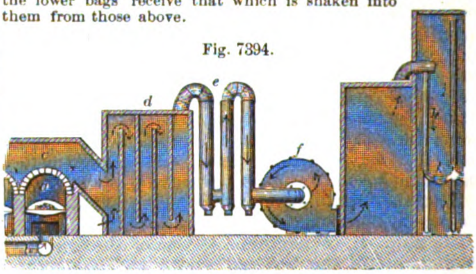
Zin′code. The positive pole of a galvanic battery.

Zinc-og′ra-phy. The design is drawn on the zinc-plate with a material which resists acid. The surface of the plate being *bit* away leaves the design in relief to be printed from by the ordinary mode in printing from woodcuts. The process does not appear to have made much headway since its introduction in 1816, though some beautiful specimens were made in England more than thirty years back. See PANICOGRAPH; GALVANOGRAPH; GALVANOPLASTIC PROCESS.

Zinc-white. Zinc-white (oxide of zinc; ZnO.) is a white powder obtained by the sublimation of the red oxide. This is found in abundance at Mount Sterling, N. J. It is pulverized, mixed with coal, heated in brick retorts, through which blasts of air are passed. The oxygen of the air combines with the vapor of the zinc, and the flocculent oxide is carried off by the draft of air through tubes leading to a chamber where the *zinc-white* falls in the shape of a fine powder.

Fig. 7394 shows the arrangements adopted in the preparation of zinc-white (oxide of zinc). The several furnaces *a* have openings in their tops, communicating with a common flue *c*. The finely ground zinc ore, mixed with its bulk or more of fine anthracite coal, is charged into the furnaces, and the mass, when ignited, is fed with a blast of air from a pipe *b*, affording the oxygen necessary for oxidation; the vapor passes through the chamber *d*, which is provided with vertical partitions, extending from the top and bottom, where its progress is checked sufficiently to allow any ash and coal passing over to settle; it is withdrawn thence by the fan *f* passing through the ascending and descending pipes *e*, and forced into a second chamber, where it is cooled and farther purified. It is thence distributed by downcast pipes *h* among a series of horizontal and vertical flannel bags *j k l*, in which it is condensed as a fine white powder; the lower bags receive that which is shaken into them from those above.

Fig. 7394.



Zinc-White Apparatus.

List of United States Patents for Zinc-White.

No.	Name and Date.	No.	Name and Date.
7,351.	Leclaire *et al.*, May 7, '50.	20,926.	Wharton *et al.*, July 13, '58.
8,308.	Seymour, August 26, '51.	27,142.	Millbank, Feb. 14, '60.
8,477.	Adams, Oct. 28, '51.	32,320.	Titterton, † May 14, '61.
8,756.	Jones, Feb. 24, '52.	33,911.	Weissenborn, Dec. 10, '61.
10,574.	Renton, Feb. 28, '54.	36,414.	Lewis, Sept. 9, '62.
10,696.	Jones, Mar. 28, '54.	37,190.	Wharton, Dec. 16, '62.
10,711.	Trotter, Mar. 28, '54.	38,493.	Lewis, May 12, '63.
12,329.	Selleck, Jan. 30, '55.	43,587.	Jenkins *et al.*, July 19, '64.
12,333.	Trotter, Jan. 30, '55.	67,839.	Bartlett *et al.*, Aug. 20, '67.
12,418.	Wetherell, Feb. 20, '55.	69,573.	Mills, Oct. 8, '67.
12,613.	Gardner, Mar. 27, '55.	72,032.	Hall, Dec. 10, '67.
13,332.	Jones, July 24, '55.	73,146.	Wetherill, Jan. 7, '68.
13,416.	Burrows,* Aug. 14, '55.	73,147.	Wetherill, Jan. 7, '68.
13,431.	Jones, Aug. 14, '55.	83,643.	Lees, Nov. 3, '68.
13,806.	Wetherill, Nov. 13, '55.	95,484.	Jones, Oct. 5, '69.
15,448.	Wharton, July 29, '56.	108,965.	Burrows, Nov. 8, '70.
15,830.	Wetherill, Sept. 30, '56.	138,684.	Osgood, May 6, '73.
16,594.	Kent, Feb. 10, '57.	136,685.	Osgood, May 6, '73.
20,655.	Monnier, June 22, '58.	139,701.	Bartlett, June 10, '73.
		142,571.	Lang, Sept. 9, '73.
		145,976.	Trotter, Dec. 30, '73.

* Extended. † Patented in England.

See also WHITE-LEAD.

Zir-co′ni-a Light. One in which a stick of oxide of zirconium is exposed to the flame of oxyhydrogen gas. Invented by Tessié du Motay. It is said to be entirely unaltered by the heat, and to develop more intense light than any other terrous oxide.

Zir-co′ni-um. A rare metal obtained from the minerals zircon and hyacinth by Berzelius in 1824.

Zith′ern. An Austrian musical instrument of the

lute order. It has twenty-eight strings, lies on the table or in the lap, and is played by both hands.

Zo'cle. 1. A low, plain, square member or plinth supporting a column.

2. A short pedestal; a footstool. *Socle.*

Zo'e-trope. This mechanical toy, like the *thaumatrope*, which amused the preceding generation, depends for its interest upon the constancy of visual impressions. See also ANORTHOSCOPE; PHENAKISTOSCOPE; STROBOSCOPE; ROTASCOPE; etc.

It consists of a rotating drum, open at the top, in which, around its inner periphery, are placed strips of paper having figures of men, animals, etc., in varying positions. By turning the cylinder, the images are seen through slots in its upper side, giving the effect of action to the figures. For instance, a porpoise is represented in perhaps a dozen different positions. The turning of the drum brings into view, in rapid succession, the varying positions of the fish until they blend into a perfect image full of motion, and operating to simulate the natural action of the animal.

A man sawing wood, an animal kicking, a clown jumping through a hoop, an acrobat playing with clubs, are thus shown in apparent motion.

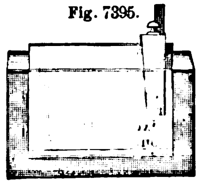
It is described in a paper by W. G. Horner, in the "Philosophical Magazine," January, 1834, "On the Properties of the *Dædaleum*, a new Instrument of Optical Illusion." See also Lincoln's patent, No. 64,117, April 23, 1867.

Its action depends upon the persistence of visual impressions. It is a cylinder rotating on a vertical shaft, and having vertical slits in the sides, through which are viewed the pictures, which are on strips placed around the inside of the cylinder. The vision is interrupted by the spaces between the embrasures, and the object consists of a figure or group, in a series of successive attitudes, which, viewed consecutively, without appreciable interval, appear as a single moving object.

Zo-oph'o-rus. (*Architecture.*) The *frieze;* so called on account of the ornaments carved on it, among which are the figures of animals.

Zo'o-phyte-trough. A device for retaining living zoophytes or infusoriæ, which are to be examined under the microscope.

Fig. 7395.



Zoophyte-Trough.

The two sides are of glass, and it has a glass false bottom sufficiently narrow to admit the edges of two glass plates between it and the sides. This is movable, so that one of the plates may be inserted on each side, forming a reservoir for the water containing the zoophytes. The upper edges of the plates are pressed together by a spring, but may be separated as far as desired by a wedge.

Zu-mom'e-ter. An instrument like a hydrometer, to show the condition of fermenting mash.

Zu-mo-sim'e-ter. See ZUMOMETER.

Zy-mom'e-ter. A measurer of the degree of fermentation.

Zy-mo-sim'e-ter. An instrument for detecting the condition and process of fermenting wort or mash. *Zymometer.*